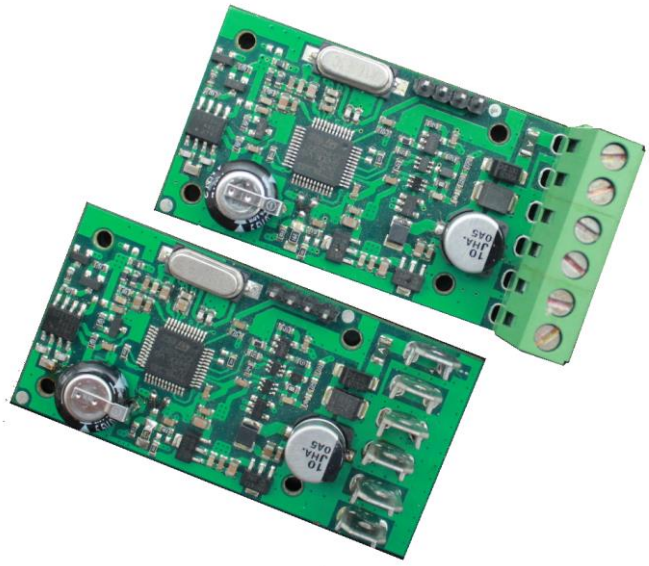
SDI-12 RAIN GAUGE INTERFACE

The TBSRGM1 is a retrofit module to equip tipping bucket rain gauges with data logging capability and SDI-12 interface.

The TBSRGM1 has been designed to work with any type of tipping bucket rain gauge with switch outputs. It is easy to install and easy to configure. The TBSRGM1 is available with either screw terminal block interface or with blade terminals. The module is sealed with Henkel Technomelt.



Features

- SDI-12 interface v1.4
- 6V - 16V supply range
- Data logging
- Low power consumption
- PCB can be customized
- Hermetically sealed
- Small size
- Rugged design
- Simple installation
- Operating Temperature Range: -40°C - +85°C

Target Applications

- Meteorology
- Agricultural monitoring

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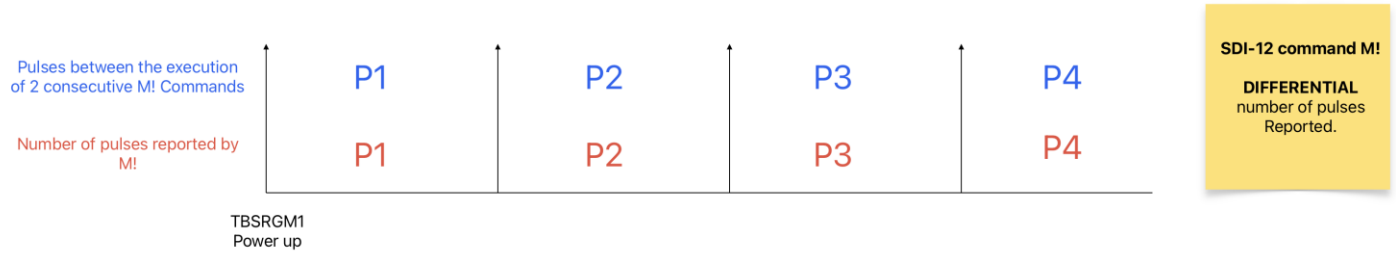
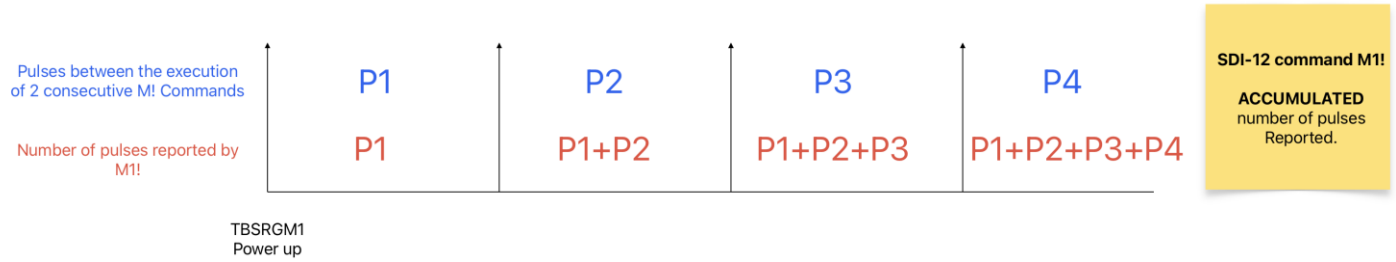
1. Introduction

The TBSRGM1 is a SDI-12 interface for retrofitting tipping bucket rain gauges and flow meter.

