



GEONOR

T-200B SERIES PRECIPITATION GAUGE

MANUAL FOR

600-mm, 1000-mm & 1500-mm capacity gauges





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1. INTRODUCTION - PRECIPITATION GAUGE

1.1. Principle of Operation

The T-200B Series Precipitation Gauges are weighing bucket precipitation gauges. They are available in **600-mm**, **1000-mm** and **1500-mm** capacity versions. It uses a precision vibrating wire (VW) transducer to weight and determine the precipitation collected. The collection container in the T-200B Series gauge is suspended from three points, each supporting 1/3 of the weight. With this type of set-up there are options available to measure precipitation with up to triple redundancy. With equal load distribution, 1, 2 or 3 VW transducers, from now on referred to as sensors, can be used to measure total precipitation and rate of precipitation. The use of extra sensors provides backup and redundancy in case one transducer stops recording. As long as 1 of the sensors is recording the precipitation rate and total will be recorded. With proper care sensors have been shown to record for more than 30 years without failing.

The Sensor was developed in the 1960's at GEONOR's then parent research foundation, The Norwegian Geotechnical Institute (NGI.) Bakkehøi¹, et al (1985). NGI used the Sensor in the T-200B gauge to measure rain and snow precipitation. NGI developed the gauge due to the need for automatically recording precipitation for avalanche research.

1.2. Why it is used

Since its introduction in 1985, based on the results of extensive tests by the World Meteorological Organization (WMO) it was adopted by several Scandinavian meteorological services. Starting in the late 90's U.S. and Canadian agencies have tested the gauge extensively with good results. Consequently it has seen increasing use in North America.

1.3. Benefits of using Vibrating Wire Transducers

The Sensor has certain advantages over other types of load transducers and counting systems used in precipitation gauges:

- (1) Sensitivity better than 0.1 mm.
- (2) It has little temperature sensitivity.
- (3) It has no moving parts.
- (4) Very low power consumption.
- (5) The pulse signal can be transmit by cable over 1 km.
- (6) Data Acquisition Systems can easily log the 0 to 5 V signal with the TH-501 Interface.
- (7) Exceptional Long-term drift free performance – measured by a 27-year test at NGI.

¹ See References – Section 3.



2. INSTALLATION

IMPORTANT: A solid foundation and rigid pedestal are needed for proper gauge performance. We recommend using a GEONOR pedestal.

2.1. Foundation considerations in soil, on rock, or on a structure

Regardless of whether the pedestal is installed in soil, on rock or on a structure, the pedestal must be rigid enough to prevent movements and vibrations due to wind, frost heave, loosening of soil, etc.

2.2. Plan height of collection orifice above anticipated snow depth

With the foundation flush with ground, and using the 1-m pedestal the inlet on the;

- T-200B (600-mm capacity) will be approximately 1.75-m above ground.
- T-200B-M (1000-mm capacity) will be approximately 1.75-m above ground.
- T-200B-MD (1500-mm capacity) will be approximately 2.05-m above ground

It is recommended to install the gauge so the inlet is at least 50 cm (20 inch) above the anticipated snow depth. For deeper snow a 2.5 m pedestal is available or the concrete foundation can be elevated.
(Customized pedestals are available.)

2.3. Locate gauge away from structures and objects

For best results, locate the gauge where the wind is least affected by structures. i.e. buildings, cliffs, and trees, etc. A minimum of 45° from the top of the inlet to open sky should be observed.

2.3.1. Attaching pedestal to foundation.

The pedestal will be attached to the foundation with 4 anchor bolts. The bolts should be oriented in a North – South & East – West cross (see Fig 7.6). Make sure bolts are set vertically. Distance between N - S bolts should be 225 mm and 225 mm between E - W bolts. A wood template can be helpful in positioning the anchor bolts properly (see Fig. 7.6).

2.3.1.1. Anchor bolt size, length & material

$\frac{7}{8}$ " , $\frac{3}{4}$ " or 20-mm – Ø galvanized or stainless steel threaded anchor bolts at a minimum length of 375 mm (15 inch). Make sure to leave at least 150 mm (6 inch) of exposed thread above foundation surface for to mount pedestal.



2.3.2. Concrete foundation

The concrete foundation block (Fig. 7.6.) must remain steady. As a general guideline, see dimensions in (Fig. 7.6). The size and depth depends mostly on frost depth and the strength of the soil. Other factors may come into play at different location. Movement of the gauge may lead to errors in the data.

2.3.2.1. Excavation depth

Excavate deep enough to avoid movement from frost heave or dynamic forces caused by wind, etc. As a general guideline excavate 600 to 1000 mm (24 to 40 inch) deep.

2.3.2.2. Size of concrete block foundation

The height of the block can extend from flush with the ground to any required height depending location. A typical concrete foundation block width is 600 mm (24 inch) square.

2.3.3. Rock foundation

On a competent rock surface, drill holes for anchor bolts (see sec 2.3.1.). Grout the anchor bolts in place at minimum depth of 200 mm. Make sure there is sufficient thread to mount the pedestal, at least 150 mm (6 inch) (see Fig. 7.7.).

