

## Modbus Master to SDI 12 Slave Converter

The TBS09S is a converter to connect SDI-12 sensors to a Modbus master. It can control multiple SDI12 sensors in parallel by individually addressing the connected SDI-12 sensors.



TBS09S Modbus Master to SDI 12 Slave Converter

### Features

- Modbus Master to SDI 12 Slave Converter
- Multiple SDI-12 sensors can be connected
- SDI-12 Standard V1.3
- Modbus RTU, 19200 baud
- Switched sensor supply voltage output
- 5 - 16V supply voltage
- 6mA current consumption when active

- 20 $\mu$ A in idle, 4mA in active mode
- Operating Temperature Range:  
- 40°C ... + 80°C

### Target Applications

- SDI-12 sensor networks with Modbus controller

# Modbus Master to SDI-12 Slave Converter

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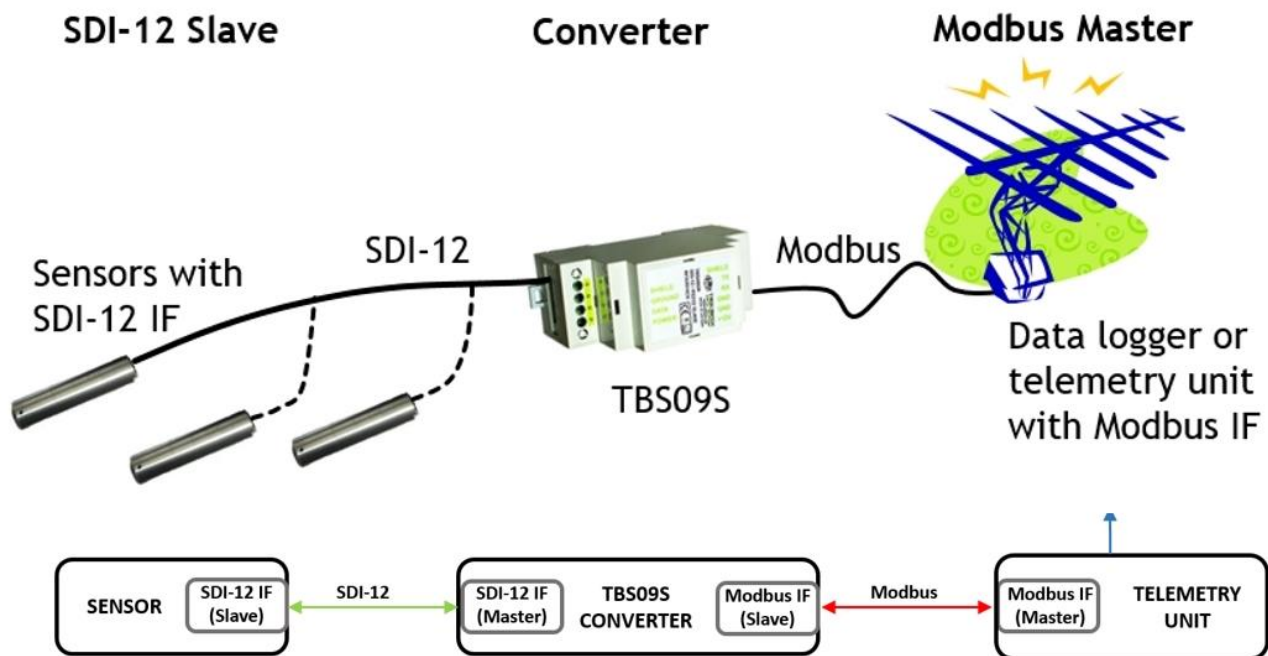
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# Modbus Master to SDI-12 Slave Converter

## 1 Introduction

The TBS09S is a converter to connect one or multiple SDI-12 sensors to a Modbus device such as a data logger or telemetry unit. The converter is inserted in between the data logger or RTU with Modbus interface and the sensor(s) with SDI-12 interface. The designation Modbus Master to SDI-12 Slave is ambiguous. Looking purely at the converter, the device got a Modbus slave interface on one side and a SDI-12 master output at the other side. However looking at its application, the device is a converter between a Modbus master (data logger, RTU, etc.) and a SDI-12 slave (sensor with SDI-12 interface).

