# Dual Inputs SDI-12 Rain Gauge Converter

The TBSRGC2 is a 2 x 1.5V AA alkaline battery powered converter to equip tipping bucket rain gauges with data logging capability and SDI-12 interface.

The TBSRGC2 has been designed to work with any type of tipping bucket rain gauge with switch output. The TBSRGC2 has a real time clock, programmable via extended SDI-12 commands. It is easy to install and easy to configure. Additional connectivity points enable distribution of SDI-12 cables to other sensors, if required.


## Features

- SDI-12 interface
- 2x AA battery powered
- Real time clock/calendar
- Data logging
- Ultra low power consumption
- Size 80 x 120 x 57 mm
- Simple installation
- 2x pulses inputs for rain gauge or flow meter applications
- Operating Temperature Range: -40°C - +85°C

## Target Applications

- Meteorology
- Agricultural monitoring


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## 1 Introduction

The TBSRGC2 is a SDI-12 converter for standard or double tipping buckets rain gauges. It has an on board real time clock/calendar to enable precipitation logging capability.

It boast 2 pulse inputs that can be individually controlled or jointly when double tipping buckets are used.

This converter is typically used for applications where either rain precipitation or surface flow volumes need to be monitored.

## 2 Measurement

The TBSRGC2 outputs precipitation or surface flow volume depending on the configuration.

**SDI-12 Measurement Commands:**

Rain gauge input (1):

| | |
|---|---|
| aM! | Read precipitation/flow parameters |
| aMC! | Read precipitation/flow parameters – measurement with cyclic redundancy check |
| aC! | Read precipitation/flow parameters |
| aCC! | Read precipitation/flow parameters – measurement with cyclic redundancy check |

Rain gauge input (2):

| | |
|---|---|
| aM2! | Read precipitation/flow parameters |
| aMC2! | Read precipitation/flow parameters – measurement with cyclic redundancy check |
| aC2! | Read precipitation/flow parameters |
| aCC2! | Read precipitation/flow parameters – measurement with cyclic redundancy check |

Rain gauge inputs (1) + (2):

| | |
|---|---|
| aM3! | Read combined precipitation/flow parameters |
| aMC3! | Read combined precipitation/flow parameters – measurement with cyclic redundancy check |
| aC3! | Read combined precipitation/flow parameters |
| aCC3! | Read combined precipitation/flow parameters – measurement with cyclic redundancy check |

Output format:

+A.A+B.B+C.C+D.D

where:

+A.A = accumulated rainfall (inches/mm) or flow (mL/L) since last measurement

+B.B = total rainfall (inches/mm) or flow (mL/L) accumulation today

+C.C = total rainfall (inches/mm) or flow (mL/L) accumulation yesterday

+D.D = total rainfall (inches/mm) or flow (mL/L) accumulation since reset

# Dual Inputs SDI-12 Rain Gauge Converter

Notes:

- Same engineering unit (inch, mL, L, …) is used for both rain gauge inputs
- When aM3!/aMC3!/aC3!/aCC3! Commands are used, the returned measurement is the sum of rain precipitation/flow from both rain gauges inputs:
  - Rain gauge input 1 measures 2mm
  - Rain gauge input 2 measures 3.4 mm
  - Then any of these SDI-12 command will return (2+3.4)=5.4mm

| | |
|---|---|
| aM1! | Read temperature |
| aMC1! | Read temperature – measurement with cyclic redundancy check |
| aC1! | Read temperature |
| aCC1! | Read temperature – measurement with cyclic redundancy check |

Note that the temperature measurement relates to chip temperature which however is close to the ambient temperature inside the housing, as due to the short measurement times, chip temperature increase can be neglected.

**Extended SDI-12 Commands:**

| | |
|---|---|
| aXSD,YYYY,MM,DD! | Set date |
| aXST,HH,MM,SS! | Set time |
| aXGD! | Query date |
| aXGT! | Query time |
| aXCT,sa.a! | Temperature calibration |
| | saa.aa: enter ambient temperature in °Celsius measured with a reference thermometer; s is the sign |
| aXTO,sa.a,u! | Set temperature offset |
| | saa.aa: enter temperature offset aa.a, s is the sign |
| | u = C for °Celsius or F for °Fahrenheit |
| aXTUu! | Set temperature unit<br>u = C for °Celsius or F for °Fahrenheit |
| aXGU! | Query temperature unit |
| aXSBV1, sn.n! | Set rain gauge bucket volume – input 1 |
| | n.n is the equivalent rainfall (mm/inch) or flow (mL/L), per bucket tip |
| aXSBV2, sn.n! | Set rain gauge bucket volume – input 2 |
| | n.n is the equivalent rainfall (mm/inch) or flow (mL/L), per bucket tip |
| aXGBV1! | Query rain gauge bucket volume – input 1 |
| | n.n is the equivalent rainfall (mm/inch) or flow (mL/L), per bucket tip |
| aXGBV2! | Query rain gauge bucket volume – input 2 |
| | n.n is the equivalent rainfall (mm/inch) or flow (mL/L), per bucket tip |
| aXSO,sn.n! | Set start value/offset for the total accumulated rainfall/flow |
| | aX_ok<CR><LF>. Applies for both rain gauge inputs. |

