NewAvionics
CORPORATION

Ice*Meister™ Model 9732-PLASTIC*

Ice Detecting Sensor for Aircraft

Technical Data Sheet

*<u>Figure 1</u> — Model 9732-PLASTIC aviation ice detector is a commercial, off-the-shelf, in-flight ice sensor that monitors the optical characteristics of whatever substance is in contact with the optical surfaces of the probe, either air (NO ICE) or water ice (ICE ALERT). Ambient wind blows standing water away, but ICE sticks. Made of nonconductive *PLASTIC, probe is electromagnetically compatible with its host aircraft's radio environment.*

GENERAL DESCRIPTION

Ice*Meister™ Model 9732-PLASTIC detects ICE on any aircraft.

Tested by NASA, it is demonstrably the smallest, lightest, most-sensitive ice detector aloft today.

The product consists of a unitized probe, circuit board, housing, and cable. The probe is a Delrin plastic cantilever that holds two optical windows and a reflecting wall below the wing, out into the airstream.

Ice forms and is sensed on any of the optical surfaces.

The probe's inboard end mates with a small interface board, the size of your thumb. The board is submerged in rock-hard epoxy inside the housing.

A lightweight, shielded 5-conductor blue cable connects the unit to its host system. The cable is jacketed in tough FEP teflon, specially formulated for harsh environments. Standard length is 10 feet, but it can be shipped in virtually any length on special order.

9732 is plastic, has no MHz clock, no moving parts. It is robust, potted in rock-hard epoxy with no exposed electronics, submersible, and solid as a brick. Made of non-conductive Delrin plastic, its probe is radio-frequency transparent, and can be installed in close proximity to radio antennas.

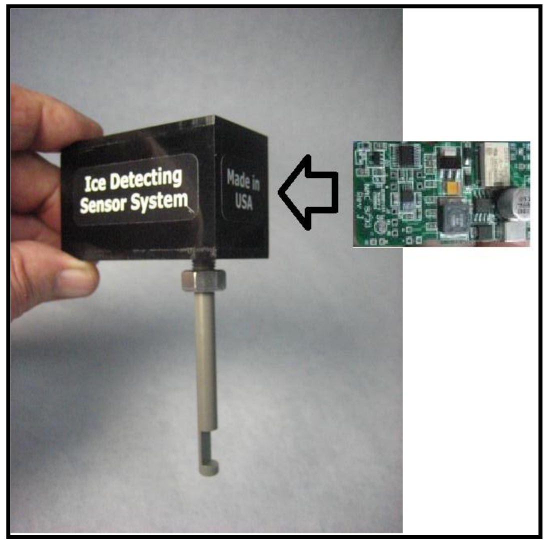


Figure 2 — 9732 is completely self-contained

The unit installs from inside the wing, extending down, facing forward into the air stream. It is fixed in place with a 5/16"-24 thread and stainless steel nut, just as an ordinary Outside Air Temperature gauge installs in a general aviation aircraft

PRINCIPLE OF OPERATION

Ice molecules forming on the optical windows or reflecting wall affects 9732's sensor excitation signal.

The excitation signal is created and received by the interface board. The board interprets and outputs transducer signal variations as ice alert (001), more ice (011), saturation ice (111).

9732's probe is pencil thin, creates minimum ram-air heating effect on airborne H2O molecules. Ambient wind stream removes liquid water from the sensor optics, but ICE sticks to it and accumulates.

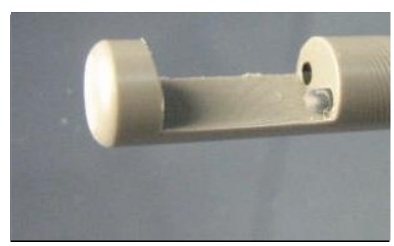


Figure 3 — ICE forms directly on the optical surfaces

9732 is sensitive to H2O phase-change between liquid water and solid ice. The probe itself does not detect ice. It is a passive cantilever-holder for the optical ice sensing elements in the air gap. When ice forms, it forms directly on the optical surfaces, thus its sensitivity.

Because of ram-air heating effects, ICE forms *last* on those airframe members with the largest cross-sectional area (windshields, leading edges, struts) but *earliest* on thin members (antennas, OAT gauges, plastic sensor probes). For this reason, 9732 is the smallest, lightest, most-sensitive ice detector aloft today.