The following diagrams describe a typical use of TBS09S module that bridges a Modbus telemetry unit with a SDI-12 sensor and highlight how the internal TBS09S Modbus/SDI-12 layers interact with them.



TBS09S application

## 2 Product specification

- Application: converter used to interface Modbus master devices (eg RTU) with SDI-12 slave devices (eg sensors)
  - The converter embeds a Modbus slave and a SDI-12 master modules
- SDI-12 compatibility:
  - Version: v1.3
  - SDI-12 commands not supported: a!, a!, aV!, aRx!, aRCx!
  - Data command supports up to 10 measurements maximum
- Modbus compatibility:

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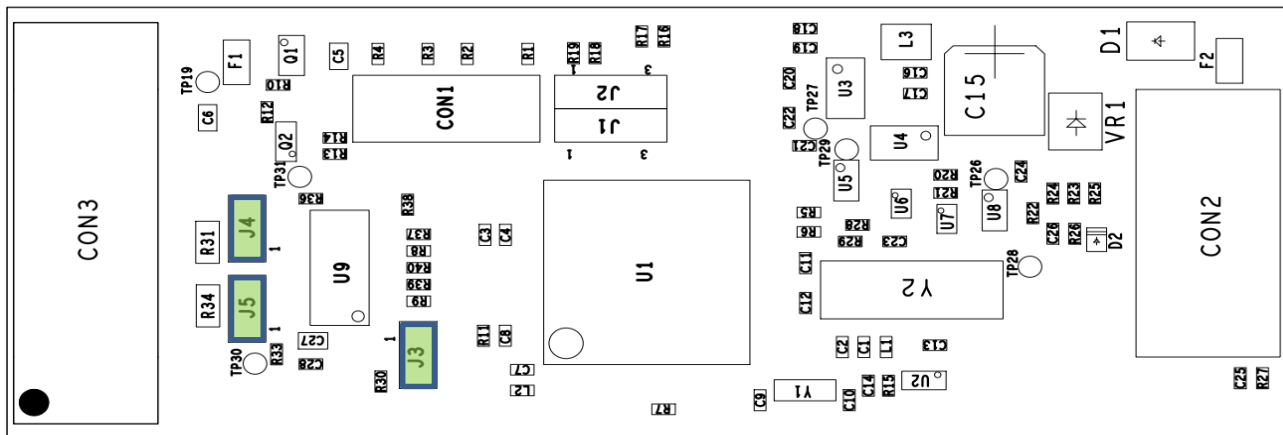
- Modbus RTU
- Baud rate: 19200
- Half or full duplex (configurable)
- 120 Ω termination (configurable)
- Supply voltage: 5 – 16 V
- Power consumption
  - Active mode: 4 mA
  - Idle mode: 20μA
- Form factor: DINRAIL

### 3 Calibration and settings

TBS09S doesn't require any calibration.

It comes factory-configured to operate by default in half duplex with no termination.

This configuration can be changed by the user by setting related jumpers J3/J4/J5 after lifting the housing:



Communication mode:

| Configuration | J3 |
|---------------|----|
| Half Duplex   | ✓  |
| Full Duplex   | x  |

Modbus termination:

| Configuration     | J4 – J5 |
|-------------------|---------|
| 120 Ω termination | ✓       |
| No termination    | x       |

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### 4 Connections

TBS09S provides one 4 slots connector (SDI-12) and one 6 slots connector (RS485):



SDI-12 terminal assignment, from top to bottom:

| Slot name | Description                 | Comment                               |
|-----------|-----------------------------|---------------------------------------|
| Shield    | Cable shield                | Connect to sensor's cable shield      |
| Ground    | Ground                      | Connect to ground                     |
| Data      | SDI-12 data line            | Connect to SDI-12 sensor data line    |
| Power*    | TBS09S supply voltage input | Connect to +12V external power supply |

RS485 terminal assignment, from top to bottom:

| Slot name | Description | Comment   |
|-----------|-------------|---|
| T+        | TXD+ output | Connect to Modbus master RXD+   |
| T-        | TXD- output | Connect to Modbus master RXD-   |
| R+        | RXD+ input  | Connect to Modbus master TXD+ ( <b>full duplex operation only – must be left unconnected in half duplex</b> ) |
| R-        | RXD- input  | Connect to Modbus master TXD- ( <b>full duplex operation only – must</b>                                      |