| | |
|---|---|
| aXGO! | Query start value/offset for the total accumulated rainfall/flow a+nnnn.nn<CR><LF |
| aXRS! | Reset total accumulated rainfall<br>Use this command to set the accumulated rainfall value to zero. |

## 3 Product Specification

- SDI-12 Interface
- Supply voltage for SDI-12 IF: 12V nominal; working range 6V ....16V. The SDI-12 voltage is used to power the SDI-12 data level shifter and only needs to be present during a SDI-12 measurement
- Supply voltage for rain gauge converter electronics: 2 x 1.5V AA alkaline battery cells
- Supply current: 4µA in sleep mode waiting for RG pulse; 8mA during SDI-12 measurement (1 sec)
- Operating temperature range: -40 … +85°C
- Dimensions: 80 x 120 x 57 mm

## 4 Configuration

Use the extended SDI-12 commands **aXSBV1, sn.n! and aXSBV2,sn.n!** to set the rain gauge bucket volume for input 1 and 2.

n.n is the equivalent rainfall (mm/inch) or flow (mL/L), per bucket tip.

## 5 Installation

The TBSRGC2 is compatible with any data logger or remote telemetry unit with SDI-12 interface. Refer to the data logger or RTU manual and to chapter 2 of this datasheet.

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

# 7 Application Examples

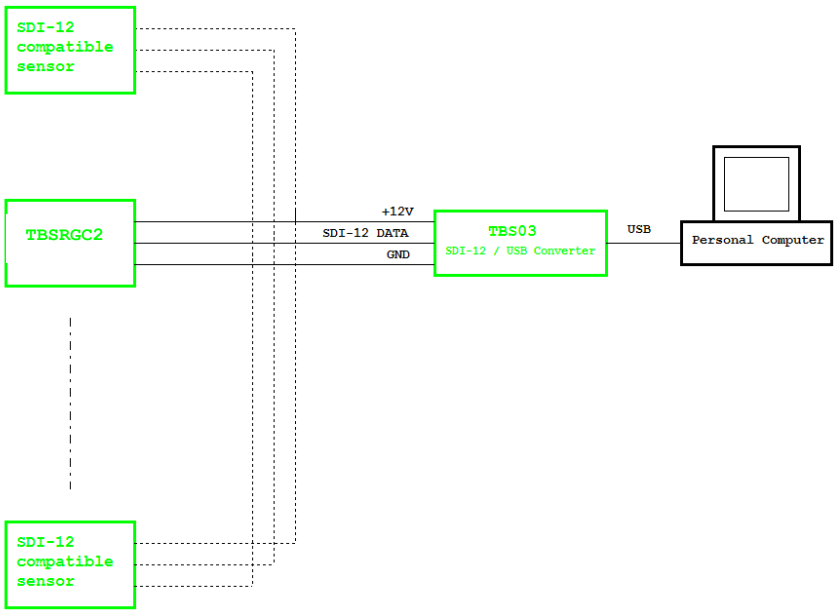


*Figure 1 – TBSRGC2 sensor connected to TBS03 SDI-12 to USB converter; setup for controlling / testing sensors and for PC based data recording*

