CS705 PRECIPITATION ADAPTER
INSTRUCTION MANUAL

REVISION: 9/01

Warranty and Assistance

The **CS705 PRECIPITATION ADAPTER** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 753-2342. After an applications engineer determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. CAMPBELL SCIENTIFIC's shipping address is:

CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

CAMPBELL SCIENTIFIC, INC. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover the repair.

CAMPBELL SCIENTIFIC, INC.

815 W. 1800 N.
Logan, UT 84321-1784
USA
Phone (435) 753-2342
FAX (435) 750-9540
www.campbellsci.com

Campbell Scientific Canada Corp.
11564 -149th Street
Edmonton, Alberta T5M 1W7
CANADA
Phone (780) 454-2505
FAX (780) 454-2655

Campbell Scientific Ltd.
Campbell Park
80 Hathern Road
Shepshed, Loughborough
LE12 9GX, U.K.
Phone +44 (0) 1509 601141
FAX +44 (0) 1509 601091

CS705 Precipitation Adapter

1. Introduction

The CS705 is manufactured by Campbell Scientific and is based on the paper "Measuring Winter Precipitation with an Antifreeze-Based Tipping Bucket System" presented at the 1996 Western Snow Conference (McCaughey and Farnes, 1996). The gage design possesses inherent delays and is not suitable for real time precipitation measurements. Three factors in the CS705 design contribute to the delays in precipitation measurement: air temperature or temperature of the liquid in the reservoir, surface tension in the overflow tube, and precipitation form. A delay of minutes is expected for liquid precipitation—after the gage receives a minimum volume (~0.03" water at 25°C). A delay of several hours (up to tens) is expected for precipitation in the form of snow. Lightest density snow at very cold air temperatures has the longest delay. All precipitation falling into the catch tube eventually flows through the overflow tube and is measured by the tipping bucket gage below.

The CS705 converts the TE525 or TE525WS tipping bucket rain gages manufactured by Texas Electronic or any 8" diameter tipping bucket rain gage into a year round precipitation gage. The CS705 is intended for use during the winter months only. The size of the antifreeze reservoir limits the use of the CS705 to valley locations or regularly visited mountainous locations. Like any sensor, optimum performance is obtained by regular site visits. Any antifreeze-based precipitation gage orifice is susceptible to capping or snow bridging. The CS705 is coated with a smooth black coating to minimize surface adhesion and maximize solar loading. But still, this is no guarantee that snow bridging may still not occur. Please keep this in mind.

The CS705 consists of a catch tube, antifreeze reservoir, and overflow tube (Figure 1). Antifreeze is used in the CS705 to convert snow to liquid water. The snow is captured in the catch tube and slowly melts into the antifreeze solution contained in the CS705 antifreeze reservoir. As the snow melts, the level in the antifreeze reservoir rises, this change in level results in a mixture of antifreeze and water flowing through the overflow tube to the funnel of the tipping bucket. A slot in the top of the overflow tube prevents the tube from developing a siphon.

2. Specifications

MODEL CS705 PRECIPITATION ADAPTOR

Material:	Black powder coated aluminum
Capacity:	8" of liquid @ -20^{0}C operating temperature (assuming 1:0 starting ratio of anti-freeze : water).
Antifreeze Capacity:	~2.5 gallons.
Catch Tube Height:	10"
Catch Tube Orifice:	8.0" diameter
Antifreeze Reservoir Height:	14"
Antifreeze Reservoir Diameter:	8.25"
Total Weight (CS705 + Antifreeze):	~20#s