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|    |   |  |
|----|---|--|
|    |   | <i>be left unconnected in half duplex)</i> |
| G  | Ground  | Connect to ground                          |
| P* | SDI-12 sensor supply voltage output (+12V, connected to the converter supply line through a high side FET switch) | Connect to SDI-12 sensor power line.       |

\*The crossed connectivity is caused by the same converter hardware being used for both the Modbus master to SDI-12 slave converter and the SDI-12 master to Modbus slave converter. This is subject to being changed in a future hardware revision.

### 5 Sending SDI-12 commands through TBS09S

SDI-12 commands are encapsulated by Modbus which acts as a communication layer.

Executing a SDI-12 command over Modbus requires sending 2 Modbus requests:

- One request with function code 6 to send the SDI-12 command
- One request with function code 4 to get the result of the executed SDI-12 command.

#### 5.1 Supported SDI-12 commands

TBS09S supports only a subset of SDI-12 commands vs SDI-12 v1.3 specification and has a limitation with respect to Send Data command.

The following commands are supported:

|  |                 |
|--|-----------------|
| Address Query                                      | ?!              |
| Change Address                                     | aAb!            |
| Start Measurement                                  | aM!             |
| Start Measurement and Request CRC                  | aMC!            |
| Additional Measurements                            | aM1! ... aM9!   |
| Additional Measurements and Request CRC            | aMC1! ... aMC9! |
| Start Concurrent Measurement                       | aC!             |
| Start Concurrent Measurement and Request CRC       | aCC!            |
| Additional Concurrent Measurements                 | aC1! ... aC9!   |
| Additional Concurrent Measurements and Request CRC | aCC1! ... aCC9! |
| Send Data (*)                                      | aD0! ... aD9!   |

Supported SDI-12 address range is aligned with SDI-12 v1.3 specification:

- 0 – 9

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- a – z
- A – Z

(\*): Send Data aD0!...aD9! supports only up to 10 measurements irrespective of the maximum number of characters that can be returned (75 for a concurrent measurement command, 35 otherwise).

### 5.2 Modbus default configuration and frames format

#### 5.2.1 Default configuration

TBS09S uses following Modbus configuration:

- Protocol: Modbus RTU
- Baud rate: 19200, Parity: none
- Modbus slave address: 1 (default). It is configurable via Modbus Address Change request within 0x01-0xFF range

#### 5.2.2 Modbus master to TBS09S: Modbus request format

All Modbus requests sent by the Modbus master (Modbus data logger, Modbus RTU) to TBS09S must be formatted as described in following table as per Modbus specification.

Each field represents one byte in hexadecimal:

|                              |
|------------------------------|
| <b>Modbus Master request</b> |
| Slave Address                |
| Function                     |
| Starting Address Hi          |
| Starting Address Lo          |
| Data Hi                      |
| Data Lo                      |
| Error Check Lo (CRC)         |
| Error Check Hi (CRC)         |

TBS09S uses only Modbus requests with function codes 4 or 6 depending on the command's purpose.

The CRC must be calculated as per Modbus RTU standard (please note the less significant CRC byte is stored first and followed by the most significant CRC byte).

Online calculators can be used for this, like <https://www.lammertbies.nl/comm/info/crc-calculation> and selecting hexadecimal input type.

#### 5.2.3 TBS09S to Modbus master: Modbus response format

Each field in below tables represents one byte.

*Generic response to a Modbus request with function code 4*

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|  |
|--|
| <b>Modbus Slave response (TBS09S)</b>                          |
| Slave Address<br><i>(TBS09S Modbus address)</i>                |
| 04   |
| Byte Count<br><i>(2*N, N is the number of Input Registers)</i> |
| Input Register 1 Hi  |
| Input Register 1 Lo  |
| ...  |
| Input Register N Hi  |
| Input Register N Lo  |
| Error Check Lo (CRC)   |
| Error Check Hi (CRC)   |

Generic response to a Modbus request with function code 6

|   |
|---|
| <b>Modbus Slave response (TBS09S)</b>           |
| Slave Address<br><i>(TBS09S Modbus address)</i> |
| 06  |
| Register Address Hi                             |
| Register Address Lo                             |
| Register Value Hi                               |
| Register Value Lo                               |
| Error Check Lo (CRC)                            |
| Error Check Hi (CRC)                            |

Note: in this case, the response is the mirror of the corresponding request.