The module logs the number of pulses and depending on the SDI-12 measurement command, it will output:

- Differential pulses number: number of pulses between the execution of two consecutive SDI-12 measurement command (M!)
- Accumulated pulses number: total number of pulses since the module has been powered up until SDI-12 command M1! is executed.





TBSRGM1 must be constantly powered as any restart of the module will reset the logged number of pulses (these parameters are stored in volatile memory only). Furthermore this is required to ensure no pulse detection is missed.

Whether the differential or accumulated metrics are fetched, the reported calculated rainfall/flow is the number of pulses multiplied by a scaling factor that is set by using aXSBV,sn.nn! extended SDI-12 command (for example the volume in ml of the rain gauge tipping bucket).

While using M1! it is possible to initialize the accumulated rainfall tally to a value different from zero by using extended SDI-12 command aXSO,snnnn.nn!.

2. Measurement

TBSRGM1 outputs 3 kind of parameters:

- Differential or accumulated number of pulses
- Differential or accumulated precipitation/flow
- Temperature

SDI-12 Measurement Commands:

Differential rainfall/flow measurement:

- aM! / aC! Read differential rainfall/flow
- aMC! / aCC! Read differential rainfall/flow – measurement with cyclic redundancy check

Output format: a+<DIFF_PULSE>+<DIFF_RAINFALL>
where: a: SDI-12 address
+<DIFF_PULSE> : differential number of pulses
+<DIFF_RAINFALL> : differential rainfall/flow

Accumulated rainfall/flow measurement:

- aM! / aC! Read accumulated rainfall/flow
- aMC! / aCC! Read accumulated rainfall/flow – measurement with cyclic redundancy check

Output format: a+<ACC_PULSE>+<ACC_RAINFALL>
where: a: SDI-12 address
+<ACC_PULSE> : accumulated number of pulses
+<ACC_RAINFALL> : accumulated rainfall/flow

Temperature measurement:

- aM2! / aC2! Read temperature
- aMC2! / aMCC2! Read temperature – measurement with cyclic redundancy check

Output format: a<Temperature>
where: a: SDI-12 address
<Temperature> : current temperature in sensor (units in C or F).

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

Extended SDI-12 Commands:

aXSTUk! Set unit of temperature in Celcius or Fahrenheit. k is an unit of temperature that value can be “C” or “F”

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aXGTU!	Get unit of temperature in Celcius or Fahrenheit. Response format of command is ak<CR><LF. a is address of sensor. k is unit of temperature that can be C or F.
aXSMTO,sff.ff!	Set offset of temperature.'sff.ff' is a float number.
aXGMTO!	Get of offset of temperature. The response format of the command is asff.ff<CR><LF>.
aXCT,saa.aa!	Temperature calibration, saa.aa: enter ambient temperature in °Celcius measured with a reference thermometer; s is the sign
aXSBV,sn.nn!	Set rain gauge bucket volume, n.nn is the equivalent rainfall in mm or inch, per bucket tip
aXGBV!	Query rain gauge bucket volume, n.nn is the equivalent rainfall in mm or inch, per bucket tip
aXSO,snnnn.nn! aX_ok<CR><LF>	Set start value/offset for the total accumulated rainfalls
aXGO!	Query start value/offset for the total accumulated rainfalls a+nnnn.nn<CR><LF>
aXRS!	Reset configuration parameters to their default values.
aXREBOOT!	Reset differential and accumulated pulses number and rainfall/flow to 0.

3. Product Specification

- SDI-12 Interface v1.4
- Supply voltage: 12V nominal; woking range 6V 16V
- Supply current: 8mA during measurement (1 sec); 80µA in sleep mode
- Operating temperature range: -40 … +85°C
- Dimensions: 60 x 30 x 19 mm

4. Configuration

Use the extended SDI-12 command **aXSBV,sn.nn!** to set the rain gauge bucket volume n.nn is the equivalent rainfall in mm, per bucket tip.