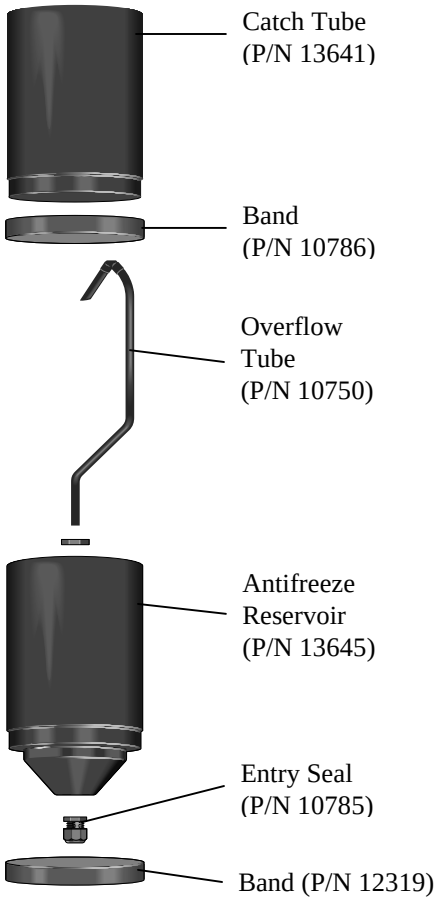

FIGURE 1. CS705 Exploded View

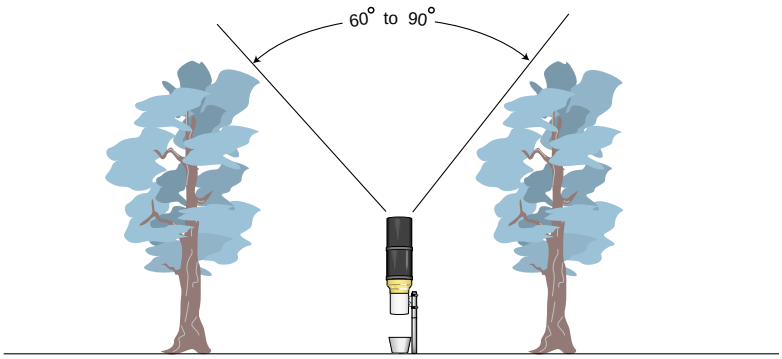

FIGURE 2. Proper Gage Siting

3. Locating Gage

The CS705 precipitation adapter and associated rain gage should be mounted in a relatively level spot which is representative of the surrounding area. The lip of the funnel needs to be horizontal and 30 inches above the ground or higher to prevent burial by snow. The ground cover around the gage should be natural vegetation or gravel. Avoid mounting the gage over concrete or paved surfaces.

The under catch of winter precipitation by antifreeze-based gages is directly related to wind speed. Errors due to wind can be minimized by properly siting your gage. The preferred gage site is in a natural "well protected" location. To ensure proper catch, an angle of 30^0 to 45^0 from a vertical line drawn through the center of the gage orifice to the surrounding obstructions should be maintained. Figure 2 illustrates the proper siting of a gage.

Gages sited improperly and subjected to high winds will under catch winter precipitation generating erroneous data. An improperly sited gage subjected to high winds can be damaged by the wind.

4. Installation

The CS705 is designed to fit inside the funnel of the TE525, TE525USW, or any 8" diameter tipping bucket rain gage.

4.1 Installing Mounting Base and Funnel to TE525 Rain Gage

Align the funnel and mounting base to the three holes found on the bottom of the TE525 rain gage. The funnel is sandwiched between the rain gage and mounting base as shown in Figure 3.

Figure 3 shows a mounting option to mount the CS705 precipitation adapter and TE525 rain gage. The user supplies items drawn as dashed lines. The 14090 mounting base screws on to 1 1/4" NPT treaded pipe. The 10487 funnel accepts 1/2" ID hose to drain the precipitation and antifreeze mixture into a suitable container. Band clamps are used to secure the CS705 to the support pipe.