### 5.3 TBS09S Modbus registers mapping

All available SDI-12 commands that can be sent over Modbus are mapped over a set of registers.

The following table lists all TBS09S Modbus registers with their associated commands ('a' refers to SDI-12 address as per SDI-12 standard and is subsequently used as is in this document):

| Register Address                     | Command                     | Description                  |
|--------------------------------------|-----------------------------|------------------------------|
| <b>Modbus configuration commands</b> |                             |                              |
| 0xB000                               | Modbus slave address change | Change TBS09S Modbus address |
| <b>SDI-12 commands</b>               |                             |                              |
| 0xA000                               | ?!                          | Address Query command        |
| 0xA100                               | aAb!                        | Change Address command       |
| 0x0010                               | aM!                         | Start Measurement            |
| 0x0011                               | aM1!                        | Additional Measurements      |
| 0x0012                               | aM2!                        | Additional Measurements      |

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|        |       |   |
|--------|-------|---|
| 0x0013 | aM3!  | Additional Measurements                 |
| 0x0014 | aM4!  | Additional Measurements                 |
| 0x0015 | aM5!  | Additional Measurements                 |
| 0x0016 | aM6!  | Additional Measurements                 |
| 0x0017 | aM7!  | Additional Measurements                 |
| 0x0018 | aM8!  | Additional Measurements                 |
| 0x0019 | aM9!  | Additional Measurements                 |
| 0x0020 | aMC!  | Additional Measurements and Request CRC |
| 0x0021 | aMC1! | Additional Measurements and Request CRC |
| 0x0022 | aMC2! | Additional Measurements and Request CRC |
| 0x0023 | aMC3! | Additional Measurements and Request CRC |
| 0x0024 | aMC4! | Additional Measurements and Request CRC |
| 0x0025 | aMC5! | Additional Measurements and Request CRC |
| 0x0026 | aMC6! | Additional Measurements and Request CRC |
| 0x0027 | aMC7! | Additional Measurements and Request CRC |
| 0x0028 | aMC8! | Additional Measurements and Request CRC |
| 0x0029 | aMC9! | Additional Measurements and Request CRC |
| 0x0030 | aC!   | Start Concurrent Measurements           |
| 0x0031 | aC1!  | Additional Concurrent Measurements      |
| 0x0032 | aC2!  | Additional Concurrent Measurements      |
| 0x0033 | aC3!  | Additional Concurrent Measurements      |
| 0x0034 | aC4!  | Additional Concurrent Measurements      |
| 0x0035 | aC5!  | Additional Concurrent Measurements      |
| 0x0036 | aC6!  | Additional Concurrent Measurements      |
| 0x0037 | aC7!  | Additional Concurrent Measurements      |
| 0x0038 | aC8!  | Additional Concurrent Measurements      |

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|        |       |  |
|--------|-------|--|
| 0x0039 | aC9!  | Additional Concurrent Measurements                 |
| 0x0040 | aCC!  | Additional Concurrent Measurements and Request CRC |
| 0x0041 | aCC1! | Additional Concurrent Measurements and Request CRC |
| 0x0042 | aCC2! | Additional Concurrent Measurements and Request CRC |
| 0x0043 | aCC3! | Additional Concurrent Measurements and Request CRC |
| 0x0044 | aCC4! | Additional Concurrent Measurements and Request CRC |
| 0x0045 | aCC5! | Additional Concurrent Measurements and Request CRC |
| 0x0046 | aCC6! | Additional Concurrent Measurements and Request CRC |
| 0x0047 | aCC7! | Additional Concurrent Measurements and Request CRC |
| 0x0048 | aCC8! | Additional Concurrent Measurements and Request CRC |
| 0x0049 | aCC9! | Additional Concurrent Measurements and Request CRC |

### 5.4 TBS09S Modbus requests detailed description

Following tables show each defined Modbus requests and the corresponding response format along with an example.

All fields represent a byte coded in hexadecimal.