2.4. Pedestal Installation

IMPORTANT: A stable pedestal is required for accurate data. If there is movement of the gauge your data may be affect.

2.4.1. Pedestal details

We recommend the T-200B gauge be mounted on a GEONOR pedestal. GEONOR provides galvanized steel pedestals in 1 m and 2.5 m heights.
**Custom lengths are available*



2.4.2. Installing pedestal

Mount the reaction nut, lock washer and washer on anchor bolt approx 1" above the surface (see Fig 7.7). *Do not let pedestal rest on concrete base. Using the level, adjust the 4 reaction nuts so they are level and add the lock-washers and washers. When mounting pedestal, the 3 taped mounting holes on top of the pedestal should form a triangle pointing south (See photo 2-2). Make adjustments to level gauge and install upper washers, lock-washers, and nuts on anchor bolts. Tighten and check that the pedestal is rigid and level. Make adjustments if necessary.



2.5. Precipitation Gauge installation

2.5.1. Remove gauge cover

To remove the cover, release the 3 clamps around the base and lift it straight up to clear the frame.

NOTE: Press hook into locking lugs to keep them from catching on base. (See photo 2-1)



(Photo 2-1)

2.5.3. Placing gauge on pedestal

Align support holes in the base of gauge with mounting holes on top of pedestal (See photo 2-3). This places 1 Sensor at the northern point.



(Photo 2-2 – Pedestal)



(Photo 2-3 – Gauge frame on Pedestal)



2.5.4. Insert mounting bolts

Insert the 3 M8x1 bolts through the black washers into the support holes in the base and screw into pedestal. Do not tighten bolts leave space to adjust level orientation of gauge. Level the gauge by using the level supplied and adjusting the leveling screw located under the gauge. When the gauge is level tighten the 3 mounting bolts.

2.5.5. Install transducer/s & support chains

IMPORTANT: The Sensor has a setscrew on the side which helps protect it. The screw must be loosened or removed for the sensor to work.

If using 1 sensor, install it at the northern support point. Install support chains in the other 2 support points. If this is a 3-sensor unit, install sensors and make notes of each location. Make sure the wires from sensor are on the same side as the hole in the rim.

Connect S-hooks at bottom of sensors and chains to support dish through predrilled holes. Place level across support dish. By turning the black knurl nuts on the sensors and chains fine-tune the level of the support dish.

2.5.6. Install container in support dish

Carefully place the container in the support dish making sure it sits snug. Align mark on bucket (black dot) with the location of similar mark at one of the support points. This is to ensure similar installation when the container is removed and replaced. Check level by placing the level on the container and adjusting the black knurl nuts again.

2.6. Electrical hookup

2.6.1. Connect Sensor to Transient Arrestor (TA) on rim

Line up wire coming from top of the sensor with opening in support rim so wire comes straight up through the rim. ***Do not bend wire in more than 3-cm radii and do not clamp the wire to the rim of the gauge without leaving enough slack (see photo 2-4).** Connect wire to green transient arrestor box on the support rim, red (+) to terminal 6, and black (-) to terminal 4. Use wire clips or cable ties to keep in place.



IMPORTANT: Leave enough slack in the wire so it feeds straight up through the hole in the rim and does not cause the sensor to move.



(Photo 2-4 - wire from sensor)

2.6.2. Connect wires from Transient Arrestor to Interface (TH501)

The wires should be properly shielded and be suitable for the environment to which it will be exposed. Geonor can supply any length cable required.

Pass cable through the base of the gauge and the strain-relief connector supplied. Strip wires to appropriate length. We suggest removing the jacket once inside the gauge for easier handling, especially if using a multi-pair cable. Run wires up gauge support through an opening in rim to Transient Arrestor. Connect (+) to terminal 5 and (-) to terminal 3. (See Fig. 7.2.). Repeat for each Sensor. Remove slack and tighten strain-relief connector. The transmission distance between gauge and data collection terminal can be up to 1 km. (3000 ft).

2.6.3. Over voltage protection – ground

If you are using a data logger it is suggested grounding the shielding at the data logger, not at the Transient Arrestor. Do not ground at both ends.

2.7. Add antifreeze as needed

When the gauge is operating below 0°C, an antifreeze blend must be added to keep collected precipitation in a liquid state. If the precipitation freezes the sublimation may occur and eventually the container may break.

It is important to notice that the capacity of the collected precipitation is decreased when antifreeze is added. The antifreeze becomes a part of the total volume collected. A blend of Propylene glycol² and Methanol² (40/60) is used by The US Climate Reference Network (USCRN). This blend is used to make the antifreeze and H₂O similar in density preventing stratification. Stratification will lead to the formation of ice. Tables in the following sections show the amount of Propylene glycol needed to keep the collected precipitation from freezing at various temperatures. Other antifreeze solutions have been used successfully.

² Check with local regulations regarding disposal.



2.7.1. Antifreeze quantities required for below freezing temperatures.

Antifreeze, at a 40/60 ratio can be purchased from Greenway Chemical Co.