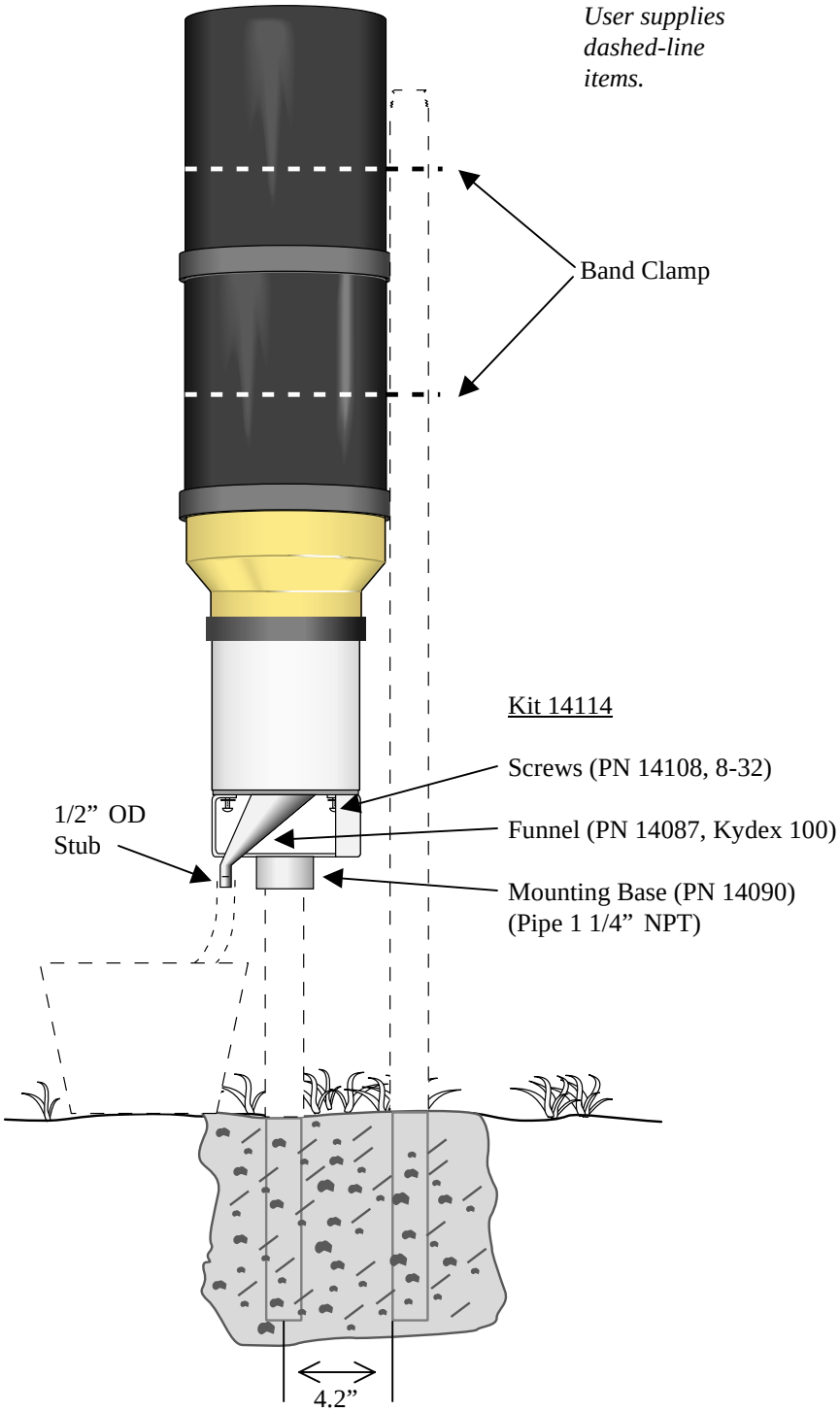

FIGURE 3. Raingage Installation

The CS705 is installed as follows:

- Take one of the black bands supplied with the CS705 and stretch over the rain gage funnel (8" funnels only).
- Insert the CS705 antifreeze reservoir into the rain gage funnel.

  Safety Precaution: Wear safety glasses during handling and pouring of antifreeze.

- Fill reservoir with antifreeze (Campbell Scientific part number 10869**), until a small amount flows out the overflow tube. The reservoir holds ~ 2.5 gallons of antifreeze.
- Add ~ 8 ounces of a low-freezing-point, environmentally safe oil to the antifreeze reservoir. This oil prevents the antifreeze solution from evaporating. The oil should cover the entire liquid surface. Some unscented baby oils (lightweight mineral oil) work well.
- Stretch the second black band over the lip of the antifreeze reservoir.
- Insert the catch tube into the antifreeze reservoir.
- Reposition the two black bands to cover the joints between the catch tube—antifreeze reservoir and reservoir—rain gage funnel. On 6" funnels the bottom band can be positioned to act as a drip lip around the base of the antifreeze reservoir.
- Container should be placed below the rain gage to collect the solution.
- Solution should be disposed of in accordance with local, state, and federal regulations.

** The recommended antifreeze is a 1:1 mixture of propylene glycol : ethanol (PGE). PGE is a less toxic substitute for glycometh (ethylene glycol and methanol), historically used in antifreeze-based precipitation gages.

5. Datalogger Programming

Refer to the manual supplied with your particular rain gage. If the CS705 is used with the standard TE525 rain bucket, the multiplier will need to be corrected for the difference in the catch orifice diameters. The TE525 has an orifice diameter of 6.064" versus the 8.0" CS705 orifice diameter. To correct for this difference, use a multiplier of 0.0058"/tip versus the standard multiplier of 0.01"/tip.

6. Maintenance

The CS705 requires minimal maintenance. During site visits, verify the slot in the top of the overflow tube is free from ice or debris and remove any debris from the catch orifice. If the slot in the overflow tube becomes plugged, the overflow tube my create a siphon and draw down the antifreeze level.