#### 5.4.1 Modbus slave address change

| Register address             | Command   |                                | Description                  |
|------------------------------|---|--------------------------------|------------------------------|
| 0xB000                       | Modbus slave address change                       |                                | Change TBS09S Modbus address |
| Modbus Master request format | Example: change TBS09S Modbus address from 1 to 2 |                                | Modbus Slave response format |
|                              | Modbus Master request                             | Modbus Slave (TBS09S) response |                              |
| TBS09S Modbus Address        | 01  | 01                             | TBS09S Modbus Address        |
| 06                           | 06  | 06                             | 06                           |
| B0                           | B0  | B0                             | B0                           |
| 00                           | 00  | 00                             | 00                           |
| 00                           | 00  | 00                             | 00                           |
| New TBS09S Modbus Address    | 02  | 02                             | New TBS09S Modbus Address    |

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|                           |    |    |                      |
|---------------------------|----|----|----------------------|
| <i>Range: 0x01 – 0xFF</i> |    |    |                      |
| Error Check Lo (CRC)      | 2E | 2E | Error Check Lo (CRC) |
| Error Check Hi (CRC)      | CB | CB | Error Check Hi (CRC) |

### 5.4.2 Query sensor's SDI-12 address (SDI-12 command: ?!)

Send SDI-12 ?! command

| Register address             | Command  |                                | Description                  |
|------------------------------|--|--------------------------------|------------------------------|
| 0xA000                       | Query sensor's SDI-12 address                  |                                | Sends ?! SDI-12 command      |
| Modbus Master request format | Example: returned sensor's SDI-12 address is 2 |                                | Modbus Slave response format |
|                              | Modbus Master request                          | Modbus Slave (TBS09S) response |                              |
| TBS09S Modbus Address        | 01   | 01                             | TBS09S Modbus Address        |
| 06                           | 06   | 06                             | 06                           |
| A0                           | A0   | A0                             | A0                           |
| 00                           | 00   | 00                             | 00                           |
| 00                           | 00   | 00                             | 00                           |
| 00                           | 00   | 00                             | 00                           |
| Error Check Lo (CRC)         | AB   | AB                             | Error Check Lo (CRC)         |
| Error Check Hi (CRC)         | CA   | CA                             | Error Check Hi (CRC)         |

Read returned SDI-12 address

| Register address             | Command  |   | Description  |
|------------------------------|--|---|--|
| 0xA000                       | Read ?! response                               |   | Read sensor's SDI-12 address                         |
| Modbus Master request format | Example: returned sensor's SDI-12 address is 2 |   | Modbus Slave response format                         |
|                              | Modbus Master request                          | Modbus Slave (TBS09S) response                  |  |
| TBS09S Modbus Address        | 01   | 01  | TBS09S Modbus Address                                |
| 04                           | 04   | 04  | 04   |
| A0                           | A0   | 02  | 02   |
| 00                           | 00   | 32<br>(ASCII code: 0x32 =><br>SDI-12 address=2) | SDI-12 Address<br>(represented by its ASCII<br>code) |
| 00                           | 00   | 00  | 00   |
| 00                           | 01   | AC  | Error Check Lo (CRC)                                 |
| Error Check Lo (CRC)         | 13   | 50  | Error Check Hi (CRC)                                 |
| Error Check Hi (CRC)         | CA   |   |  |

## Modbus Master to SDI-12 Slave Converter

### 5.4.3 Change sensor's SDI-12 address (SDI-12 command: aAb!)

Send SDI-12 aAb! command

| Register address  | Command                                      |                                | Description   |
|---|--|--------------------------------|---|
| 0xA100  | Change sensor's SDI-12 address               |                                | Sends aAb! SDI-12 command                                 |
| Modbus Master request format                              | Example: change SDI-12 address from 3 to 4   |                                | Modbus Slave response format                              |
|   | Modbus Master request                        | Modbus Slave (TBS09S) response |   |
| TBS09S Modbus Address                                     | 01   | 01                             | TBS09S Modbus Address                                     |
| 06  | 06   | 06                             | 06  |
| A1  | A1   | A1                             | A1  |
| 00  | 00   | 00                             | 00  |
| Current SDI-12 Address<br>(represented by its ASCII code) | 33<br>(ASCII code: 0x33 => SDI-12 address=3) | 33                             | Current SDI-12 Address<br>(represented by its ASCII code) |
| New SDI-12 Address<br>(represented by its ASCII code)     | 34<br>(ASCII code: 0x34 => SDI-12 address=4) | 34                             | New SDI-12 Address<br>(represented by its ASCII code)     |
| Error Check Lo (CRC)                                      | BF   | BF                             | Error Check Lo (CRC)                                      |
| Error Check Hi (CRC)                                      | 11   | 11                             | Error Check Hi (CRC)                                      |