Use the extended SDI-12 command **aXSO,sn.nn!** to set the start totalliser for flow meter in unit of liter.

aXRS! resets the module configuration parameters to their default values:

- Temperature unit: Celcius
- Accumulated rainfall offset: 0
- Scaling factor (rain gauge tipping bucket volume): 1
- Temperature offset: 0
- Calibrated temperature: 0

aXREBOOT reset the module calculated parameters to zero:

- Differential number of pulses
- Accumulated number of pulses
- Differential precipitation
- Accumulated precipitation

5. Installation

The TBSRGM1 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.

To ensure correct operations, TBSRGM1 must be **constantly** powered.

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 standard is available on the website of the SDI-12 Support Group.

7. Application Examples

The below picture is connection between the interface and TBS03 via a SDI-12 bus. And The PC can read parameters of the TBSRGM1 sensor from recorder.

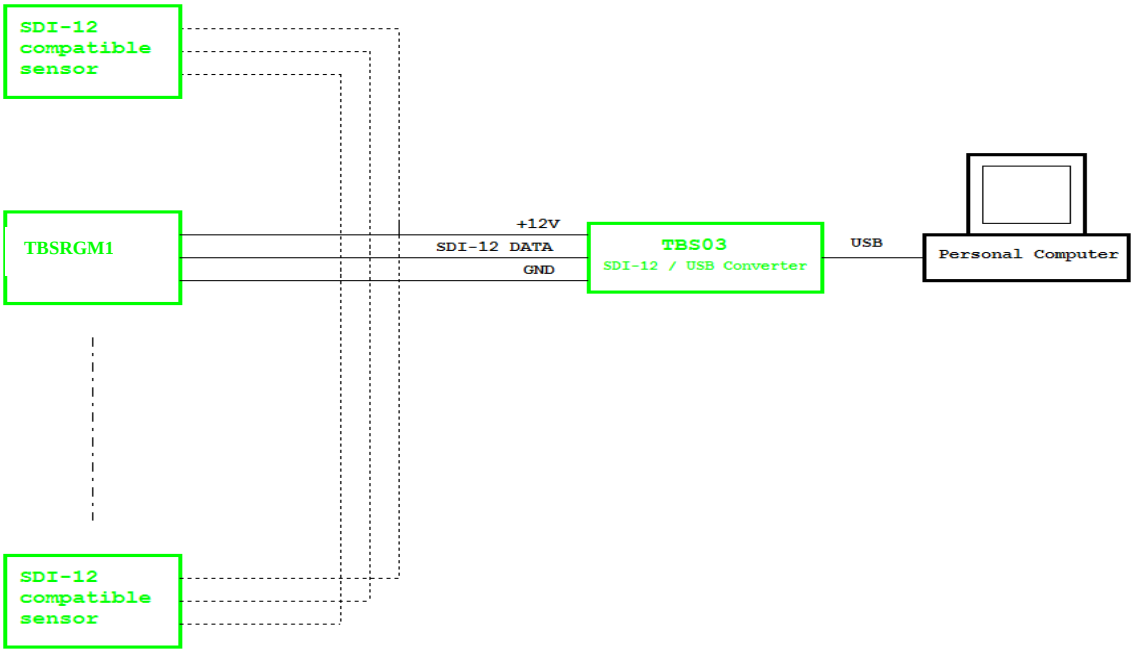

Figure 1 – TBSRGM1 sensor and TBS03(SDI-12 to USB converter)

The below picture is connection between the interface and the remote telemetry via a SDI-12 bus.

