Rain gauges

User manual

Revisions list

Issue	*Date*	*Author*	*Description of changes*
Origin	10/10/2019	Reschiotto	
A	25/05/2021	Reschiotto	Replacement of obsolete codes

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1 Introduction

It defines rainfall: “the liquid or solid product of steam’s condensation coming from clouds or left on the soil. In the first case it’s called rain, hail and snow; in the second case it’s called dew and hoarfrost”.

Total rainfall, which gets to the soil during a stated period of time, consists of the high of liquid (rainfall) that covers an horizontal area of the ground. So the rainfall’s unit of measurement is the following: linear units referred to the time; i.e. mm/min, mm/hour, mm/day, etc. They have been obtained dividing the collected water’s quantity by the inlet surface, i.e. the “pluviometric section”.

The millimeters of rain that fall in an hour define what in meteorology is called "intensity" of the rain; it is also possible to define the "maximum" intensity within the hour. In that case, it is necessary to measure the intensity per minute and with this data apply the calculation of the maximum.

A Rain gauge is a device to measure liquid rain fall amount and intensity. The device is composed of a rain collector cone and a double-chamber tipping bucket connected to a magnet. The magnet operates one reed switch, which generates impulses that can be counted by external meters.

DQA230.1/230.3/231.1 versions are equipped with a siphon placed on the cone’s nozzle; it has function during heavy rain, to regulate the flow into the bascule permitting all the water to fall inside the tipping bucket. This solution gives its best results where the main need is the measurement of the total amount of rain over long periods, not rain intensity.

DQA230/231/235/236 versions are not equipped with a siphon and, when the correction formula is applied, they have “Class A” accuracy as described by the UNI11452:2012 standard - this class is the most accurate class for intensity measurement.

2 Instrument description

2.1 Main features

The gauging equipment consists of one funnel for collection of the water and one seesaw part (tipping bucket). This one consists of two symmetric tubs which rotates on their own axis on unstable equilibrium.

The electronic device consists of: two magnetic switches (reed relay) placed on two stand-by positions, or one switch placed in central position.
The electronic device counts the number of tipping buckets and gives out a countable impulse; the addition of impulses computes the rainfall quantity.

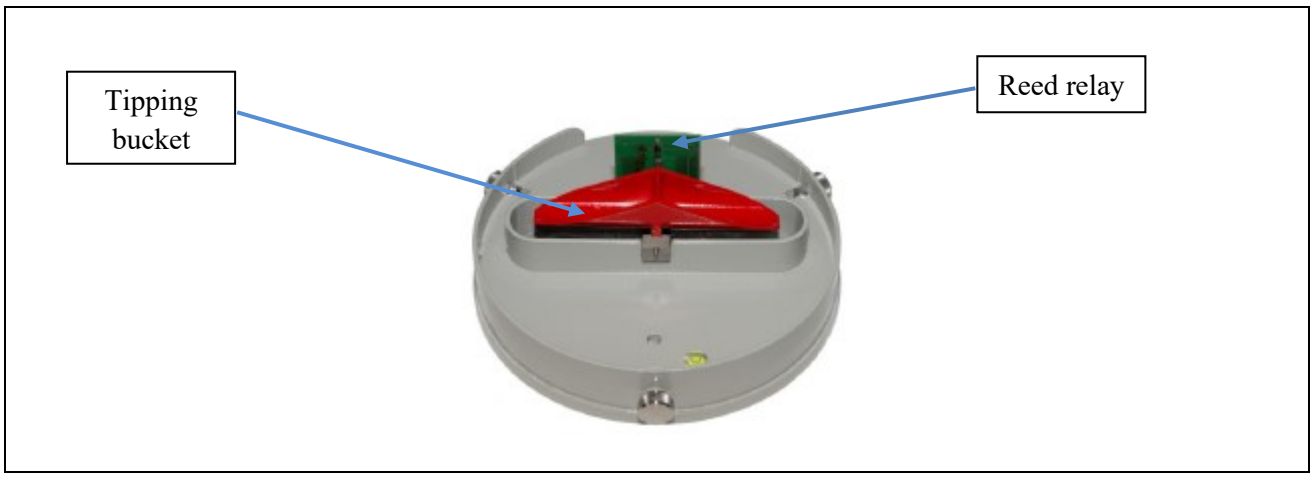


Fig. 1 – Instrument description.