T-200B - 600 mm gauge collection container max capacity of 12 liters.

T-200B-M -1000 mm gauge collection container max capacity of 20 liters.

T-200B-MD - 1500 mm gauge collection container max capacity of 30 liters.

| Antifreeze Solution Propylene Glycol (40%) / Methanol (60%) | | |
|--|---------------------|---------------------|
| Antifreeze as % of total capacity | Freezing Point (°F) | Freezing Point (°C) |
| 0 | 32 | 0 |
| 10 | 26 | -3 |
| 20 | 20 | -7 |
| 30 | 10 | -12 |
| 36 | 0 | -18 |
| 40 | -5 | -20 |
| 43 | -10 | -23 |
| 48 | -20 | -29 |
| 52 | -30 | -34 |
| 55 | -40 | -40 |
| 58 | -50 | -46 |
| 60 | -60 | -51 |

2.8. Add thin layer of Oil to Eliminate Evaporation

To eliminate evaporation it is essential to use oil in both winter and summer. Add 0.4 liters oil. We recommend the Low Pour Hydraulic Oil from Lubriplate Co. Other oils have been used. It must not become viscous in the temperature ranges anticipated. It is recommended to change the oil at least once a year to avoid deterioration, which can result in evaporation of collected precipitation.

2.9. Loosen Setscrew on transducer

***If you have not already installed sensor and support chains, go to section 2.5.5 before continuing.**

Unscrew the setscrew at least 4 revolutions to keep it clear of the vibrating wire. It can be removed completely or left in place after loosening. If left in place, wrap the electrical that came with the sensor around the sensor and setscrew again to keep it in place.

We recommend keeping the setscrew tight until maintenance has been completed.

2.10. Replace gauge cover

Replace gauge cover and snap the 3 clips in place.

NOTE: The clips fasten to sections of the base with a lip. Look or feel for these sections.



2.11. Install Alter Type Wind Screen (see section 4, p.13)

To prevent undesirable effects of wind turbulence around the gauge, a Wind Screen should be installed.

The GEONOR pedestal has Wind Screen mounts on the pedestal. Using the Geonor Alter Wind Screen assures a proper installation at the specified, 13-mm height above the top of the gauge orifice. (See Section 4, p. 13)

Install the Alter windscreen so the blades are approximately 13-mm above the top of the T-200B inlet.

2.12. Connect data logger or manual read-out unit and begin readings

The Sensor is audible when power is supplied. Each transducer is slightly different but the approximate range is from 1000 Hz when empty to 3000 Hz with a full container.

To calculate the amount of precipitation in cm from the frequency, use the following formula.

Each sensor comes with its own calibration sheet specific for that sensor.

$$P = A (f - f_0) + B (f - f_0)^2$$

Where:

P = precipitation (in cm)
f = frequency reading (Hz)
A = Calibration constant, *given*
B = Calibration constant, *given*
f₀ = frequency with empty bucket at calibration (Hz), *given*



3. REFERENCES

Bakkehøi, Steinar; Kjell Øien and E. J. Førland (1985) An Automatic Precipitation Gauge based on Vibrating-Wire Strain Gauges, Nordic Hydrology No. 16, pp. 193-202

Tunbridge, Lloyd and Kjell Øien (1988) The advantage of Vibrating Wire Instruments in Geomechanics, 2nd Intl. Symposium on Field Measurements in Geomechanics, Balkema, Rotterdam, ISBN 90 6191 7786. Also publ. In Norwegian Geotechnical Institute (NGI) internal report 55100-7 April 1987.



4. INSTRUCTIONS FOR ALTER WINDSCREEN

If using a double Alter windscreen, it requires the installation of cement foundations for the 8 outer Alter windscreen posts. A diagram and dimensions can be found on page 17. We suggest installing the pedestal first and use the horizontal sections with the Kee-Klump to hold 4 of the vertical post in place while cement cures. **Important! Do not forget to slide the inner Kee-Klump on the horizontal section first.**

INNER ALTER WINDSCREEN PARTS

1. Blades (qty 32)
2. Spacers (qty 24)
3. Ring segments (qty 4)
4. Ring segment connectors (qty 4)
5. Kee-Klumps for ring segments (qty 4)
6. Kee-Klumps, 90° pipe fitting (qty 4)
7. 2-ft galvanized pipe, (thread on one end) (qty 4)
8. 3-ft or 4-ft galvanized pipe, (no thread) (qty 4)