PRINCIPLE OF OPERATION, cont

In-flight ice sensing occurs when molecules of ice appear on the surfaces of the exposed optical surfaces.

9732's ice formation and detection has been tested and documented at NASA Glenn Icing Research Tunnel according to a matrix of temperature, humidity, altitude, air speed, liquid water content, drizzle drop diameter, and air pressure. Test tunnel matrix and report available upon request.

Ice formations on an exposed surface in an icing domain can be either clear ice or rime ice, depending upon atmospheric variables. 9732 detects clear ice by its optical index-of-refraction, and rime ice by its optical opacity, both simultaneously. If it is necessary for the pilot to differentiate between clear and rime ice formations on the airframe, 9732 reports its presence by annunciating SATURATION ICE directly, skipping over intermediate ICE ALERT and MORE ICE states.

IN NON-ICING CONDITIONS, the aircraft's ambient wind stream removes liquid H2O from the probe. Air is in contact with the probe. The probe senses air, and reports NO-ICE.

IN ICING CONDITIONS, H2O molecules bind together and accumulate on the optical surfaces as a solid, resisting removal by the ambient windstream. ICE is in contact with the probe. The probe senses ICE, and 9732 reports one or more of three icing conditions: ICE ALERT, MORE ICE, SATURATION. See the red panel below:

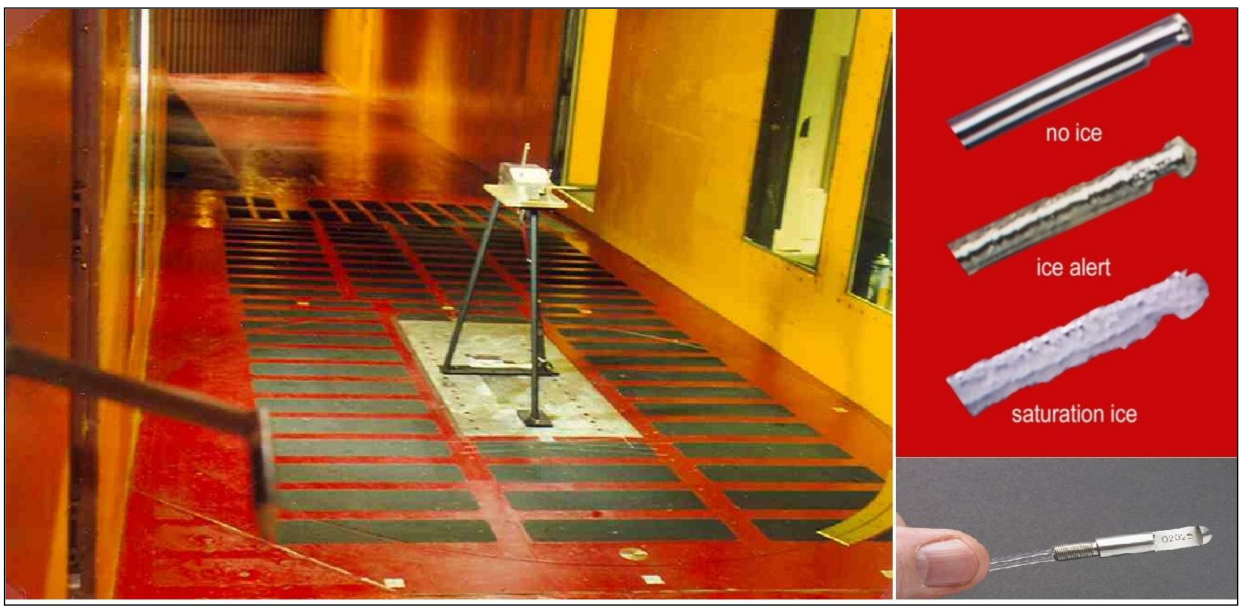


Figure 4 a, b, c -- Test program conducted at NASA Glenn's Icing Research Tunnel demonstrates Model 9732 conforms to defacto standard Minimum Operational Performance for In-flight Icing Detection Systems SAE AS 5498 ¶ 5.2.1.1.1. See also SAE AIR 4367 ¶ 4.11.

Note Pitot tube in left foreground, rotating deck for adjusting angle-of-attack.

