HydroLynx Systems, Inc.

Model 2595
Precipitation Gauge Calibration
Bottle Assembly

Instruction Manual

Document No: A102714
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Receiving and Unpacking

Carefully unpack all components and compare to the packing list. Notify HydroLynx Systems immediately concerning any discrepancy. Inspect equipment to detect any damage that may have occurred during shipment. In the event of damage, any claim for loss must be filed immediately with the carrier by the consignee. If the equipment was shipped via Parcel Post or UPS, contact HydroLynx Systems for instructions.

Returns

If equipment is to be returned to the factory for any reason, call HydroLynx between 8:00 a.m. and 4:00 p.m. Pacific Time to request a Return Authorization Number (RA#). Include with the returned equipment a description of the problem and the name, address, and daytime phone number of the sender. Carefully pack the equipment to prevent damage during the return shipment. Call HydroLynx for packing instructions in the case of delicate or sensitive items. If packing facilities are not available, take the equipment to the nearest Post Office, UPS, or other freight service and obtain assistance with packaging. Please write the RA# on the outside of the box.

Warranty

HydroLynx Systems warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from the date of shipment from the factory. HydroLynx Systems' obligations under this warranty are limited to, at HydroLynx's option: (i) replacing; or (ii) repairing; any product determined to be defective. In no case shall HydroLynx Systems' liability exceed product's original purchase price. This warranty does not apply to any equipment that has been repaired or altered, except by HydroLynx Systems, or that has been subjected to misuse, negligence, or accident. It is expressly agreed that this warranty will be in lieu of all warranties of fitness and in lieu of the warranty of merchantability.

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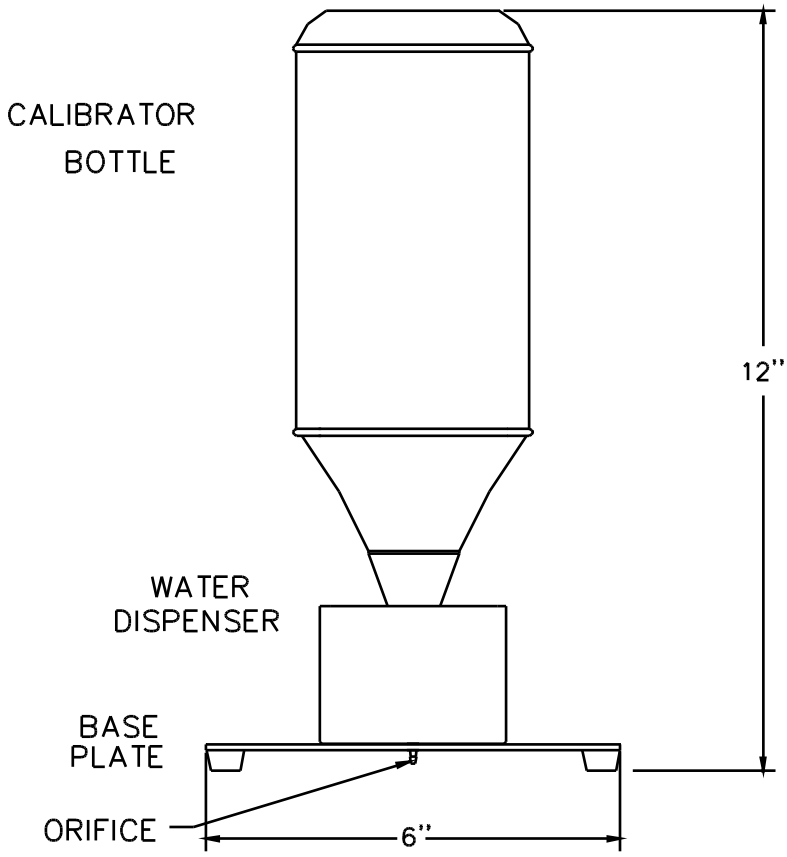


HYDROLYNX SYSTEMS
RAIN GAUGE
CALIBRATION BOTTLE ASSEMBLY

MODEL 2595

1.0 INTRODUCTION

The HydroLynx Model 2595 Precipitation Gauge Calibration Bottle is designed to simplify rain gauge calibration and verification. The assembly includes a 946 ml calibration bottle, a constant flow water dispenser with base plate, four calibration orifices, and a 10cc (ml) syringe.

2.0 ASSEMBLY AND USE

2.1 Orifice

The four orifices included provide a range of rainfall rates. The 5050P is calibrated at the 128 mm/hr rate. Select the correct orifice by measuring the nozzle length from the face of the hexagon shoulder to the tip; refer to the table below.