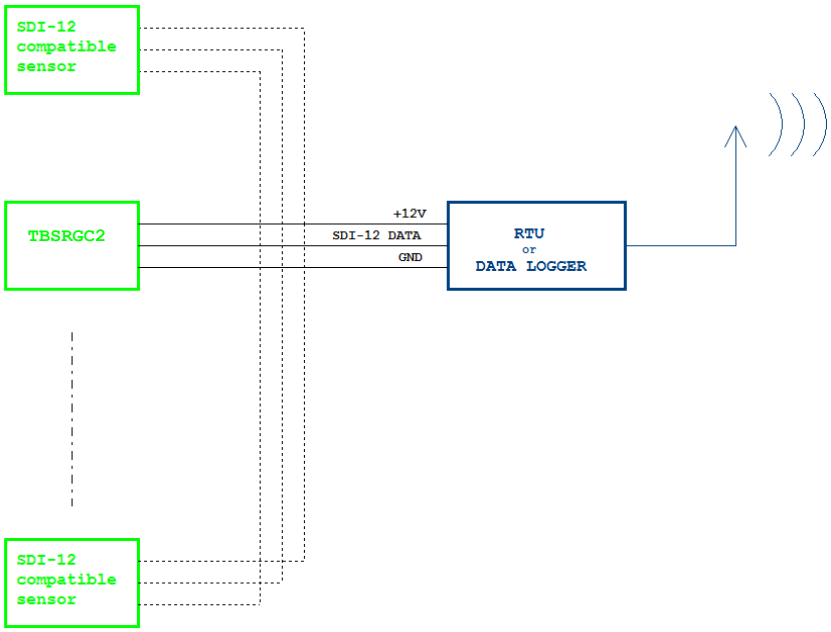


*Figure 2 –TBSRGC2 sensors connected to Remote Telemetry Unit or Data Recorder*

# 8 Supported SDI-12 Commands

| Command | Description | Response |
|---|---|---|
| **a!** | Acknowledge Active | a<CR><LF> |
| **aI!** | Send Identification | 013TEKBOXVN_TBSRGC2_Vx.ynnnnnn<CR><LF><br>With nnnnnns representing the serial number<br>x.y firmware version |
| **aAb!** | Change Address | b<CR><LF><br>Changing the sensor address from a to b |
| **?!** | Address Query | a<CR><LF> |
| **aM!** | Start Measurement<br>Measures precipitation parameters – Input 1 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aMC!** | Start Measurement and request CRC<br>Measures precipitation parameters and calculates CRC – Input 1 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aC!** | Start Concurrent Measurement<br>Measures precipitation parameters – Input 1 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aCC!** | Start Concurrent Measurement and request CRC<br>Measures precipitation parameters and calculates CRC – Input 1 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aM2!** | Start Measurement<br>Measures precipitation parameters – Input 2 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aMC2!** | Start Measurement and request CRC<br>Measures precipitation parameters and calculates CRC – Input 2 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aC2!** | Start Concurrent Measurement<br>Measures precipitation parameters – Input 2 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aCC2!** | Start Concurrent Measurement and request CRC<br>Measures precipitation parameters and calculates CRC – Input 2 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aM3!** | Start Measurement<br>Measures precipitation parameters – Input 1+2 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aMC3!** | Start Measurement and request CRC<br>Measures precipitation parameters and calculates CRC – Input 1+2 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aC3!** | Start Concurrent Measurement<br>Measures precipitation parameters – Input 1+2 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| **aCC3!** | Start Concurrent Measurement and request CRC<br>Measures precipitation parameters and calculates CRC – Input 1+2 | a0014<CR><LF><br>Delay (ttt = 001) in seconds and number of values (4) |
| | | |
| **aM1!** | Start Measurement | a0011<CR><LF> |

| | | |
|---|---|---|
| | Measures temperature | Delay (ttt = 001) in seconds and number of values (1) |
| **aMC1!** | Start Measurement and request CRC<br>Measures temperature and calculates CRC | a0011<CR><LF><br>Delay (ttt = 001) in seconds and number of values (1) |
| **aC1!** | Start Concurrent Measurement<br>Measures temperature | a0011<CR><LF><br>Delay (ttt) in seconds and number of values (1) |
| **aCC1!** | Start Concurrent Measurement and request CRC<br>Measures temperature CRC | a0011<CR><LF><br>Delay (ttt) in seconds and number of values (1) |
| **aD0!** | Get Measurement Result(s) | Upon issuing the aD0! Command, the TBSRGC2 will send the measurement results.<br>Response:<br>+A.A+B.B+C.C+D.D<br>where:<br>+A.A = accumulated rainfall (inches/mm)/flow (mL/L) since last measurement<br>+B.B = total rainfall accumulation today (inches of rain)<br>+C.C = total rainfall accumulation yesterday (inches of rain)<br>+D.D = total rainfall accumulation since reset. (inches/mm of rain) |
| **aV!** | Start Verification | a0000<CR><LF><br>Not supported |
| **aRn!**<br>**aRCn!** | Continuous Measurement<br>Continuous Measurement + CRC | a<CR><LF><br>Not supported |