INSTALLATION

9732 installs downward from inside the wing's undersurface, air gap facing forward. This maximizes sensitivity, helps protect the probe from unwanted UV and IR radiation, and shelters the probe from precipitating dirt and other debris while the aircraft is parked on the tarmac.

The probe shaft is fixed in place with a stainless steel nut on its 5/16-24 thread at the base of the probe, same as an Outside Air Temperature gauge per FAA TSO-C43c.

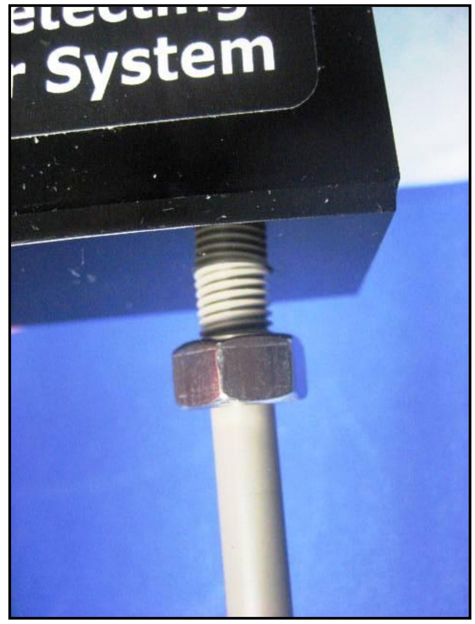


Figure 5 -- 9732 installs with the same 5/16-24 thread as an ordinary OAT gauge

LIGHTWEIGHT BLUE CABLE.

MULTICONDUCTOR SIGNAL CABLE
STRANDED SHIELDED FEP TEFLON
NEC TYPE CL2P/CMP -70DEG C +200DEG C

CONSTRUCTION:

CONDUCTOR: STRANDED TINNED COPPER.
INSULATION: FEP TEFLON
COLOR CODE: BLACK-WHITE-RED-GREEN.
ASSEMBLY/SHIELD: INSULATED CONDUCTORS CABLED WITH ALUMINUM FOIL SHIELD AND STRANDED TINNED COPPER DRAIN.
JACKET: GRAY FEP TEFLON JACKET.

Charlotte Wire Part#	Size AWG	Number of Condr's	Number of Strands	Insulation Thickness (in.)	Jacket Thickness (in.)	Overall Diameter (in.)	Approx. Net Wt. (Lbs/Mft.)
CW09102-FEP	24	4	7	.006"	.010"	.12"	13

Application:
Suitable for general purpose use. Used in sound/audio systems, intercom/P.A. systems, security systems, power limited controls and remote control signalling.

Standards:
NEC Article 800 (Type CMP).
NEC Article 725 (Type CL2P).

Buf

Figure 6 -- Lightweight blue cable specifications.

CONNECTION TO HOST AIRCRAFT

Model 9732 provides a rate-of-accumulation feature. Three discrete logic (TRUE/FALSE) outputs cumulatively indicate ICE ALERT, MORE ICE and SATURATION ICE. The aircraft's pilot monitors the rate of icing accumulation for advisory as to when to disengage autopilot, activate anti-icing systems, activate engine anti-ice, climb, descend, turn around, etc. See figure 7 below.

Logic table 1

ICING STATE	ice alert wht	more ice grn	sat ice blk
no ice 000	0	0	0
ice alert 100	1	0	0
more ice 110	1	1	0
sat ice 111	1	1	1