### 5.4.4 SDI-12 Measurement (SDI-12 commands: aM!/aMC!/aMx!/aMCx!/aC!/aCC!/aCCx!)

The procedure is similar to a regular SDI-12 communication to get sensor's measurements, except that the SDI-12 commands are sent over Modbus.

This implies:

- Send a SDI-12 measurement command (aM!/aMC!/aMx!/aMCx!/aC!/aCC!/aCCx!)
- Get the specified time (ttt) and the number of measurement values (n / nn)
- Send the SDI-12 data command (aD0! ... aD9!)
- Retrieve the measurements

#### Step 1 - Send a Measurement Command to the SDI-12 sensor:

TBS09S can transmit any of the following measurement commands to a SDI-12 sensor: aM!...aM9, aMC!...aMC9!, aC!..aC9!, aCC!..aCC9!

Note: refer to [TBS09S Modbus registers mapping](#) for a complete list of supported SDI-12 commands and the corresponding register address.

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- Send SDI-12 measurement command(aM!/aMC!/aMx!/aMCx!/aC!/aCC!/aCCx!)

| Register address   | Command  |                                | Description  |
|--|--|--------------------------------|--|
| <a href="#">SDI-12 register address</a>                  | <a href="#">SDI-12 Measurement Command</a>             |                                | <a href="#">aM!/aMC!/aMx!/aMCx!/aC!/aCC!/aCCx!</a>       |
| Modbus Master request format                             | Example: send SDI-12 command bM!                       |                                | Modbus Slave response format                             |
|  | Modbus Master request                                  | Modbus Slave (TBS09S) response |  |
| TBS09S Modbus Address                                    | 01   | 01                             | TBS09S Modbus Address                                    |
| 06   | 06   | 06                             | 06   |
| SDI-12 command register address Hi                       | 00<br><i>(M! register address Hi)</i>                  | 00                             | SDI-12 command register address Hi                       |
| SDI-12 command register address Lo                       | 10<br><i>(M! register address Lo)</i>                  | 10                             | SDI-12 command register address Lo                       |
| 00   | 00   | 00                             | 00   |
| SDI-12 address<br><i>(represented by its ASCII code)</i> | 62<br><i>(ASCII code: 0x62 =&gt; SDI-12 address=b)</i> | 62                             | SDI-12 address<br><i>(represented by its ASCII code)</i> |
| Error Check Lo (CRC)                                     | 09   | 09                             | Error Check Lo (CRC)                                     |
| Error Check Hi (CRC)                                     | E6   | E6                             | Error Check Hi (CRC)                                     |

### Step 2 – Get the specified time and the number of measurements

As per SDI-12 standard, the measurements commands will return the specified time and the number of measurement values:

- M!/MC!/M1!...M9!/MC1!...MC9!
  - Specified time: ttt
  - Number of measurement values: n
- C!/CC!/C1!...C9!/CC1!...CC9!
  - Specified time: ttt
  - Number of measurement values: nn

| Register address   | Command                                   |                                | Description   |
|--|---|--------------------------------|---|
| 0xmm10<br><i>(mm: SDI-12 address ASCII code)</i>         | Read SDI-12 measurement command response  |                                | Read Specified time (ttt) and Number of Measurements (n/nn) |
| Modbus Master request format                             | Example: time=1s and 2 measurement values |                                | Modbus Slave response format                                |
|  | Modbus Master request                     | Modbus Slave (TBS09S) response |   |
| TBS09S Modbus Address                                    | 01  | 01                             | TBS09S Modbus Address                                       |
| 04   | 04  | 04                             | 04  |
| SDI-12 address<br><i>(represented by its ASCII code)</i> | 62<br><i>(ASCII code 0x62 =&gt;</i>       | 04                             | 04  |