OUTER ALTER WINDSCREEN PARTS

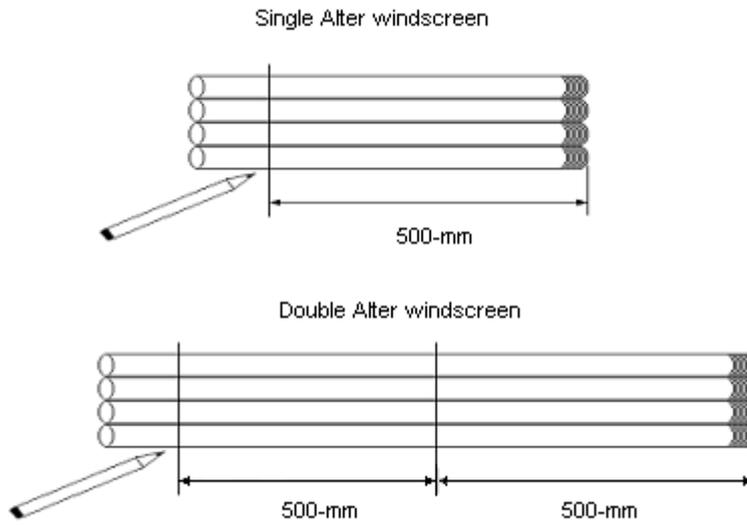
1. Blades (qty 64)
2. Spacers (qty 48)
3. Ring Segments (qty 8)
4. Ring Segment connectors (qty 8)
5. Kee-Klumps for ring segments (qty 8)
6. Kee-Klumps, 90° pipe fitting (qty 8)
7. Kee-Klumps, outer alter footings (qty 8) *
8. 4-ft galvanized pipe, threaded on one end (qty 4)
9. 3-ft or 4-ft galvanized pipe, no thread (qty 4)
10. 6-ft galvanized pipe, vertical support of outer Alter, no thread (qty 8) **

* Kee-Klump footings use 18" x ½" bolts, nuts and lock-washers to mount (see p.18).

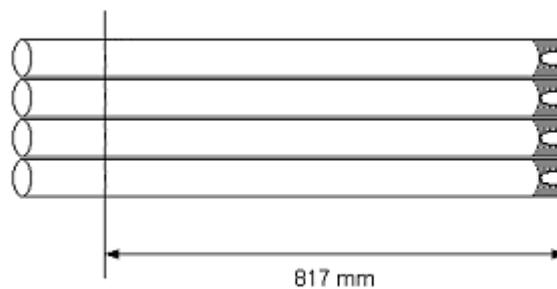
** The vertical support may require adjustments in length depending on the final height of the gauge inlet and the surrounding terrain. Standard inlet height is approximately 1.75-m (5.75-ft) above the surface.

Double Alter windscreen requires both the Inner and Outer Alter windscreen.

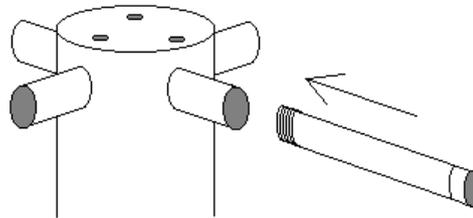
1. Mark 500-mm from the threaded end on the horizontal pipes for Inner Alter and mark 1000-mm for Outer Alter.



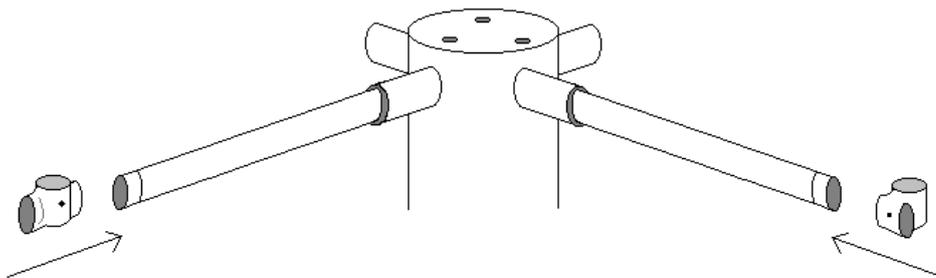
2. Mount connectors for ring segment on vertical sections of pipe. Mark 817-mm below the connector by wrapping tape around the pipe several times. This marks the level of the Kee-Klump. (See photo 4-1). Connectors for outer Alter can be mounted at a later time.



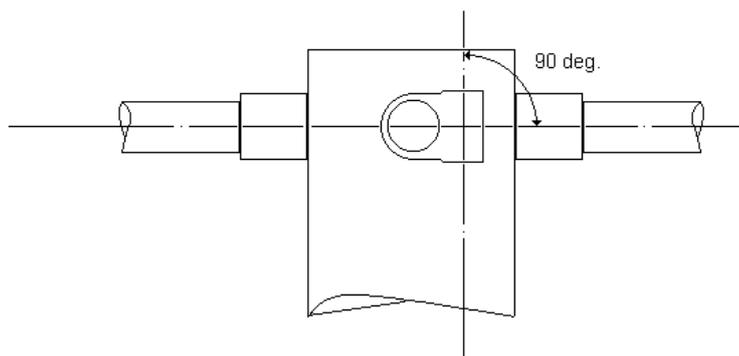
3. Insert horizontal tubes into the threaded fittings on the pedestal. Tighten with pipe wrench.