0 <0.5 volts 1 >3.0 volts

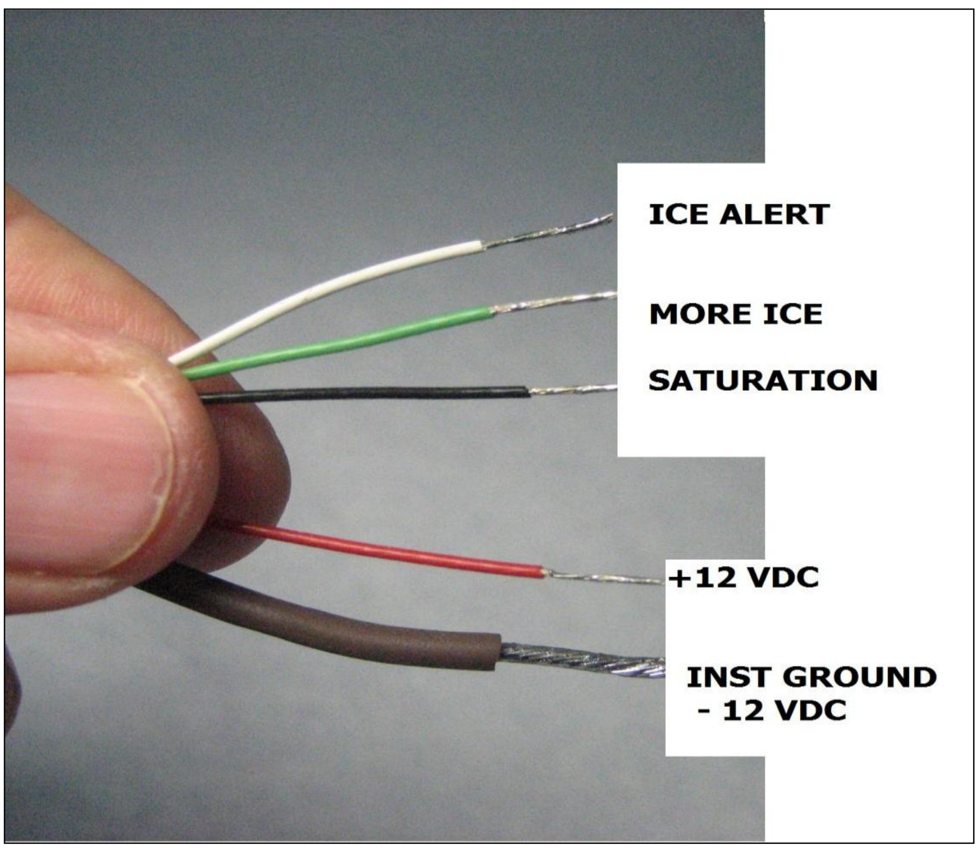


Figure 7
Lightweight blue cable provides three discrete outputs that report the icing rate-of-accumulation .

TESTING

STANDARD TEST CONDITIONS for testing in a laboratory		
ambient temperature	energize unit, soak at ambient temp ½ hour	25 deg C (normal office temp)
ambient lighting	fluorescent illumination (from ceiling)	500 lux (normal office lighting)
	white LED illumination	no limit
	sunlight	0.0
	incandescent lamp	0.0
mechanical	sensor air-gap orientation	as shown in fig 8.
	probe body orientation	as shown in fig 8.
	proximity of foreign objects other than supporting table.	nothing within 6 inches.
technique I	primary test for RIME ICE with tetrafluoroethane sprayed into air gap for 5-10 seconds	may take up to 30 sec to respond.
technique II	primary test for CLEAR ICE with tumbler of clean tap water	differentiates clear ice from rime ice.
technique III	field test for RIME ICE with charcoal packing foam or other soft, dry, resilient, opaque, non-reflective substance	convenient field test.

TECHNIQUE I: PRIMARY TEST FOR RIME ICE WITH COLD SPRAY.

The primary test for Model 9732 is to test for rime ice sensitivity with a sprayed blast of Radio Shack tetrafluoroethane component cooler p/n 64-4321. See figure 9. It leaves no residue. Cold spray freezes moisture out of the ambient air, creates detectable surface frost in the air gap.

As frost forms, observe output logic states as they progress from NO ICE >> ICE ALERT >> MORE ICE >> SATURATION. Then as frost ablates, observe reverse sequence from SATURATION >> MORE ICE >> ICE ALERT >> NO ICE. In the absence of an ambient airstream to remove residual moisture on the optics, use a soft clean paper towel to blot it away. This concludes the test.

