

## Modbus Master to SDI 12 Slave Converter

The TBS09S is a converter to connect to a SDI-12 sensors to Modbus. It can connect multiple sdi12 sensors in parallel by setting the corresponding address.



TBS09S Modbus Master to SDI 12 Slave Converter

### Features

- Modbus Master to SDI 12 Slave Converter
- Multiple sensors can be connected
- SDI-12 Standard V1.3
- Highly configurable
- Switched sensor supply voltage output
- 6 - 16V supply voltage
- 7mA current consumption when active

- Less than 100µA idle current
- Operating Temperature Range:  
- 40°C ... + 80°C

### Target Applications

- SDI-12 sensor networks

# Modbus Master to SDI 12 Slave Converter

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# Modbus Master to SDI 12 Slave Converter

## 1 Introduction

The TBS09S is a converter to connect one or multiple sdi12 sensors to a modbus device such as a data logger or telemetry unit.

User will use it when they got RTU support modbus and they want using it to read data of sdi12 sensors.

## 2 Connections

### RS485 Side, from left to right:

- TX+ output (or half duplex)
- TX- output (or half duplex)
- RX+ input
- RX- input
- Ground
- 12V, switched sensor supply voltage

### SDI-12 Side, from left to right:

- Cable shield
- Ground
- SDI-12 Data line
- SDI-12 Supply voltage



Figure 1 – TBS09S terminals

### **4 Pin terminal block:**

CON1 – SDI-12 Interface

*Shield:* connect to the shield of the SDI-12 cable or leave it unconnected; shield and ground are internally connected together

*Ground:* connect to the GND wire of the SDI-12 cable

*SDI-12 data:* connect to the data wire of the SDI-12 cable

*SDI-12 Power:* connect to the positive supply voltage wire of the SDI-12 cable;

### **6 Pin terminal block:**

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CON2 – Power supply & RS485 (Modbus) interface

*TX+*, connect to *RX+* of the Modbus Sensor; half duplex

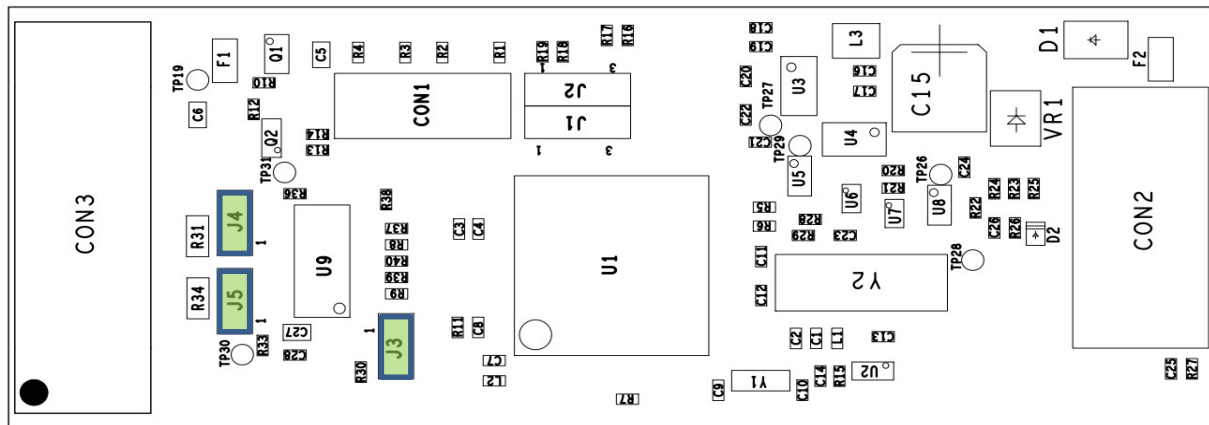
*TX-*, connect to *RX-* of the Modbus Sensor; half duplex

*RX+*, connect to *TX+* of the Modbus Sensor

*RX-*, connect to *RX-* of the Modbus Sensor

*Ground*, connected to the GND of the SDI-12 supply for TBS09S

*+12V*, supply output for the Modbus sensor. It is connected to the SDI-12 supply line, with a high side FET switch and a 700mA fuse in between. The switch can either be controlled by SDI-12 (ON-time determined by the warm-up time setting) or it can be configured to be permanently on.