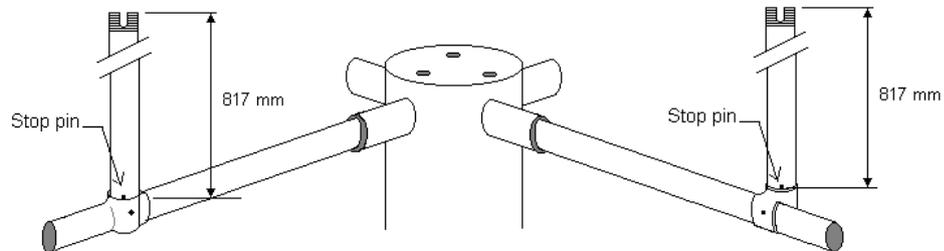
4. Slide the Kee-Klamps on so the inside edge lines up with the 500-mm mark and 1000-mm mark if applicable.



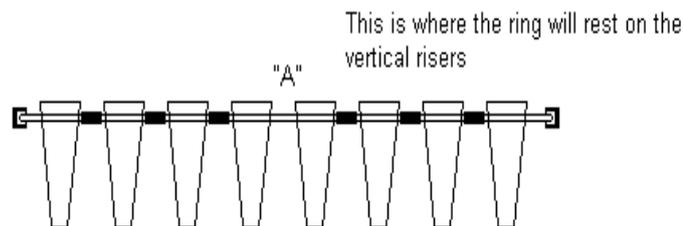
5. Align the clamps vertically and tighten nut with Allen key supplied. Adjustments will to be made later.



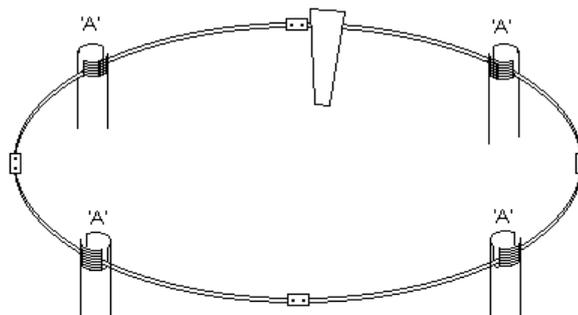
6. Insert vertical pipes for Inner Alter in Kee-Klamp with connector for ring at top. The tape will rests on the Kee-Klamp.



7. Lay ring segments of inner Alter down and attach a ring connector to end of each segment. Slide the blades and spacers in order shown below. Keep the channels of the blades facing outward. Connect the segments to complete a full circle.
(Note: The ring connectors and the ring slot "A" act as spacers.)