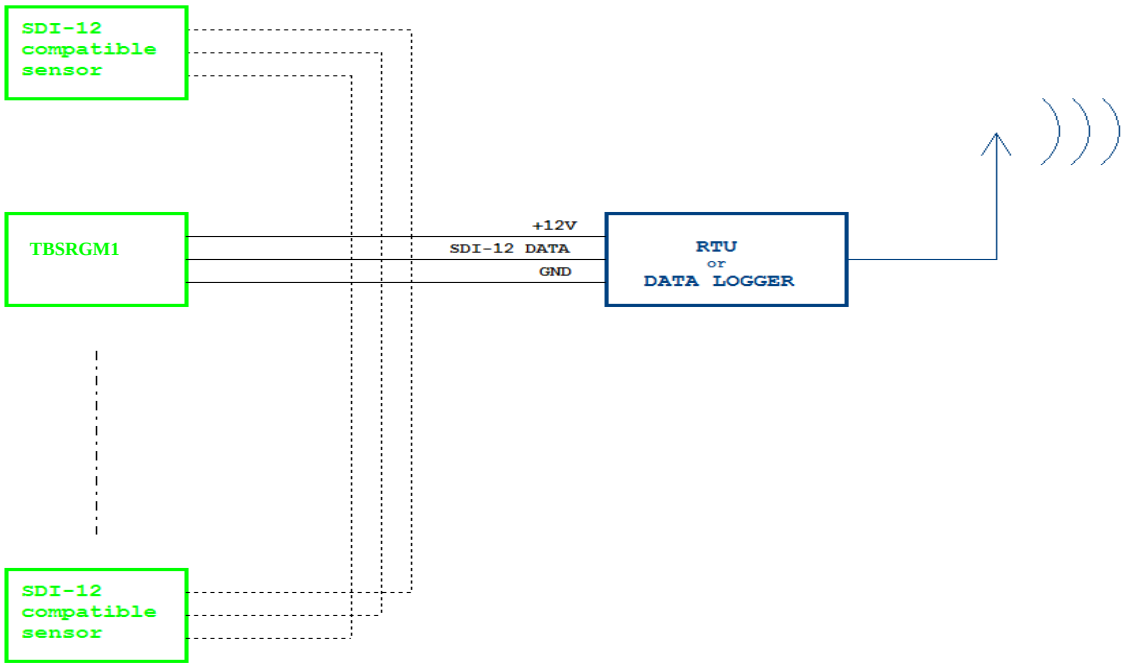

Figure 2 –TBSRGM1 sensors connected to Remote Telemetry Unit or Data Recorder

8. Supported SDI-12 V1.3 Commands

List of supported commands on the interface in the SDI-12 standard.

Command	Description	Response
a!	Acknowledge Active	a<CR><LF>
aI!	Send Identification	a14TEKBOXVNTBSRGMrv<h><nnnnnn><fffffff><CR><LF> With: o <a>: SDI-12 address o <h>: HW revision (one letter) o <nnnnnn>: serial number (6 digits) o <fffffff>: firmware version (7 digits) Example: 514TEKBOXVNTBSRGMrvB0000021300105<CR><LF>
aAb!	Change Address	b<CR><LF> Changing the sensor address from a to b
?!	Address Query	a<CR><LF>
aM!	Start Measurement Measures differential number of pulses and precipitation parameters	a0012<CR><LF> a: SDI-12 address Delay (1) in seconds and number of returned values (2)
aMC!	Start Measurement and request CRC Measures differential number of pulses and precipitation parameters and calculates CRC	a0012<CR><LF> a: SDI-12 address Delay (1) in seconds and number of returned values (2)
aC!	Start Concurrent Measurement Measures differential number of pulses and precipitation parameters	a00102<CR><LF> a: SDI-12 address Delay (1) in seconds and number of returned values (2)
aCC!	Start Concurrent Measurement and request CRC Measures accumulated number of pulses and precipitation parameters and calculates CRC	a00102<CR><LF> a: SDI-12 address Delay (1) in seconds and number of returned values (2)
aM1!	Start Measurement Measures accumulated number of pulses and precipitation parameters	a0012<CR><LF> a: SDI-12 address Delay (1) in seconds and number of returned values (2)
aMC1!	Start Measurement and request CRC Measures accumulated number of pulses and precipitation parameters and calculates CRC	a0012<CR><LF> a: SDI-12 address Delay (1) in seconds and number of returned values (2)
aC1!	Start Concurrent Measurement Measures accumulated number of pulses and precipitation parameters	a00102<CR><LF> a: SDI-12 address Delay (1) in seconds and number of returned values (2)
aCC1!	Start Concurrent Measurement and	a00102<CR><LF>