Default J4 and J5 jumpered - Modbus terminated with 120Ω  
Default J3 jumpered – half duplex

Figure 2 – TBS09S jumpers

## 3 Measurement

### 3.1 General configuration commands

TBS09S is default with baudrate: 19200, **Parity: None = 0**  
Modbus slave address : 1

#### Modbus slave settings

Slave Address Register: 0xB000

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Modbus command:

Modbus Master send	Example (Hex)	Modbus Slave(TBS09S) response
Slave Address	01- current addr	01
Function	06	06
Starting Address Hi	B0	00
Starting Address Lo	00	00
Data Hi	00	00
Data Lo	02 - new addr	02
Error Check (LRC or CRC)	2 bytes CRC	2 bytes CRC

Modbus address: 0x01 -> 0xFF

### Query sensor address ?!

Sdi12 sensor Address Register: 0xA000

Modbus command:

Modbus Master send	Example (Hex)	Modbus Slave(TBS09S) response
Slave Address	01	01
Function	06	06
Starting Address Hi	A0	00
Starting Address Lo	00	00
Data Hi	00	00
Data Lo	00	02
Error Check (LRC or CRC)	2 bytes CRC	2 bytes CRC

That command will send ?! to sensor, after that using second command to read out the data:

## Modbus Master to SDI 12 Slave Converter

Modbus command:

Modbus Master send	Example (Hex)	Modbus Slave(TBS09S) response
Slave Address	01	01
Function	04	04
Starting Address Hi	A0	02
Starting Address Lo	00	Sdi sensor address
Data Hi	00	00
Data Lo	01- read 1 register	
Error Check (LRC or CRC)	2 bytes CRC	2 bytes CRC

Data response is 2 bytes, that is the sdi12 sensor address is connected.

### **Change sdi12 sensor address aAb!**

Slave Address Register: 0xA100

Modbus command:

Modbus Master send	Example (Hex)	Modbus Slave(TBS09S) response
Slave Address	01	01
Function	06	06
Starting Address Hi	A1	00
Starting Address Lo	00	00
Data Hi	03- current addr	00
Data Lo	04 - new addr	02
Error Check (LRC or CRC)	2 bytes CRC	2 bytes CRC

That command is Change Address aAb!, with Data Hi is old address, Data Lo is new address

### 3.2 Measurement commands

When user want read data from sdi12 sensors, please following 3 steps:

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### 3.2.1 Send measurement command to sdi12 sensors:

TBS09S will send measurement command to sdi12 sensor: aM!...aM9, aMC!...aMC9!, aC!...aC9!, aCC!...aCC9!

Register map:

sdi12 command	register	sdi12 command	register	sdi12 command	register	sdi12 command	register
aM!	0x0010	aMC!	0x0020	aC!	0x0030	aCC!	0x0040
aM1!	0x0011	aMC1!	0x0021	aC1!	0x0031	aCC1!	0x0041
aM2!	0x0012	aMC2!	0x0022	aC2!	0x0032	aCC2!	0x0042
aM3!	0x0013	aMC3!	0x0023	aC3!	0x0033	aCC3!	0x0043
aM4!	0x0014	aMC4!	0x0024	aC4!	0x0034	aCC4!	0x0044
aM5!	0x0015	aMC5!	0x0025	aC5!	0x0035	aCC5!	0x0045
aM6!	0x0016	aMC6!	0x0026	aC6!	0x0036	aCC6!	0x0046
aM7!	0x0017	aMC7!	0x0027	aC7!	0x0037	aCC7!	0x0047
aM8!	0x0018	aMC8!	0x0028	aC8!	0x0038	aCC8!	0x0048
aM9!	0x0019	aMC9!	0x0029	aC9!	0x0039	aCC9!	0x0049

Modbus command:

Modbus Master send	Example (Hex)	Modbus Slave(TBS09S) response
Slave Address	01	01
Function	06	06
Starting Address Hi	00	00
Starting Address Lo	10	00
Data Hi	00	00
Data Lo(sdi12 address)	30 – sdi12 sensor address	30
Error Check (LRC or CRC)	2 bytes CRC	2 bytes CRC

TBS09S support total 62 sdi12 sensors. Data Lo byte is hex value of sensor address('0' = 0x30, '1' = 0x31.....)

#### Read time and number measurement:

After send measurement command, user can read : ttt - the specified time, nn - the number of measurement values the sensor will make and return in response to one or more subsequent D commands

Register map:

sdi12 sensor#	register
---------------	----------

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0	0x3010
1	0x3110
2	0x3210
3	0x3310
4	0x3410
5	0x3510
6	0x3610
7	0x3710
8	0x3810
9	0x3910
any	0xZZ10

ZZ is the hex value of sensor address, base on ASCII

Modbus command:

Modbus Master send	Example (Hex)	Modbus Slave(TBS09S) response
Slave Address	01	01
Function	04	04
Starting Address Hi	30	04
Starting Address Lo	10	00
Data Hi	00	01 - ttt time
Data Lo	02 - read 2 registers	00
Error Check (LRC or CRC)	2 bytes CRC	02 -nn number
		2 bytes CRC

Data response is 4 bytes, 2 bytes - the specified time + 2 bytes - the number of measurement values

### 3.2.2 Send Data command to sdi12 sensors:

TBS09S will send data command to sdi12 sensor: aD0!...aD9!