8. Place the ring in the slots of the Kee-Klamp (photo 4-1) on the vertical pipes.
(Note: Blades not shown)



9. Install Kee-Klamps on top of vertical pipes.



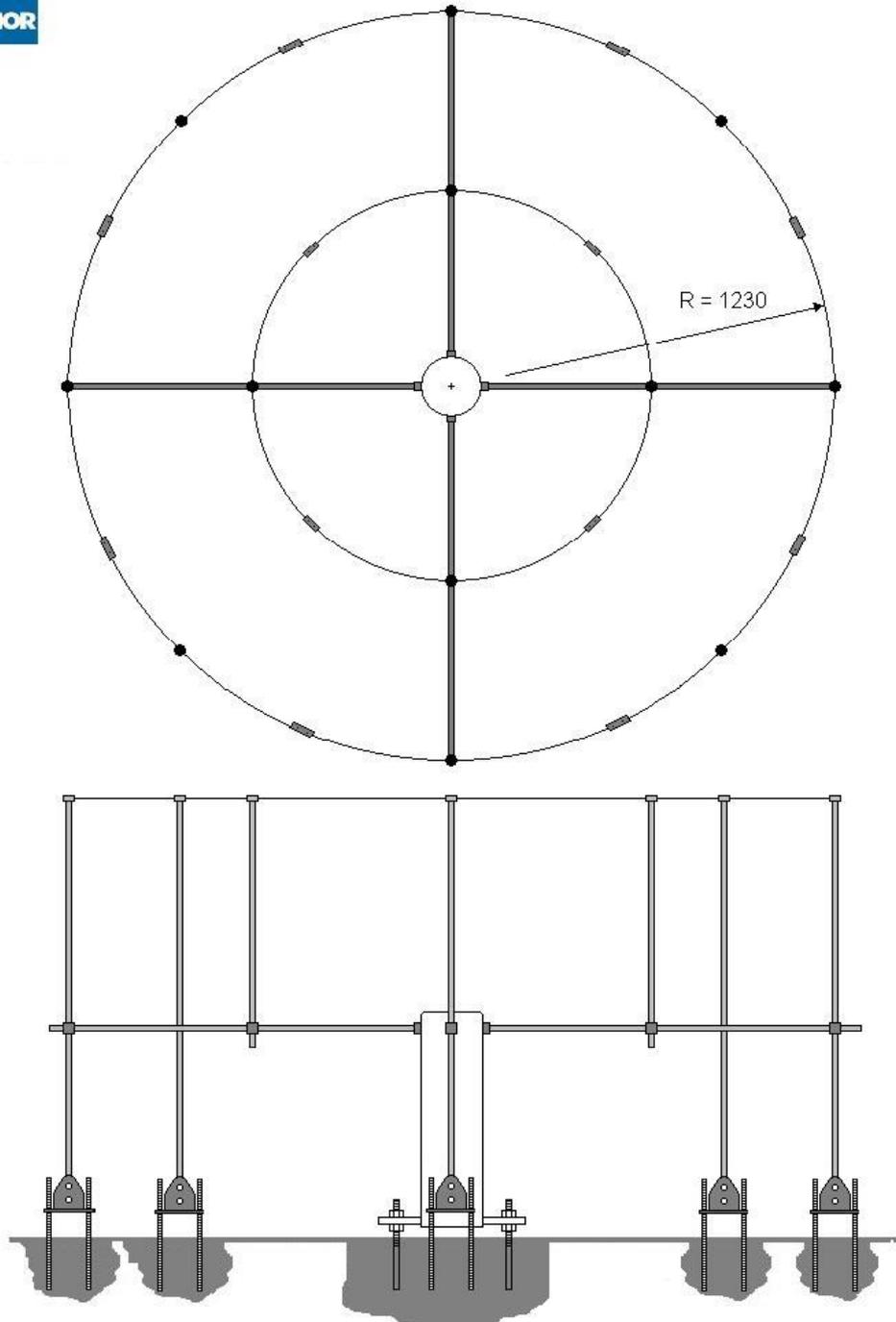
Photo 4 - 1

10. Make adjustments.

- 11. Arrange the 8 ring segments for outer Alter and follow steps to install blades, spacers and ring connector like step 7.**
- 12. With 3 or more people you can connect the 8 segments to form the complete the ring and put it in place. If not connect 4 sections to make a half circle and connect the 2 halves in place.**



GEONOR Inner & Outer Alter windscreen with pedestal



5. MAINTENANCE

5.1. Tools needed

- Screw driver, 4-mm blade
- Hammer
- Adjustable spanner (wrench) 0-27 mm
- Container for disposal of anti-freeze mixture (12 liter minimum)
- Funnel
- Measuring cylinder, 1 liter

Supplied tools

- Siphon
- Level

5.2. Service interval

Service the gauge when the container needs to be emptied. Inspection is recommended 2 times a year.

Automatic emptying systems have been used. Please contact us for more information.

5.3. Servicing

You may find servicing the gauge easier by removing the windscreen from 3 of the 4 posts as shown below.



(Photos 5-1 & 5-2)

Disengage the 3 spring fasteners holding gauge cover to the base and remove the housing (see Section 2.5.1.). Tighten the setscrew of the Sensor to avoid damaging the vibrating wire.

Antifreeze mixtures are toxic. Do not attempt to suck on tube to start flow.

NOTE: If the oil in the container does not need to be replaced there is no need to remove it.

Use the siphon pump supplied or something similar to remove liquid from container or remove manually. Remember a full container is very heavy.



Using the siphon pump supplied, place the shorter end at the bottom of the bucket. Holding the receptacle at a lower level than the bucket pump the siphon until flow starts. Once the flow has started there is no need to pump. Simply wait until you have removed the proper amount.

You can empty the bucket by hand. Be careful not to overload the VW load cell or subject it to any shock.

Clean bucket and add required anti-freeze mixture and oil. Replace carefully in the weighing dish aligning the black dot on the rim of the bucket with the one on the support rim.

*****Loosen the set-screw on transducer*****

Replace the gauge cover and lock 3 clamps.

5.4. Checking the function of the transducer

Empty bucket check

Level the bucket accurately (see Sections 2.5.4 & 2.5.6.). Check the frequency with an empty bucket (f_0 -value) using a datalogger or a GEONOR P-520N portable frequency counter³. Compare with the f_0 -value on the calibration certificate for the transducer. If the difference is equal or less than 10 Hz no adjustment is necessary. If the difference exceeds 10 Hz a new value for constant A should be calculated. Use the new f_0 and the new A in your calculations.

Formula for calculating a new constant A with new f_0

$$A' = A + 2B(f_0' - f_0)$$

Where A' and f_0' are new values, and A , B and f_0 are the original calibration values. (See Section 2.13. or calibration sheet)

Check with precipitation in the bucket

Fill the container with 1-kg of water. If the water is free of air this equals a volume of 1 liter. (Water from the tap can contain considerable air, which must be taken into account. Boiling for 10 minutes can remove most of the air.) 1 kg (1 liter) of water represents exactly 50 mm of precipitation. Recalibrate the Sensor if it differs by more than 0.5% from the value on the calibration sheet.

³ GEONOR model P-520M portable frequency counter.



GEONOR offers calibration services.

5.5. Removing and replacing transducer

- Remove gauge cover
- Tighten setscrew on VW load cell
- Lift out container carefully
- Disconnect electrical leads from the transient arrestor
- Unhook the S-hook from the support dish
- Hold the Sensor and remove knurled nut from top of adjustment screw
- Remove the Sensor from square guide in the support rim.

Install a new Sensor in the reverse order (see Section 2.5.5.)

IMPORTANT: The support dish must be free to swing in all directions without noticeable resistance. Resistance in the support links can contribute to error especially with low weights in the container.

When installing a new or recalibrated Sensor, use the new values for A, B and f_0 . These are given on the calibration sheet with the Sensor.