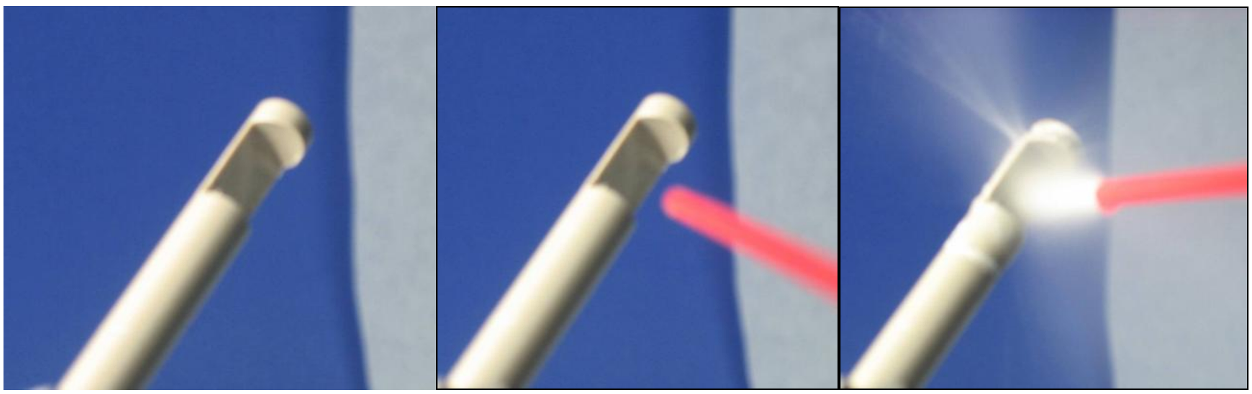


Figure 8 a,b,c – *Primary test technique simulates rime ice by using cold spray.*

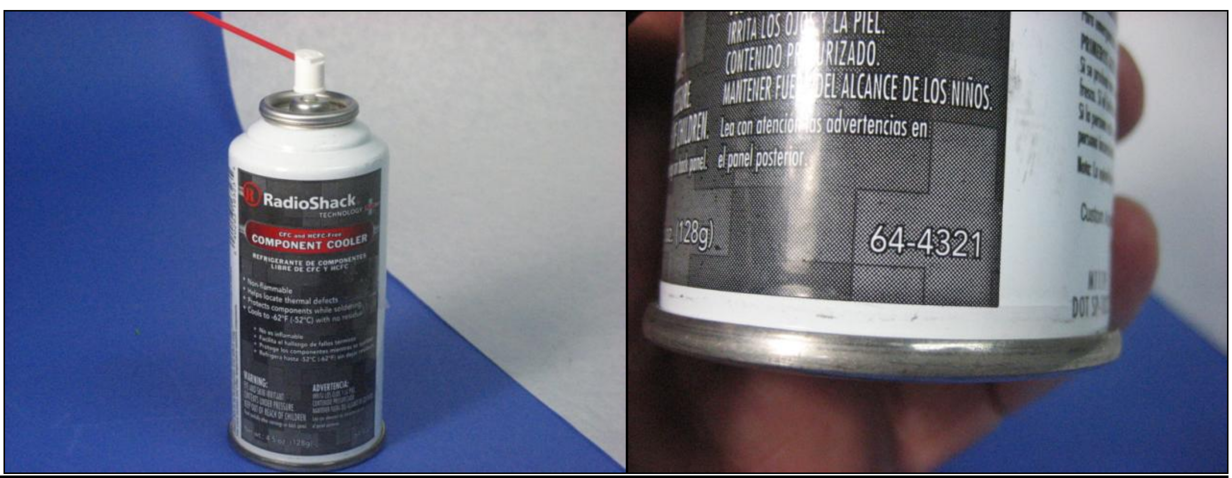


Figure 9 a,b -- *Radio Shack component cooler. Be certain to use ONLY tetrafluoroethane component cooler to avoid damage to the acrylic optical components in the air gap.*

TESTING II: TEST FOR CLEAR ICE WITH CLEAN TAP WATER.

To differentiate the formation of clear ice from rime ice, clear ice forces 9732 to set all three states TRUE *simultaneously*, not *sequentially*. ICE ALERT = MORE ICE = SATURATION ICE = TRUE.

Submerge probe tip in clean tap water and observe all three states come TRUE simultaneously. Remove probe from water, dry with a soft clean paper towel, and observe all three states return to FALSE.