Rainfall Rate (mm/hr)	Nozzle Length	Orifice Diameter
19	3/16"	1/32"
61	5/16"	1/16"
128	3/8"	3/32"
288	5/8"	1/8"

Carefully align threads with hole in water dispenser and tighten by hand. The orifices are made of soft plastic and are easily damaged; always place the assembly orifice side up when not in use.

2.2 Calibration Bottle

Fill the calibration bottle with water to the "fill line" which is 946 ml; the standard volume of water for calibration. Thread the water dispenser, with the orifice installed, onto the bottle.

2.3 Use of Calibration Bottle

Place the calibration bottle into the rain gauge by first covering the orifice with the tip of a finger and then inverting the bottle assembly. The bottle must be turned smoothly and quickly to avoid losing water out of the slots in the water dispenser; this may take some practice. When the bottle is empty a small amount of water will remain in the water dispenser; hold the calibrator bottle over the rain gauge funnel and tip the bottle so that the remaining water spills into the funnel. Avoid contact with the rain gauge to prevent accidental tipping of the bucket.

3.0 THEORY OF OPERATION

The original design constraint for the calibration bottle was "A simple and accurate calibration method".

3.1 Tipping Bucket Calibration Requirements

3.1.1 Volume

The calibrator must deliver a measured volume of water, 72.97 ml per tip. For static calibration we deliver measured volume of water for one tip; and for dynamic calibration we deliver enough for multiple tips.

3.1.2 Constant Flow Rate

Dynamic calibration requires a constant flow rate. One cause of error inherent in the tipping bucket design is the time it takes for the bucket to tip. Water continues to flow into the bucket while it is tipping, this water is not measured. The higher the flow rate the more water is lost. Assuming that the "time-for-tip" is constant, this error is linear to the flow rate. Thus, at a constant flow rate, the error is also constant and can be accounted for in the calibration procedure.

3.1.3 128mm/hr Flow Rate

The calibrator must have repeatable results. A second cause of error inherent with the tipping bucket design has to do with the time the bucket is in a balanced position. When the bucket is in this balanced position events other than the correct measured amount of water can cause the bucket to tip. This error is random but the probability of early tips decreases inversely with the flow rate. At 128 mm/hr this error no longer has a measurable effect.

3.1.4 Reliable Test Procedure

The calibrator must have a test procedure which can be preformed reliably in the field. Another cause of errors is test procedures which produce unreliable and non-repeatable results in field situations. This is partially due to the required precision of measurement; as with static tests, or equipment which is not standardized for volume and flow rates. Extensive factory testing with a number of 5050P Tipping Buckets has allowed HydroLynx to create a typical calibration curve and error bands around the curve. From these a test procedure was developed which allows a single point calibration method which ensures that the gauge meets specified error parameters. This procedure is simple and quick for field use, yet reliable enough for bench calibration tests.

3.2 Calibration

The calibration procedure measures the amount of water required to tip the bucket some number of times. To make this as simple as it sounds there are many parameters which must be determined:

(1) Number of tips: 13
(2) Volume of water: 948.6
(3) Flow rate: 128 mm/hr
(4) Error and Limits: -0.85 % ± 0.77 %
(5) Limits expressed as volume: 949.3 to 963.9 ml

These values where determined from factory testing.

3.3 Calibration Constants and Calculations

3.3.1 Constants and Conversion Factors

1 inch = 2.54 centimeters (cm)
0.1 cm = 1 millimeter (mm)
1 cm^3(cc) = 1 milliliter (ml)

3.3.2 Volume per Tip

Volume/Tip = Area of rain gauge orifice x measured rain/tip
Area = πr^2
1 Tip = 1 mm

Volume = π (6 in x 2.54 cm / 1 in)^2 x 0.1 cm
= 72.965877 cm^3
= 72.97 ml

3.3.3 Volume per Thirteen Tips and Bottle Measurement

13 x 72.97 ml = 948.6 ml
1 Bottle = 946.0 ml

3.3.4 Limits

The limits are determined from the 5050P error curve. The error at 128 mm/hr is -0.85 % ± 0.77%; which is: -8.0 ml ±7.3 ml or -0.07 to -15.3 ml.

(Volume/13 tips - error band = total volume) - bottle = limit on water added
(948.6 - (-0.07) = 949.3) - 946.0 = 3.3 ml
(948.6 - (-15.3) = 963.9) - 946.0 = 17.9 ml

4.0 TESTING AND CALIBRATION

Refer to Document #'s: A100900 Calibration and Testing Certificate, AC108024 Typical Calibration Curve and AC108025 5050P Error Curve.