5.6. Rust protection maintenance

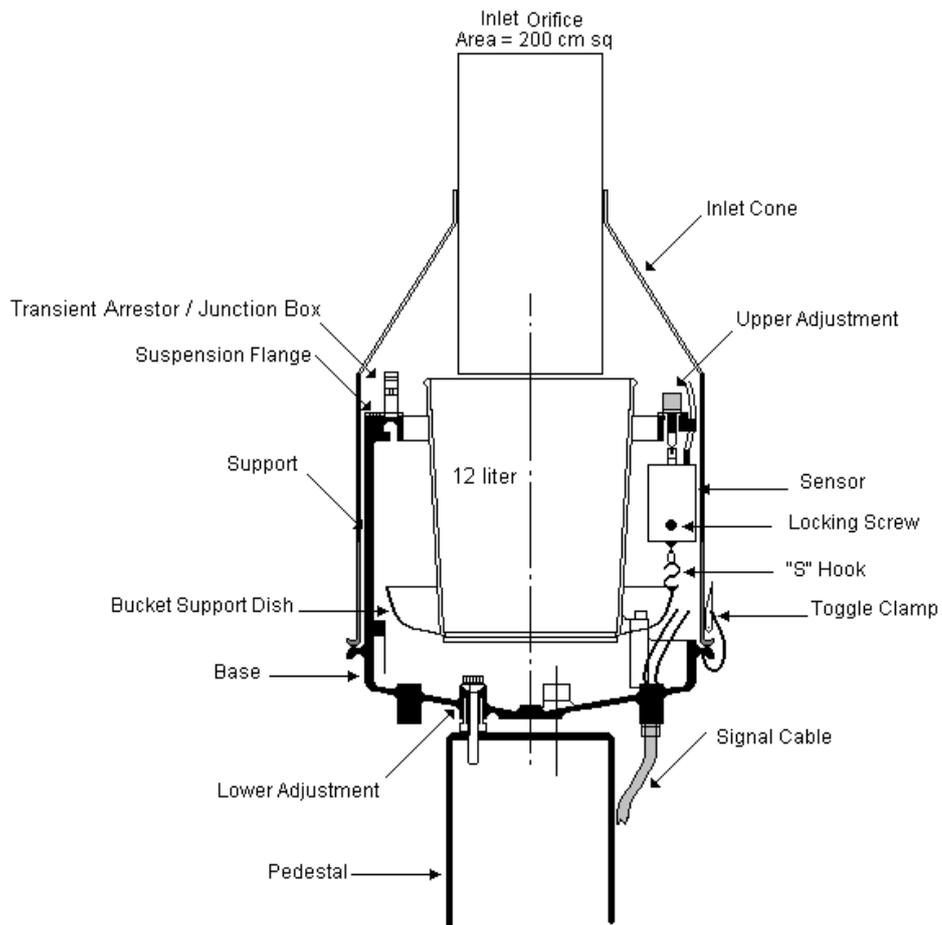
For added protection, apply two layers of a rust preventing coating such as paint, zinc-galvanizing spray or similar on all threaded parts of the pedestal and Wind Screen.



6. DRAWINGS / DIAGRAMS / FIGURES

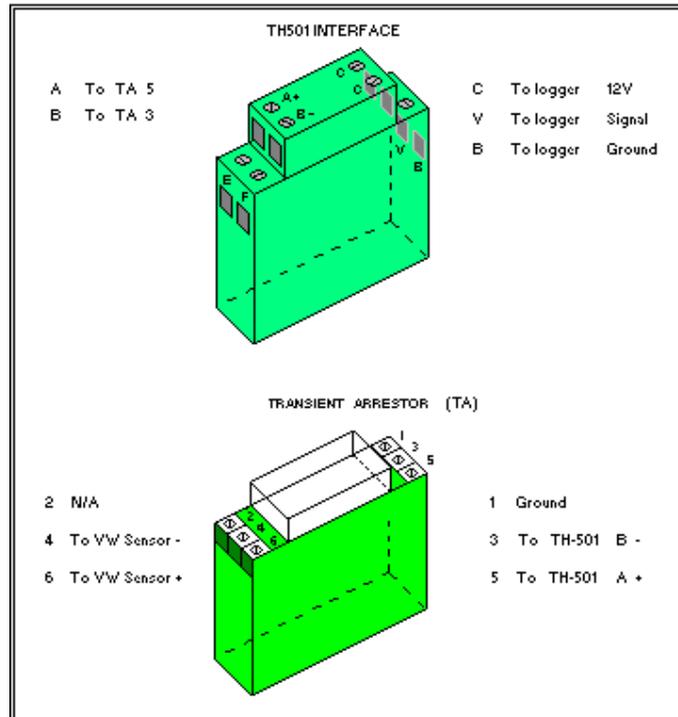
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GEONOR T-200B PRECIPITATION GAUGE