Register map:

sdi12 command	register
aD0!	0x00D0
aD1!	0x00D1
aD2!	0x00D2



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aD3!	0x00D3
aD4!	0x00D4
aD5!	0x00D5
aD6!	0x00D6
aD7!	0x00D7
aD8!	0x00D8
aD9!	0x00D9

Modbus command:

Modbus Master send	Example (Hex)	Modbus Slave(TBS09S) response
Slave Address	01	01
Function	06	06
Starting Address Hi	00	00
Starting Address Lo	D0	00
Data Hi	00	00
Data Lo	30 – sdi12 sensor address	30
Error Check (LRC or CRC)	2 bytes CRC	2 bytes CRC

### 3.2.3 Modbus master get data from TBS09S:

After send sommand aMx! and aDx! to sdi12 sensors, TBS09 will store data to REGISTER DATA 0 to 9.

Sdi12 data format will be:

a+d0+d1+d2+d3+d4+d5+d6+d7+d8+d9 (maximum)

TBS09 will use 2 Registers = 4 bytes to store each data with floating format.

Register map:

sdi12 data	REG SENSOR 0	REG SENSOR 1	REG SENSOR 2	REG SENSOR--	REG SENSOR 9	REG SENSOR X
d0	0x3000	0x3100	0x3200	-	0x3900	0xZZ00
d1	0x3001	0x3101	0x3201	-	0x3901	0xZZ01
d2	0x3002	0x3102	0x3202	-	0x3902	0xZZ02
d3	0x3003	0x3103	0x3203	-	0x3903	0xZZ03

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d4	0x3004	0x3104	0x3204	-	0x3904	0xZZ04
d5	0x3005	0x3105	0x3205	-	0x3905	0xZZ05
d6	0x3006	0x3106	0x3206	-	0x3906	0xZZ06
d7	0x3007	0x3107	0x3207	-	0x3907	0xZZ07
d8	0x3008	0x3108	0x3208	-	0x3908	0xZZ08
d9	0x3009	0x3109	0x3209	-	0x3909	0xZZ09

ZZ is the hex value of sensor address, base on ASCII

Modbus command:

Modbus Master send	Example (Hex)	Modbus Slave(TBS09S) response
Slave Address	01	01
Function	04	04
Starting Address Hi	30	04
Starting Address Lo	00	41
Data Hi	00	CF
Data Lo	02 - read 2 registers	1E
Error Check (LRC or CRC)	2 bytes CRC	B8
		2 bytes CRC

This example read data from temperature sdi12 sensor.

Data 0 is floating format with 4 bytes = 0x41, 0xCF, 0x1E, 0xB8 = 25.89 (degree celsius)

Float to hex convert online: <https://www.h-schmidt.net/FloatConverter/IEEE754.html>

## Modbus Master to SDI 12 Slave Converter

### 4 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 V1.3 which dates from July 18<sup>th</sup>, 2005. The standard is available on the website of the SDI-12 Support Group.

More information on SDI-12 is presented in chapter 3.

### 5 Supported SDI-12 Commands

Following standard SDI-12 commands are supported:

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!

Example – controlling the soil moisture/temperature Sensor:

<https://www.sdi-12products.com/collections/sensors/products/sdi-12-soil-moisture-temperature-probe-tbsmp02>

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```

[TX] - 01 06 00 11 00 30 D9 DB      master send 0M1! to sensor
[RX] - 01 06 00 00 00 30 89 DE      TBS09S response ACK
[TX] - 01 06 00 D0 00 30 88 27      master send 0D0! to sensor
[RX] - 01 06 00 00 00 30 89 DE      TBS09S response ACK
[TX] - 01 04 30 00 00 02 7E CB      master read 1st parameter (moisture)
[RX] - 01 04 04 41 2D 99 99 8B FF    TBS09S response data = 41,2D,99,99 =10.85
[TX] - 01 04 30 01 00 02 2F 0B      master read 2ndparameter (temperature)
[RX] - 01 04 04 41 DB 70 A4 F8 FF    TBS09S response data = 41,DB,70,A4 = 27.43

```

Example above is measurement sdi12 moisture/temperature probe with addressed 0, modbus sensor is addressed 1.

Command to get data is: 0M1! and wait 1s to send 0D0! to get humidity+ temperature with floating format.

## 6 History

Version	Date	Author	Changes
V1.0	9.8.2018	Thin	Creation of the document
V1.1	9.19.2019	Thin	Update new command
V1.5	06.24.2020	Hoa Hoang	Update naming to Modbus Master to SDI 12 Slave Converter

Table 1 – History