The PGE solution becomes more dilute as precipitation is captured and mixed. Initially, the CS705 is charged with a pure antifreeze mixture giving it a 1:0 antifreeze : water ratio. The ratio increases to 1:1 with the equivalent of six inches of liquid, 1:2 with eight inches, and 1:3 with nine inches. The 1:1 solution becomes slushy at a temperature of ~ -35°C, the 1:2 solution becomes slushy at ~ -20°C, and the 1:3 solution at ~ -10°C (McGurk, 1992). Ratios greater than 1:3 are not recommended. Refer to figure 4 to determine the amount of remaining antifreeze based on precipitation (water equivalent) recorded.

Tipping bucket rain gages typically are designed to discharge precipitation directly to the surrounding environment. This means the toxicity of any antifreeze solution used in this application needs to be considered. The PGE antifreeze consists of propylene glycol and denatured ethanol. Propylene glycol is a non-toxic biodegradable solution. Commercial ethanol often contains additives to prevent ingestion. These additives result in it being toxic to mammals. Nevertheless, ethanol evaporates rapidly when exposed to air and should pose a limited risk. Individual site requirements will need to be considered though.

When recharging, the solution should be disposed of in accordance with local, state, and federal regulations.

McCaughey, W. and Farnes, P., 1996. Measuring Winter Precipitation with an Antifreeze-Based Tipping Bucket System. Proceedings 64th Western Snow Conference, Bend, OR. pp. 130-136.

McGurk, B.J., 1992. Propylene Glycol and Ethanol as a Replacement Antifreeze for Precipitation Gauges: Dilution, Disposal, and Safety, in Proceedings 60th Western Snow Conference, Jackson Hole, WY. pp. 56 - 65.

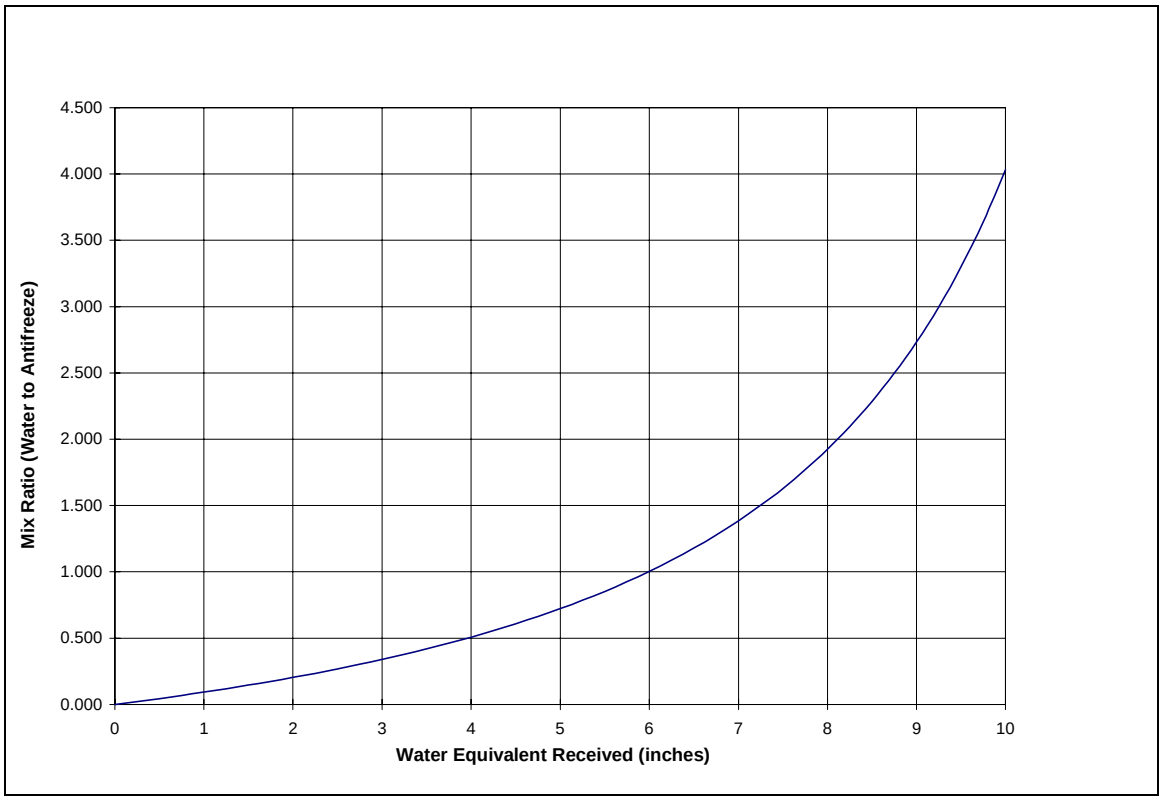

FIGURE 4. Mix ratio versus precipitation received.