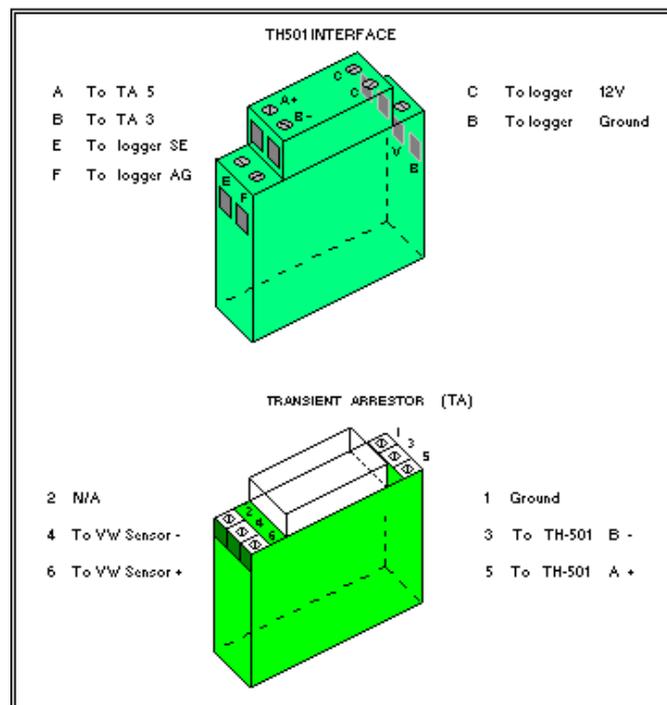
6.2

TH-501 INTERFACE & TRANSIENT ARRESTOR 0 to 5 V Square Wave Singal Option (Pulse Counting)



Ver 20080506

TH-501 INTERFACE & TRANSIENT ARRESTOR Using -2.5 to 2.5 V Square Wave Singal Option (Period Averaging)



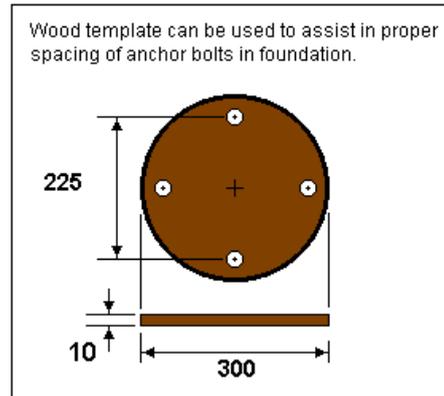
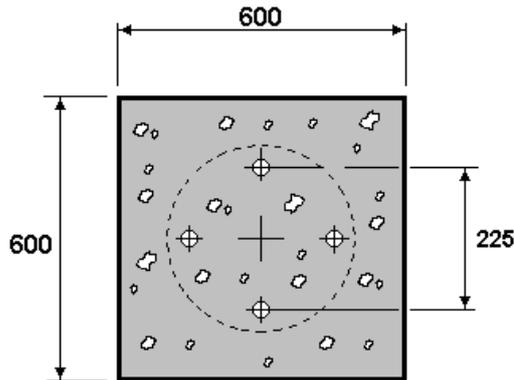
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6.3

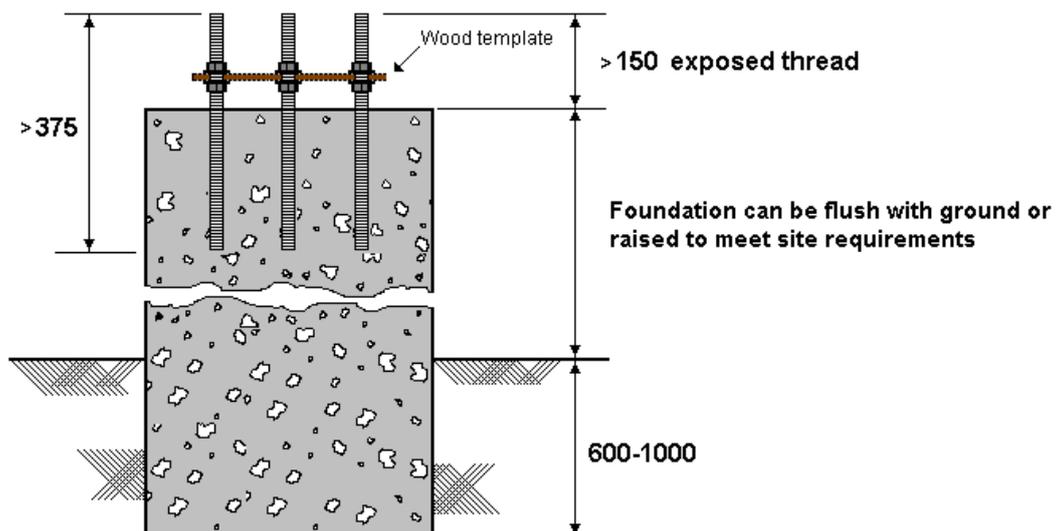
FOUNDATION BLOCK

Rev. 20091711

⚠ Dimensions in millimeters unless specified



Anchor Bolts $\frac{7}{8}$ " , $\frac{3}{4}$ " or M20



6.4

Rev. 20091711