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|                      |                          |    |                             |
|----------------------|--------------------------|----|-----------------------------|
|                      | <i>SDI-12 address=b)</i> |    |                             |
| 10                   | 10                       | 00 | 00                          |
| 00                   | 00                       | 01 | Specified time ttt          |
| 02                   | 02                       | 00 | 00                          |
| Error Check Lo (CRC) | 6F                       | 02 | Number of measurements n/nn |
| Error Check Hi (CRC) | B6                       | 2B | Error Check Lo (CRC)        |
|                      |                          | 85 | Error Check Hi (CRC)        |

### Step 3 - Send SDI-12 Data Command to the SDI-12 sensor

Send the data command (any of aD0!...aD9!):

| Register address  | Command                                      |                                | Description   |
|---|--|--------------------------------|---|
| 0x00Dm (m: 0 to 9)  | Send SDI-12 Data command                     |                                | Send aDm! (m: 0 to 9)                                     |
| Modbus Master request format                              | Example: send SDI-12 data command bD0!       |                                | Modbus Slave response format                              |
|   | Modbus Master request                        | Modbus Slave (TBS09S) response |   |
| TBS09S Modbus Address                                     | 01   | 01                             | TBS09S Modbus Address                                     |
| 06  | 06   | 06                             | 06  |
| 00  | 00   | 00                             | 00  |
| SDI-12 Data Command<br>(D0! To D9! coded as 0xD0 to 0xD9) | D0<br>(0xD0 => D0! Data command)             | D0                             | SDI-12 Data Command<br>(D0! To D9! coded as 0xD0 to 0xD9) |
| 00  | 00   | 00                             | 00  |
| SDI-12 address<br>(represented by its ASCII code)         | 62<br>(ASCII code: 0x62 => SDI-12 address=b) | 62                             | SDI-12 address<br>(represented by its ASCII code)         |
| Error Check Lo (CRC)                                      | 09   | 09                             | Error Check Lo (CRC)                                      |
| Error Check Hi (CRC)                                      | DA   | DA                             | Error Check Hi (CRC)                                      |

### Step 4 – Retrieve the measurements

The Send Data command is implemented in TBS09S so it can handle up to 10 values (this is a limitation vs SDI-12 v1.3 standard).

aDx! will then return a maximum of 10 measurements as follows:

a<Value0><Value1><Value2><Value3><Value4><Value5><Value6><Value7><Value8><Value9>

Each value is identified by its index:

|       |        |        |        |        |        |        |        |        |        |        |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Value | Value0 | Value1 | Value2 | Value3 | Value4 | Value5 | Value6 | Value7 | Value8 | Value9 |
| Index | 0x00   | 0x01   | 0x02   | 0x03   | 0x04   | 0x05   | 0x06   | 0x07   | 0x08   | 0x09   |

and is stored in hexadecimal floating point over 4 bytes (0xByte3Byte2Byte1Byte0) and must be then individually fetched with a specific modbus request.

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### Retrieve a measurement

| Register address   | Command  |                                | Description                  |
|--|--|--------------------------------|------------------------------|
| 0xmmii<br>mm: SDI-12 address<br>ASCII code, ii: value index<br>(0x00-0x09) | Retrieve aDx! value  |                                | Return aDx! value at index   |
| Modbus Master request format   | Example: retrieve the 6 <sup>th</sup> value returned by bD0!           |                                | Modbus Slave response format |
|  | Modbus Master request  | Modbus Slave (TBS09S) response |                              |
| TBS09S Modbus Address  | 01   | 01                             | TBS09S Modbus Address        |
| 04   | 04   | 04                             | 04                           |
| SDI-12 address<br>(represented by its ASCII code)                          | 62<br>(ASCII code 0x62 =><br>SDI-12 address=b)                         | 04                             | 04                           |
| Value Index<br>(00x00 to 0x09)   | 05<br>(0x05 => index of the 6 <sup>th</sup><br>value returned by bD0!) | 41                             | Value – Byte3                |
| 00   | 00   | CF                             | Value – Byte 2               |
| 02   | 02   | 1E                             | Value – Byte 1               |
| Error Check Lo (CRC)   | 7E   | B8                             | Value – Byte 0               |
| Error Check Hi (CRC)   | 72   | D6                             | Error Check Lo (CRC)         |
|  |  | 55                             | Error Check Hi (CRC)         |

The above example shows how to read the 6<sup>th</sup> measurement from a temperature sensor with SDI-12 interface.