	request CRC Measures accumulated number of pulses and precipitation parameters and calculates CRC	a: SDI-12 address Delay (1) in seconds and number of returned values (2)
aM2!	Start Measurement Measures temperature	a0011<CR><LF> a: SDI-12 address Delay (1) in seconds and number of returned values (1)
aMC2!	Start Measurement and request CRC Measures temperature and calculates CRC	a0011<CR><LF> a: SDI-12 address Delay (1) in seconds and number of returned values (1)
aC2!	Start Concurrent Measurement Measures temperature	a00101<CR><LF> a: SDI-12 address Delay (1) in seconds and number of values (1)
aCC2!	Start Concurrent Measurement and request CRC Measures temperature and calculate CRC	a00101<CR><LF> a: SDI-12 address Delay (1) in seconds and number of values (1)
aD0!	Get measurement result on commands (aM!, aMC!, aC! and aCC!)	Upon issuing the aD0! Command, the TBSRGM1 will return the measurement results. a+<DIFF_PULSE>+<DIFF_RAINFALL> where: a: SDI-12 address +<DIFF_PULSE> : differential number of pulses +<DIFF_RAINFALL> : differential rainfall/flow
	Get measurement result on commands (aM1!, aMC1!, aC1! and aCC1!)	Upon issuing the aD0! Command, the TBSRGM1 will return the measurement results. a+<ACC_PULSE>+<ACC_RAINFALL> where: a: SDI-12 address +<DIFF_PULSE> : accumulated number of pulses +<DIFF_RAINFALL> : accumulated rainfall/flow
	Get measurement result on commands (aM2!, aMC2!, aC2! and aCC2!)	Upon issuing the aD0! Command, the TBSRGM1 will return the measurement results. a<Temperature> where: a: SDI-12 address +<DIFF_PULSE> : temperature in Celcius or Fahrenheit depending on the selected unit.
aV!	Start Verification	a<CR><LF> a: SDI-12 address
aRn! aRCn!	Continuous Measurement Continuous Measurement + CRC	a<CR><LF> a: SDI-12 address

		Not supported

Table 1 – Standard SDI-12 commands supported by the TBSRGM1

9. Supported SDI-12 V1.4 Commands

Command	Description	Response
aIM!	aM! Identify Measurement Returns delay and number of parameters	a0012<CR><LF> Delay: (1) seconds and number of values (2)
aIMC!	aMC! Identify Measurement Returns delay and number of parameters	a0012<CR><LF> Delay: (1) seconds and number of values (2)
aIC!	aC! Identify Measurement Returns delay and number of parameters	a00102<CR><LF> Delay: (1) seconds and number of values (2)
aICC!	aCC! Identify Measurement Returns delay and number of parameters	a00102<CR><LF> Delay: (1) seconds and number of values (2)
aIM1!	aM1! Identify Measurement Returns delay and number of parameters	a0012<CR><LF> Delay: (1) seconds and number of values (2)
aIMC1!	aMC1! Identify Measurement Returns delay and number of parameters	a0012<CR><LF> Delay: (1) second, number of values (2)
aIC1!	aC1! Identify Measurement Returns delay and number of parameters	a00102<CR><LF> Delay: (1) second and number of values (2)
aICC1!	aCC1! Identify Measurement Returns delay and number of parameters	a00102<CR><LF> Delay: (1) second, number of values (2)
aIM2!	aM2! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) seconds and number of values (1)
aIMC2!	aMC2! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) second, number of values (1)
aIC2!	aC2! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second and number of values (1)
aICC2!	aCC2! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second, number of values (1)
aIM_001!	aM! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Internal,Units;<CR><LF> (***)
aIMC_001!	aMC! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a, Internal,Units; <CRC><CR><LF> (***)
aIC_001!	aC! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a, Internal,Units;<CR><LF> (***)
aICC_001!	aCC! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a, Internal,Units;<CR><LF> (***)
aIM_002!	aM! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Rainfall,mm;<CR><LF> (*)

aIMC_002!	aMC! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Rainfall,mm; <CRC><CR><LF> (*)
aIC_002!	aC! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Rainfall,mm;<CR><LF> (*)
aICC_002!	aCC! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Rainfall,mm; <CRC><CR><LF> (*)
aIM1_001!	aM1! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Internal,Units;<CR><LF> (***)
aIMC1_001!	aMC1! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a, Internal,Units; <CRC><CR><LF> (***)
aIC1_001!	aC1! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a, Internal,Units;<CR><LF> (***)
aICC1_001!	aCC1! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a, Internal,Units;<CR><LF> (***)
aIM1_002!	aM1! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Volume,l; <CRC><CR><LF> (*)
aIMC1_002!	aMC1! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Volume,l;<CR><LF> (*)
aIC1_002!	aC1! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Volume,l;<CR><LF> (*)
aICC1_002!	aCC1! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Volume,l;<CR><LF> (*)
aIM2_001!	aM2! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,AirTemperature,*t_unit*;<CR><LF> (**)
aIMC2_001!	aMC2! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,AirTemperature,*t_unit*; <CRC><CR><LF> (**)
aIC2_001!	aC2! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,AirTemperature,*t_unit*;<CR><LF> (**)
aICC2_001!	aCC2! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,AirTemperature,*t_unit*; <CRC><CR><LF> (**)

Table 2 – Standard SDI-12 v1.4 commands

(*) Unit is set for reference purpose only. It actually depends on the volume of the coefficient set by aXSBV command.