2.2 Versions

Code	Description
DQA230	Class A rain gauge, with collector area of 323 cm^2; resolution: 0.2 mm
DQA231	Class A rain gauge, with collector area of 323 cm^2 and heater (24 Vac); resolution: 0.2 mm
DQA230.1	Rain gauge with collector area of 323 cm^2 e siphon; resolution: 0,2 mm
DQA231.1	Rain gauge with collector area of 323 cm^2, siphon and heater (24 Vac); resolution: 0.2 mm
DQA230.3	Rain gauge with collector area of 323 cm^2, con siphon; resolution: 0.1 mm
DQA235	Classe A rain gauge, with collector area of 1000 cm^2; resolution: 0.2 mm
DQA236	Classe A rain gauge, with collector area of 1000 cm^2 and heater (24 Vac); resolution: 0.2 mm

3 Installation

Install your equipment in exposed area. This open space must be a long way to walls, trees, buildings, etc., because in case of cross rainfall they could obstruct the filling of rain gauge's funnel.

WMO (World Meteorological Organization) recommends that the distance between the rain gauge and the objects must be two times the height of these objects or more.

If the sensor is placed on the ground, do not put it on hard surface (cement, etc), because it could give "in-splashing", that is the relapse (through rebound) inside the cone of rain gauge of drops of rain falls indeed externally.

Fig. 2 – Installation examples: at the top of the pole, on the side of the pole, on the ground.

3.1 Mounting on the top of the pole

1. Unscrew three radial knurled screws and remove the cylindrical casing of the rain gauge. **WARNING!** The heated versions have one cable that connects the rain gauge's base to the thermo-cover sticking to the cone, remove the cone carefully and disconnect the plug placed on the base.
2. Remove three screws fixed on the base of rain gauge and mount them (with their head looks down) on DYA040.2 support.
3. Now fix the base to DYA040.2 by means of three suitable screws.
4. Clamp DYA040.2 to pole, by means of its screws.
5. Set the sensor's locking bolts to DYA040.2 support by means of suitable water level (it's on the base of rain gauge) and lay flat the equipment.
6. Clamp three lock-nuts of the bolts definitively, using suitable spanners.
7. Remove the elastic band from the tipping bucket. For DQA230.3 also remove the protection elements. **WARNING!** In versions with heater, remember to reconnect the heating system plug, making sure that the cable does not interfere with the movement of the tipping bucket.
8. Reassemble and connect the instrument as shown in the drawing supply with the sensor.

3.2 Mounting on the side of the pole

In case of mounting on the side of the pole, clamp DYAO58 connection bar to pole.
Afterwards mount DYA040.2 support on DYA058 bar and start the installation following the instruction in §3.1.

3.3 Mounting on the ground

For mounting of the rain gauge on the ground use DYA039.1 steel plate. Proceed as follows:

1. Fix the base of rain gauge on the steel plate by menas of three long screws (supplied together with the plate).
2. Place the plate in suitable position and according to WMO advices.
3. Using a small sledgehammer, block the plate to the ground using the four DYA043 steel pegs, making sure that it is in a perfectly horizontal position. **WARNING!** Hit the peg in such a way that the blows do not affect the rain gauge base.
4. Remove the elastic band from the tipping bucket. For DQA230.3 also remove the protection elements. **WARNING!** In versions with heater, remember to reconnect the heating system plug, making sure that the cable does not interfere with the movement of the tipping bucket.
5. Reassemble and connect the instrument as shown in the drawing supply with the sensor.

3.4 Electrical connection

For the electrical connection, refer to the documentation supplied with the rain gauge.

4 Maintenance

The rain gauge, unlike other weather sensors, requires more frequent interventions to remove leaves, twigs, sand and other dirt that has fallen or been transported by atmospheric agents that clog the collected cone.

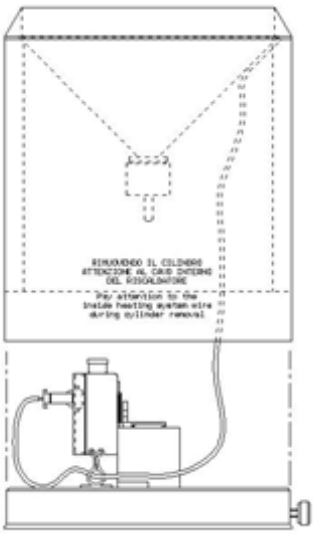
4.1 Visual check

4.1.1 Internal check

In the internal check it is verified that the sensor is still level and that the internal parts are clean and functional.