4.1 Field Verification

4.1.1 Setup

- Clean debris from funnels and buckets.
- Check level on the 5050P.
- Thoroughly wet the 5050P funnel and buckets.
- Connect 5050P to 5096.

4.1.2 Test Procedure

- Record beginning count.
- Use 128 mm/hr flow rate.
- Fill bottle with 946 ml water.
- Invert bottle and place into 5054TS funnel or place on 5050P funnel.
- Wait for water to empty into gauge.
- Empty remaining water from water dispenser into gauge.
- Record count.
- Add water using syringe to obtain final count.
- Record amount of water added.

4.1.3 Test Results

The field verification should produce the following results:

- Record count: 12
- Record amount of water added: 3.3 to 17.9 ml

4.2 Bench Calibration

Follow the same procedure as field verification to perform a dynamic test on the bench. The results will vary when flow rates other than 128 mm/hr are used.

4.2.1 Calibration Curve Offset

The typical calibration curve is an average of multiple bottle tests performed on many 5050Ps at the four flow rates provided by the supplied orifices. This curve is centered at zero % error for 128 mm/hr flow rate because of the linear nature of the error curve at this point. When the error band is added to this curve the 128 mm/hr point is negatively offset so that all points are within specified error.

Based on specific conditions at the rain gauge location, it may be advantageous to offset the calibration curve so the rain fall rate of interest is at zero % error.

Example: To offset the curve so that 25 mm/hr (1 in/hr) is at zero % error, the 128 mm/hr rate must be offset -1.79 %. The error at 128 mm/hr is therefore -1.79 % ± 0.77%; which is: -17.0 ml ±7.3 ml or -9.7 to -24.3 ml.

(Volume/13 tips - error band = total volume) - bottle = limit on water added

(948.6 - (-9.7) = 958.3) - 946.0 = 12.3 ml
(948.6 - (-24.3) = 972.9) - 946.0 = 26.9 ml

- Record count: 12
- Record amount of water added: 12.3 to 26.9 ml

4.2.2 Multiple Bottle Tests

Due to the random nature of the error at low flow rates, multiple bottle tests may be required to check the accuracy of the gauge at these rates. Care must be taken when removing and replacing the bottle to keep gauge from tipping. Also, the remaining water in the water dispenser must be added to the gauge. During factory testing six bottles were used for multiple bottle tests.

Example: To test the 61 mm/hr rate for the standard 5050P calibration the error is 0.45% ±0.77% which is an error band of 1.22% to -0.32%.

Volume/78 tips = (6 x 13 = 78 tips) x 72.97 ml = 5691.7 ml
Volume/6 bottles = 6 x 946 ml = 5676 ml
error band = (5691.7 x 0.0122) = 69.4 ml
error band = (5691.7 x -0.0032) = -18.2 ml
(Volume/78 tips - error = total volume) - 6 bottles = limit on water added

(5691.7 - 69.4 = 5666.1) - 5676 = -53.7 ml

- Record count: 78
- Record amount of water added: -53.7 ml

The negative value for the amount of water added means there is water in the bucket after the last tip. This water can be measured with the syringe or water can be added to cause another tip.

5691.7 + 18.2 - 5676 = 33.9 ml

- Record count: 77
- Record amount of water added: 33.9 ml

5.0 FORMS AND DRAWINGS

A100900 Calibration and Testing Certificate
AC108024 Typical Calibration Curve
AC108025 5050P Error Curve

5050P CALIBRATION AND TESTING CERTIFICATE

Document Number A100900-1

Date:	Job number:
Inspector:	Serial number:

TEST PERFORMED:

Set the static operating points of the two tipping buckets. Measure dynamic operation accuracy. Static tipping point is measured using 30 cc and 10 cc syringes, accuracy +/- 1 ml. Dynamic test requires a measured amount of water applied at a known flow rate. Tested accuracy of the gauge should fall within the shaded area of the graph at bottom of page. Test starts with left bucket tipping first for consistency.

CALIBRATION EQUIPMENT:

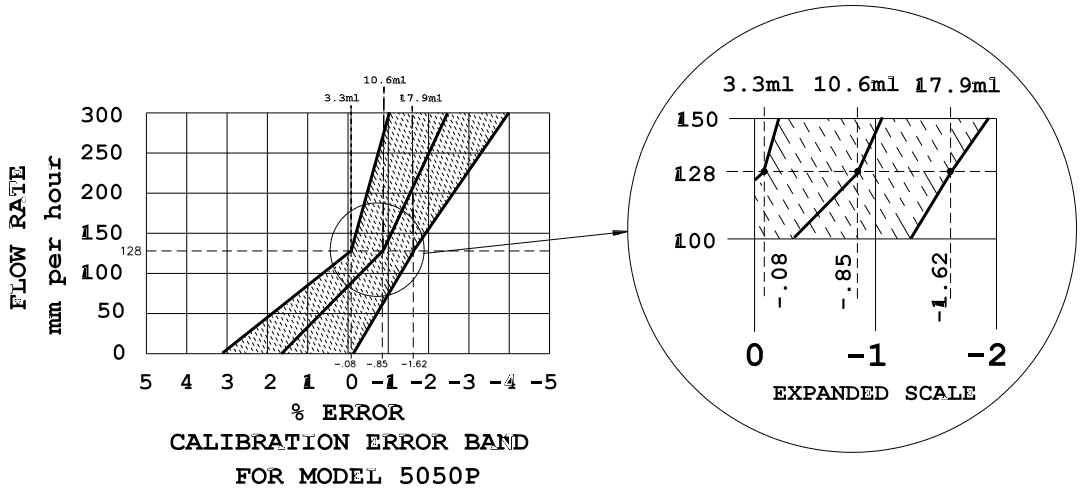
Model 260-2595 Calibration Bottle With 5 in/hr NOZZLE
Electronic Counter
100 cc Calibrated Cylinder
30 cc Syringe
10 cc Syringe
Digital Scale

CALCULATED VALUES:

1 Bucket Tip = 1 mm (72.96 ml) of rain
Test Flow Rate Is at 128 mm/hr (5 in/hr)
Flow Test Volume of Water = 946 ml
Calculated Results: Total Tips = 12.96
Desired Dynamic Test Results: Total Tips = 12.75 to 12.85

MEASURED RESULTS: Adjusted Bucket Tipping Points:

Left Bucket:	ml	Right Bucket:	ml
Dynamic Test:	counts	Accuracy:	%



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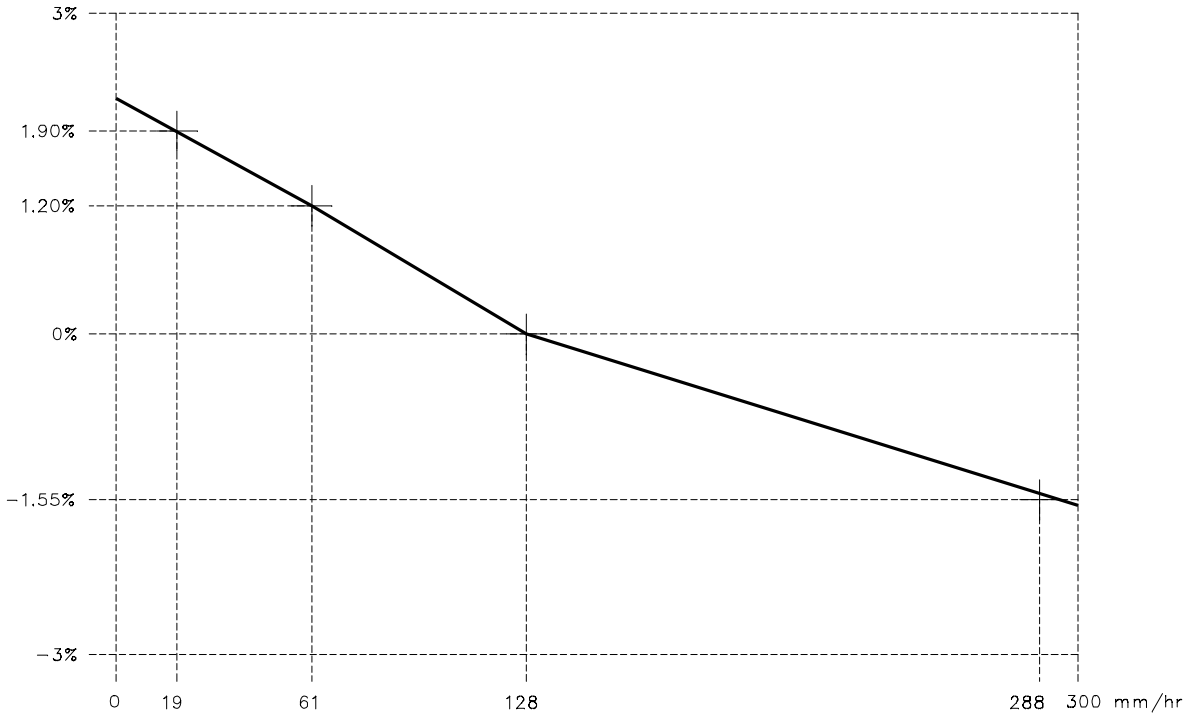
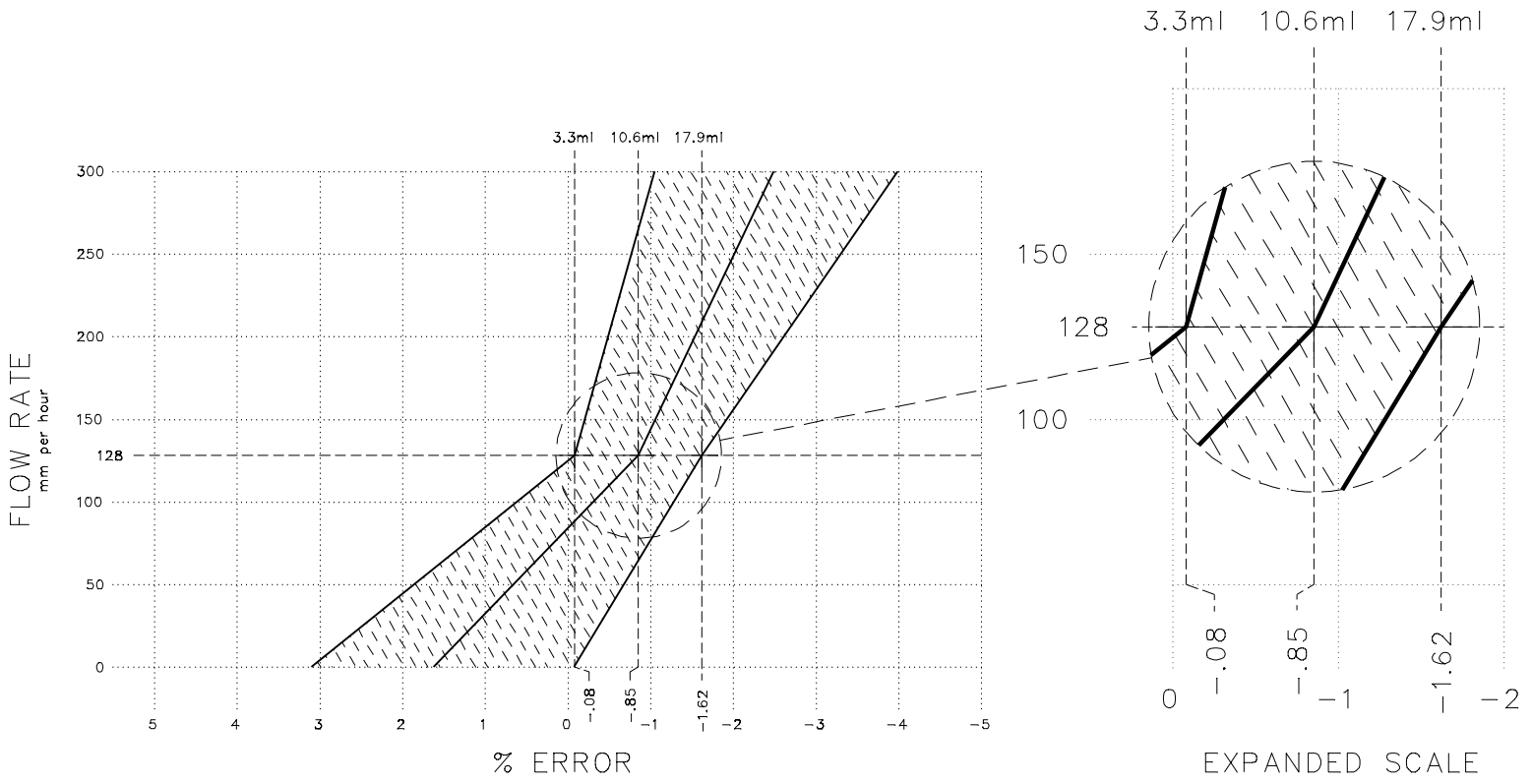


MODEL USAGE		HydroLynx		
		MODEL NO. 5050P		
		TITLE TYPICAL CALIBRATION CURVE		
DRAWN BY M.MALONEY	DATE 2-9-99	DWG TYPE CURVE		
CHECKED BY J.JOHNSON	DATE 2-9-99	SIZE A	DWG NO. AC108024	REV A



CALIBRATION ERROR BAND
FOR MODEL 5050P

MODEL USAGE		HydroLynx	
		MODEL NO.	5050P
		TITLE	CALIBRATION CURVE WITH ERROR BAND CURVE
DRAWN BY: M.MALONEY	DATE: 2-18-99	DWG TYPE	CURVE
CHECKED BY	DATE	SIZE: A / DWG NO.: AC108025	REV: A