*Table 1 – Standard SDI-12 commands supported by the TBSRGC2*

## 9 Supported Extended Commands

| Command | Description | Response |
|---|---|---|
| **aXSD,YYYY,MM,DD!** | set date<br>where a represents the address, YYYY the year, MM the month and DD the day | aX_ok<CR><LF> |
| **aXST,HH,MM,SS!** | set time<br>where a represents the address, HH the hour, MM the minute and SS the second | aX_ok<CR><LF> |
| **aXGD!** | query date | a,YYYY.MM,DD<CR><LF> |
| **aXGT!** | query time | a,HH,MM,SS<CR><LF> |
| **aXCT,sa.a!** | Calibrate temperature<br>where a represents the address, s the sign (+ or -), a.a the ambient temperature in °Celsius measured with a reference thermometer | aX_ok<CR><LF> |
| **aXTUu!** | Set temperature unit<br>where a represents the address and u the temperature unit (C for °Celsius and F for °Fahrenheit) | aX_ok<CR><LF> |
| **aXGU!** | Query temperature unit | a,C or a,F<CR><LF> |
| **aXTO,sn.n,u!** | Set temperature offset<br>where a represents the address, n.n the offset and u the temperature unit (C for °Celsius and F for °Fahrenheit) | aX_ok<CR><LF> |

| | | |
|---|---|---|
| **aXSBV1, sn.n!** | Set the volume of the Rain Gauge bucket – Input 1<br>where a represents the address and s the sign (+ or -)<br>n.n is the equivalent rainfall (mm/inch) or flow (mL/L), per bucket tip | aX_ok<CR><LF> |
| **aXSBV2, sn.n!** | Set the volume of the Rain Gauge bucket – Input 2<br>where a represents the address and s the sign (+ or -)<br>n.n is the equivalent rainfall (mm/inch) or flow (mL/L), per bucket tip | aX_ok<CR><LF> |
| **aXGBV1!** | Query the volume of the Rain Gauge bucket – Input 1 | asn.n<CR><LF> |
| **aXGBV2!** | Query the volume of the Rain Gauge bucket – Input 2 | asn.n<CR><LF> |
| **aXSO,sn.n!** | Set initial value/offset for the total accumulated rainfall or flow<br>where a represents the address and s the sign (+ or -)<br>n.n is the start value/offset of the accumulated rainfall (mm/inch) or flow (mL/L) | aX_ok<CR><LF> |
| **aXGO!** | Query the start value/offset for the total accumulated rainfall | asn.n<CR><LF> |
| **aXRS!** | Reset total accumulated rainfall (to zero) | aX_ok<CR><LF> |

*Table 2 – Extended SDI-12 Commands*

## 10 Technical Specifications

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Is | Supply current | Active mode (during measurement) | | 8 | | mA |
| Is | Supply current | Sleep mode, waiting for pulse interrupt | | 4 | | µA |
| Vs | Supply voltage | 2 x AA alkaline cells | | 3 | | V |
| tm | Measurement Time | Time in active mode upon receiving a measurement command | | 1 | | s |
| TR | Temperature measurement range | | -40 | | +85 | °C |