After loosening the 3 radial knurled screws, remove the rain gauge cone (**WARNING!** In the versions with heater there is a cable that connects the base of the rain gauge to the thermo-cover sticking to the cone; remove the cone carefully and remove the plug from the box placed on the base) and proceed as follows:

1. Check that rain gauge is laid flat (use suitable water level on the base of rain gauge); at the opposite set it using two bolts under the base of rain gauge and adjust its heigh.
2. Check that water drain hole, on the base of rain gauge, is not clogged.
3. Check that no dirty occludes the end of cone.
4. For versions equipped with siphon, check that it is clean. To perform this check, unscrew the siphon from its seat. If necessary, wash it with running water or clean it with a damp cloth.



4.1.2 Mechanical check

The mechanical check involves the verification of all the mechanical parts placed inside the rain gauge.
In particular:

1. Check that dumping tub can seesaw with no efforts, and that pin for bearing of the tipping buckets on the rollers is well clean; at the opposite clean it using a small brush or compressed air.
2. Check that reed relay (optional: n. 2 relay reeds) trips at every passing of tipping bucket. You can hear a weak noise at every touch.

4.1.3 Operation check

Check that the rain gauge generates an impulse with each tipping triggered manually or with the pouring of water. If you have an electromechanical pulse counter, you can check its tolerance.

In the versions with heater, the operation of the thermostat and its circuit part is checked.

- Check with LSI LASTEM data logger:
  1. Read the rain value displayed on the data logger display.
  2. Move the internal rain-gauge tipping bucket to give an impulse.
  3. Now check that the value previously read is increased by 0.2 mm (0.1 mm for model DQA230.3). Remember that a few moments will pass from the mechanical impulse to the display on the display unit.

- Check with ohmmeter or multimeter:
  1. Set the multimeter for resistance or circuit continuity measurement.
  2. Connect the tester leads to the ends of the rain gauge signal wires (refer to the DISACC supplied with the sensor for this purpose) and detect a value equal to "open circuit" (infinite resistance).
  3. Move the tipping-bucket to the opposite position, detecting on the multimeter a value equal to "closed circuit" (0 ohm) when the tipping-bucket passes in front of the magnet. With the tipping-bucket at the end of its travel, detect again a value equal to "open circuit".

- Tolerance check (only for versions with siphon):
  1. Equip yourself with a three-digit electromechanical pulse counter.
  2. Connect the pulse counter to the reed following the relative diagram supplied with the rain gauge. For two reed versions put them in parallel.
  3. Slowly drop one liter of water (in about 30/40 minutes) into the rain gauge.
  4. At the end of the test verify that the data obtained are congruous with those reported in the table.

Rain gauge with collection area	**Amount of H_2O**	**Water pouring time**	**Pulse number**	**mm H_2O**
323 cm^2	1 litre	20/30 minutes	50 ± 1 pulse	10 ± 0.2 mm
1000 cm^2	1 litre	20/30 minutes	154 ± 3 pulse	30.8 ± 0.3 mm

- Thermostat check - heating resistors (only for versions with heater):
  1. Flush the thermostat located above the reed box with refrigerant gas or in contact with ice. Wait for the thermostat to switch.
  2. Check a resistance of about 10 ohm between the ends of the resistance on the cone.
  3. Check a resistance of about 110 ohm between the ends of the resistance on the base.

4.1.4 External check

In the external control the fixing of the various components of the sensor and of the supports connected to it is verified. In particular:

1. Check that the rain gauge is well fixed to the structure that secures it to the support pole.
2. Check that the upper part of the rain gauge is well fixed, using the 3 radial knurled screws, at the base of the rain gauge.
3. Check that the filter placed at the mouth of the cone is clean.
4. Check that the cone is well cleaned, if it is not clean, clean it with water and a cloth.

5 Use with XLA003.1/XLA003.2 converters

XLA003.1 and XLA003.2 are devices that allow to convert the impulsive signal generated by the rain gauge into an analog (XLA003.1: current) or digital (XLA003.1: RS485 Modbus RTU) signal.

When switched on, the counter output is set at the beginning of the scale (equal to 0 mm). At each pulse it increases until it reaches full scale (equal to 20 mm). At the next impulse the counter returns to the beginning of the scale (it resets itself).

5.1 Operation check

For versions with analogue output, the operation check takes place by means of a multimeter. It is verified that each tilting of the tipping-bucket corresponds in output to a precise value in current or in voltage, depending on the version.

Verification of the digital output (RS485) can be made using a PC, equipped with an RS485 serial port (or RS232-RS485 converter) and in which the third-party modpoll.exe program is installed (https://www.modbusdriver.com/modpoll.html). It is verified that at every tilting of the tipping-bucket the value read is increased by 0.2 mm (0.1 mm for the model DQA320.3).