The hexadecimal floating point value is 0x41CF1EB8; once converted to decimal representation this results in +25.89°C.

Online hexadecimal floating point to decimal converters can be used to make the measurement readable like <https://www.h-schmidt.net/FloatConverter/IEEE754.html>

### 5.5 TBS09S / SDI-12 sensor communication flow example

The below example shows how to measure and read the soil moisture and soil temperature over Modbus by using SDI-12 TBSMP03 Tekbox sensor (<https://www.tekbox.com/product/tbsmp03-sdi-12-soil-moisture-temperature-probe/>) connected to TBS09S.

With this test setup:

- TBS09S Modbus slave address is 1
- TBSMP03 SDI-12 address is 0
- TBSMP03 returns 2 parameters, soil temperature first and then the soil moisture

## Modbus Master to SDI-12 Slave Converter

|                               |                                |   |
|-------------------------------|--------------------------------|---|
| <b>[Modbus Master]</b>        | <b>01 06 00 11 00 30 D9 DB</b> | <b>Modbus Master sends 0M1! to the sensor</b>                     |
| [TBS09S]                      | 01 06 00 11 00 30 D9 DB        | TBS09S responds with ACK  |
| <b>[Modbus Master]</b>        | <b>01 04 30 10 00 02 7F 0E</b> | <b>Modbus Master reads ttt and n</b>                              |
| [TBS09S]                      | 01 04 04 00 01 00 02 2B 85     | TBS09S returns ttt=1s and n=2 values                              |
| <i>Modbus Master waits 1s</i> |                                |   |
| <b>[Modbus Master]</b>        | <b>01 06 00 D0 00 30 88 27</b> | <b>Modbus Master sends 0D0! to the sensor</b>                     |
| [TBS09S]                      | 01 06 00 D0 00 30 88 27        | TBS09S responds with ACK  |
| <b>[Modbus Master]</b>        | <b>01 04 30 00 00 02 7E CB</b> | <b>Modbus Master reads 1<sup>st</sup> parameter (moisture)</b>    |
| [TBS09S]                      | 01 04 04 41 2D 99 99 8B FF     | TBS09S response data = 41,2D,99,99 =10.85                         |
| <b>[Modbus Master]</b>        | <b>01 04 30 01 00 02 2F 0B</b> | <b>Modbus Master reads 2<sup>nd</sup> parameter (temperature)</b> |
| [TBS09S]                      | 01 04 04 41 DB 70 A4 F8 FF     | TBS09S response data = 41,DB,70,A4 = 27.43                        |

## 6 SDI-12

SDI-12 is a standard for interfacing data recorders with microprocessor-based sensors. SDI-12 stands for serial/digital interface at 1200 baud. It can connect multiple sensors with a single data recorder on one cable. It supports up to 60 meter cable between a sensor and a data logger.

The SDI-12 standard is prepared by

**SDI-12 Support Group  
(Technical Committee)  
165 East 500 South  
River Heights, Utah  
435-752-4200  
435-752-1691 (FAX)  
<http://www.sdi-12.org>**

The latest standard is version V1.4 which dates from Jan 10<sup>th</sup>, 2019. The standard is available on the website of the SDI-12 Support Group.

## 7 History

| Version | Date      | Author     | Changes   |
|---------|-----------|------------|---|
| V1.0    | 9.8.2018  | Thinh      | Creation of the document                                  |
| V1.1    | 9.19.2019 | Thinh      | Update new command  |
| V1.5    | 24.6.2020 | Hoa Hoang  | Updated naming to Modbus Master to SDI 12 Slave Converter |
| V1.6    | 15.7.2020 | Mayerhofer | Complete rework of the document                           |
| V1.7    | 17.7.2020 | Philippe   | Updated link in 5.5                                       |
| V1.8    | 2.4.2021  | Mayerhofer | Updated drawing in chapter 1                              |