*Table 3 – Technical Specifications*

## 11 Connections

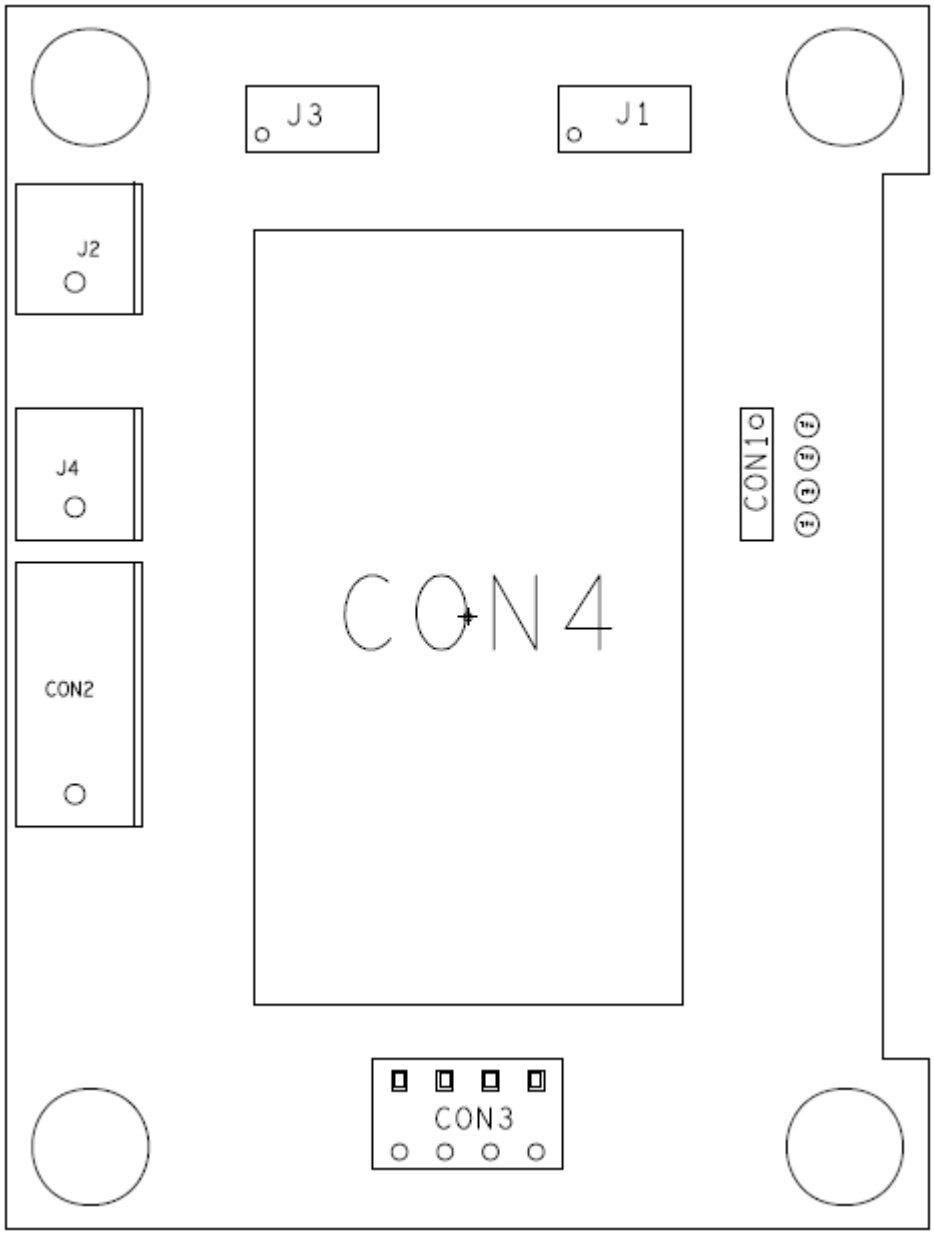


*Figure 3 –connector assignment*

CON 1: Production connector – do not connect

CON2: Main SDI-12 connector, screw terminal block
Pin1 – SDI-12 power (6…12V)
Pin2 – SDI-12 data
Pin3 – SDI-12 ground
Pin4 – Cable shield, decoupled to ground with 100K//100nF

CON3: Optional SDI-12 connector footprint
Pin1 – SDI-12 power (6…12V)
Pin2 – SDI-12 data
Pin3 – SDI-12 ground
Pin4 – Cable shield, decoupled to ground with 100K//100nF

CON4: Battery connector
Pin1 – V_BATT
Pin2 - Ground

J1, J3: Optional 2 x Combined SDI-12 / Rain Gauge Berg connectors; 2.54mm header
Pin1 – Rain Gauge Input 2; internally pulled up to 3V with 4.7K; ESD protected and debounced
Pin2 – Ground
Pin3 – Ground
Pin4 – SDI-12 data
Pin5 – Cable shield, decoupled to ground with 100K/100nF
Pin6 – SDI-12 power OUTPUT 12V
Pin7 – Ground
Pin8 – Rain Gauge Input 1; internally pulled up to 3V with 4.7K; ESD protected and debounced

J2: Raingauge connector – input 1; screw terminal block
Pin1 – Rain Gauge input; internally pulled up to 3V with 4.7K; ESD protected and debounced
Pin2 – Rain Gauge input; internally connected to GND

J4 Raingauge connector – input 2; screw terminal block
Pin1 – Rain Gauge input; internally pulled up to 3V with 4.7K; ESD protected and debounced
Pin2 – Rain Gauge input; internally connected to GND

## 12 Environmental Specifications

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Operating Ambient Temperature Range | | -40 | +85 | °C |

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $T_{STG}$ | Storage Temperature Range | | -40 | +85 | °C |
| | Moisture level | Non condensing | - | 95 | % |

*Table 4 - Environmental Specifications*

## 13 Ordering Information

| Part Number | Description |
|---|---|
| TBSRGC2 | TBSRGC2, SDI-12 Rain Gauge Interface Dual Inputs *) |

*) available with additional grommets or IP67 connectors upon order

*Table 5 – Ordering Information*

## 14 History

| Version | Date | Author | Changes |
|---|---|---|---|
| V1.0 | 23.10.2019 | Philippe Hervieu | Creation of the document |
| | | | |

*Table 6 – History*