- For converter with current output:

1. Set the multimeter for direct current (DC) measurements with 20 mA scale.
2. Disconnect the wire corresponding to the negative signal (- Sig) and connect it to the test lead + (red) of the multimeter. The lead - (black) fix it instead of the disconnected wire.
3. Read the value on the multimeter.
4. Generate an impulse by moving the tipping-bucket from one position to the other, checking that the value displayed by the multimeter has increased by the corresponding *Current value*.

XLA003.1 output	Current value [mA]
0÷20 mA	0.2 mA per pulse
4÷20 mA	0.16 mA per pulse

- For converter with digital output:

1. Connect the sensor serial cable to the PC serial port.
2. Open a DOS Prompt window and type the following command (it is assumed that the transmission parameters are set as follows: *Baudrate: 9600 bps, Parity: None* and that the PC serial port used is COM1):

   modpoll -a 1 -r 1 -c 1 -t 4:float -p none -b 9600 com1 [Enter]

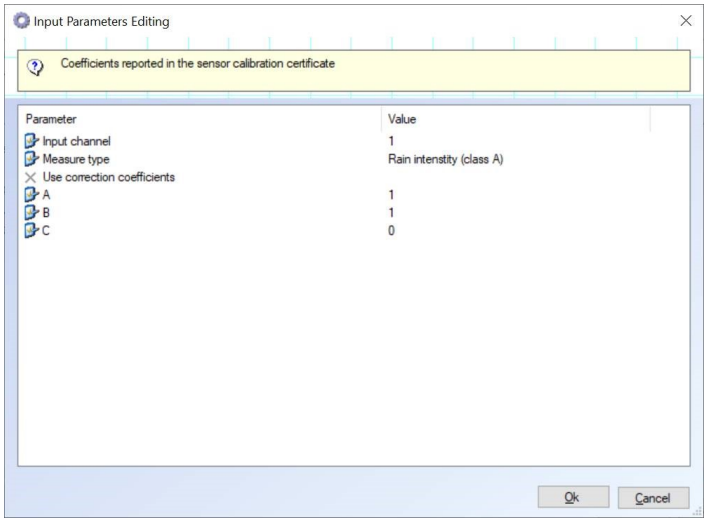
   For the list of available commands, type the command *modpoll /help*.
3. Read the rain value on the program.

4. Generate an impulse by manually tilting the tipping-bucket and check that the rainfall value on the program has increased by 0.2 mm (0.1 mm for model DQA320.3).

6 Class A rain gauge

The Italian UNI-11452: 2012 standard classifies the rain gauges based on their accuracy in measuring the rainfall intensity, a fundamental parameter also for the calculation of rainfall totals. This standard was recently implemented by the UNI-EN-17277: 2020 European standard: a great step forward for the classification of rain gauges also at European level. The standard defines relative percentage error limits on the measurement of precipitation intensity, compared to a reference value on the 1 minute scale, to classify the instruments in three classes: Class A, with relative error <± 3%, Class B, with relative error <± 5%, Class C, with relative error <± 10%.
In order to be classified into Class A, rain gauges must be built with particular attention to the mechanics of the components. Mechanics alone, however, is not enough to define a Class A rain gauge, for this reason it is always necessary to apply a software correction to modify the intensity values measured by the rain gauge as close as possible to the reference ones.
The LSI Lastem DQA230-231-235-236 rain gauges, if supplied with the calibration certificate for Class A, made in our laboratory, and if connected to the Pluvi-ONE and Alpha-Log data loggers that have the ability to correct the intensities, are in Class A.
The calibration procedure is divided into 3 parts: a check of the balance of the tipping scales, a procedure for quantifying the relative error between the measured and reference intensities and the interpolation of the curve of the relative errors as a function of the intensities to obtain of the 3 correction parameters (a, b and c).
Thanks to a formula that takes into account the error curve applied to the data, it is possible to correct the measured intensity, obtaining the statistical distribution of the residual error at the various intensities, up to 300 mm/hr. If the residual error is <± 3%, then the rain gauge is classified in Class A.

The LSI LASTEM DQA230-231-235-236 rain gauges fit the Class A classification when connected to Pluvi-ONE and Alpha-Log data loggers where it is possible to set (using 3DOM software) the a, b and c parameters obtained on the SVICA3105 calibration certificate.