(**) Where *t_unit* depends on the unit set with aXSTUn! (Celcius Fahrenheit)

(***) Internal parameter reserved for monitoring purposes (pulse counter)

10. Supported Extended Commands

List of supported external commands on the interface.

Command	Description	Response
aXSTUk!	Set unit of temperature in ahrenh or ahrenheit. K: unit of temperature in “C” or “F”.	aX_OK<CR><LF> a: SDI-12 address
aXGTU!	Get unit of temperature in ahrenh or ahrenheit.	Ak<CR><LF. A: SDI-12 address K: unit of temperature in C or F.
aXSMTO,sn.n!	Set offset of temperature. ’sn.n’ is a float number. S is sign ‘+’ or ‘–‘.	aX_OK<CR><LF> a: SDI-12 address
aXGMTO!	Get of offset of temperature.	Asff.ff<CR><LF> a: SDI-12 address ’sff.ff: decimal number.
aXCT,sa.a!	Calibrate temperature where a represents the address, s the sign (+ or -), a.a the ambient temperature in °Celcius measured with a reference thermometer	aX_OK<CR><LF> a: SDI-12 address
aXSBV,sn.n!	Set the volume of the Rain Gauge bucket where a represents the address and s the sign (+ or -) n.n is the equivalent rainfall in mm or inch, per bucket tip	aX_OK<CR><LF> a: SDI-12 address
aXGBV!	Query the volume of the Rain Gauge bucket	asn.nn<CR><LF> a: SDI-12 address s: + or – n.nn: bucket tip volume in inch/mm
aXSO,sn.n!	Set start value/offset for the total accumulated rainfall where a represents the address and s the sign (+ or -) nnnn.nn is the start value/offset of the accumulated rainfall in mm or inch	aX_OK<CR><LF> a: SDI-12 address
aXGO!	Query the start value/offset for the total accumulated rainfall	asf.f<CR><LF> a: SDI-12 address s: + or – f.f: value/offset of total accumulated rainfall.
aXRS!	Reset current configuration to default values.	aX_OK<CR><LF> a: SDI-12 address
aXREBOOT!	Reset calculated parameters (differential/accumulated pulses/rainfall)	aX_OK<CR><LF> a: SDI-12 address

Table 3 – Extended SDI-12 Commands

11. Technical Specifications

List of electrical parameters on the interface.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Is	Supply current	Active mode (during measurement)		8		mA
Is	Supply current	Sleep mode		80		µA
Vs	Supply voltage		6	12	17	V
tm	Measurement Time	Time in active mode upon receiving a measurement command		1		s
TR	Temperature measurement range		-40		+85	°C

Table 4 – Technical Specifications

12. Connections

Figure 3 – Module connections

The reed switch input B is internally pulled up(connecting signal here), de-bounced and EMC/overvoltage protected. Reed switch input A is internally connected to ground.

13. Environmental Specifications

List of environment parameters on the intercafe.

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

Table 5 – Environmental Specifications

14. Ordering Information

Part Number	Description
TBSRGM1	TBSRGM1, SDI-12 Rain Gauge Interface (*)

Table 6 – Ordering Information

(*) available with conformal coating or conformal coating + Hotmelt coating upon order

15. History

Version	Date	Author	Changes
V1.0	11.7.2015	Mayerhofer	Creation of the document
V1.1	29.04.2016	THINH	Correct pulse input
V1.2	29.05.2018	THINH	Fix some SDI-12 commands descriptions
V1.3	30.05.2018	Philippe Hervieu	Minor updates in sections 8./9. (SDI-12 commands)
V1.4	Jun30 2022	TanTrinh	Updated commands, remove RTC, etc.
V1.5	03.10.2022	Philippe Hervieu	Fix aXSBV command format / Add SDI-12 v1.4 commands
V1.6	02.12.2022	Philippe Hervieu	Update 5. Installation (12V always on requirement)
V1.7	06.04.2023	Philippe Hervieu	Update M!/M1!/M2! commands description + functional description

Table 7 – History