7 Accessories / Spare parts

Code	Description
DYA039.1	Base plate for ground installation (DQA230-231-230.1-231.1)
DYA040.2	Mast mounting device for ø 50 mm pipe (DQA230231-230.1-231.1)
DYA040.3	Mast mounting device for ø 50 mm pipe (DQA235-236)
DYA058	Lateral support. Requires DYA040.2-.3
DWA505	Cable L. = 5 m
DWA510	Cable L. = 10 m
DWA525	Cable L. = 25 m
MG2251	7 pin free female connector
XLA003.1	Interface for 4÷20 mA output Input: pulse / Output: 4÷20 mA (with auto-reset) / Power supply: 10÷30 Vdc (typ. 4mA@12 Vdc) / Mounting: Din Rail / Operative temperature: 40÷80 °C
XLA003.2	Interface for RS485 output / Input: pulse / Output: RS485-Modbus RTU / Power supply: 10÷30 Vdc (typ. 4mA@12 Vdc) / Mounting: Din Rail / Operative temperature: 40÷80 °C / Field rainfall verification system

Calibration certificate

The LSI LASTEM laboratory is equipped with an automatic calibrator to verify the result of the measurements at different intensities in accordance with the UNI11452-2012 standard. Each rain gauge is supplied with a Report Test. Calibration certificates are supplied upon request.

Two types of certificates are available: on totals, or on intensity; in this case the correction formula of the measures is provided in the certificate.

8 Technical specifications

Order numb.	DQA230	DQA231	DQA230.1/.3	DQA231.1	DQA235	DQA236
Class A (UNI11452:2012)	Yes (if correction formula is used)		No		Yes	
Calibration certificate	Not included (required for Class A recognition)		On demand		Not included (required for Class A recognition)	
Diameter	203 mm		203 mm		360 mm	
Area di raccolta	323 cm^2		323 cm^2		1000 cm^2	
Heater	No	Yes AC 24V (max 60 W)	No	Yes AC 24V (max 60 W)	No	Yes AC 24V (max 50 W)
Heater operative temperature	-	-20÷4 °C	-	-20÷4 °C	-	-20÷4 °C
Sifone	No	No	Yes	Yes	No	No
Accuracy	0÷500 mm/h intensity 3% UNI11452-2012 (using correction formula)		Rain fall amount 0÷20 mm/h: ± 0.2 mm (± 0,1 mm per DQA230.3) 20÷240 mm/h: 1% >240 mm/h: 2%		0÷300 mm/h intensity 3% UNI11452-2012 (using correction formula)	
Protections	Capacitor debounce circuit		Capacitor debounce circuit		Polarity reverse and transient. Capacitor debounce circuit	
Operative temperature	0÷80 °C	-20÷80 °C	0÷80 °C	-20÷80 °C	0÷80 °C	-40÷80 °C
Cable	Not included (DWA5xx)					
Material	Housing: aluminium Tipping spoon: teflonate plastic Base: plastic		Housing: aluminium Tipping spoon: teflonate plastic Base: plastic		Housing: aluminium Tipping spoon: stain-less steel Base: PED	

Common features:

Principle	Tipping-bucket
Design	WMO accordance
Output	Dry reed switch contact pulses
Pulse duration	100 ms ± 50
Output resistance	100 mΩ
Leveling unit	Air bubble attached to the base
Protection from dirt	Removable filter at the entrance
Protections	IP66
Data logger compatibility	M-Log (ELO008), E-Log, Pluvi-ONE, AlphaLog

9 Disposal

This product is a device with high electronic content. In accordance with the standards of environmental protection and collection, LSI LASTEM recommends to handle the product as waste of electrical and electronic equipment (RAEE). For this reason, at the end of its life, the instrument must be kept apart from other wastes.

LSI LASTEM risponde della conformità della filiera di produzione, vendita e smaltimento del prodotto, assicurando i diritti dell'utente. Lo smaltimento abusivo di questo prodotto provoca sanzioni a norma di legge.

10 How to contact LSI LASTEM

In case of problem contact the technical support of LSI LASTEM sending an e-mail to support@lsi-lastem.com, or compiling the technical support request module at www.lsi-lastem.com.

For further information refer to addresses and numbers below:

- Phone number +39 02 95.414.1 (switchboard)
- Address: Via ex S.P. 161 – Dosso n. 9 - 20049 Settala Premenugo, Milano
- Web site: www.lsi-lastem.com
- Commercial service: info@lsi-lastem.com
- After-sales service: support@lsi-lastem.com, Repairs: riparazioni@lsi-lastem.com