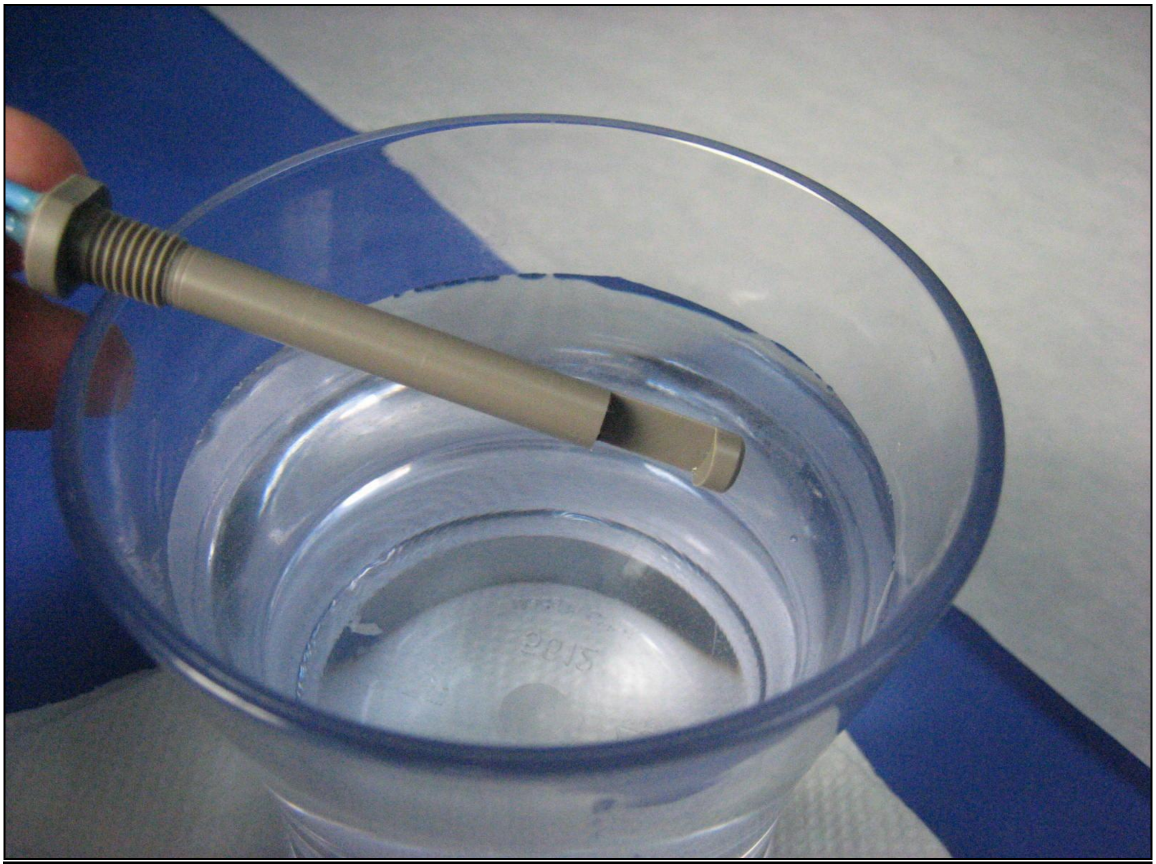
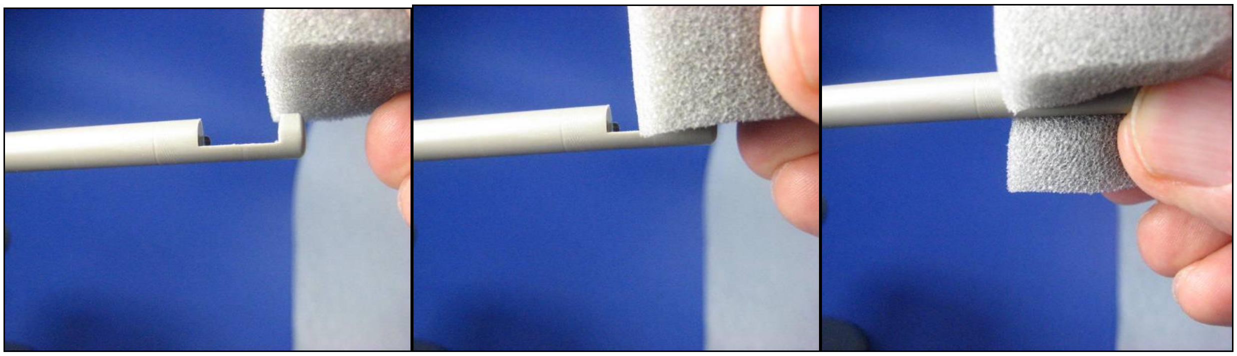
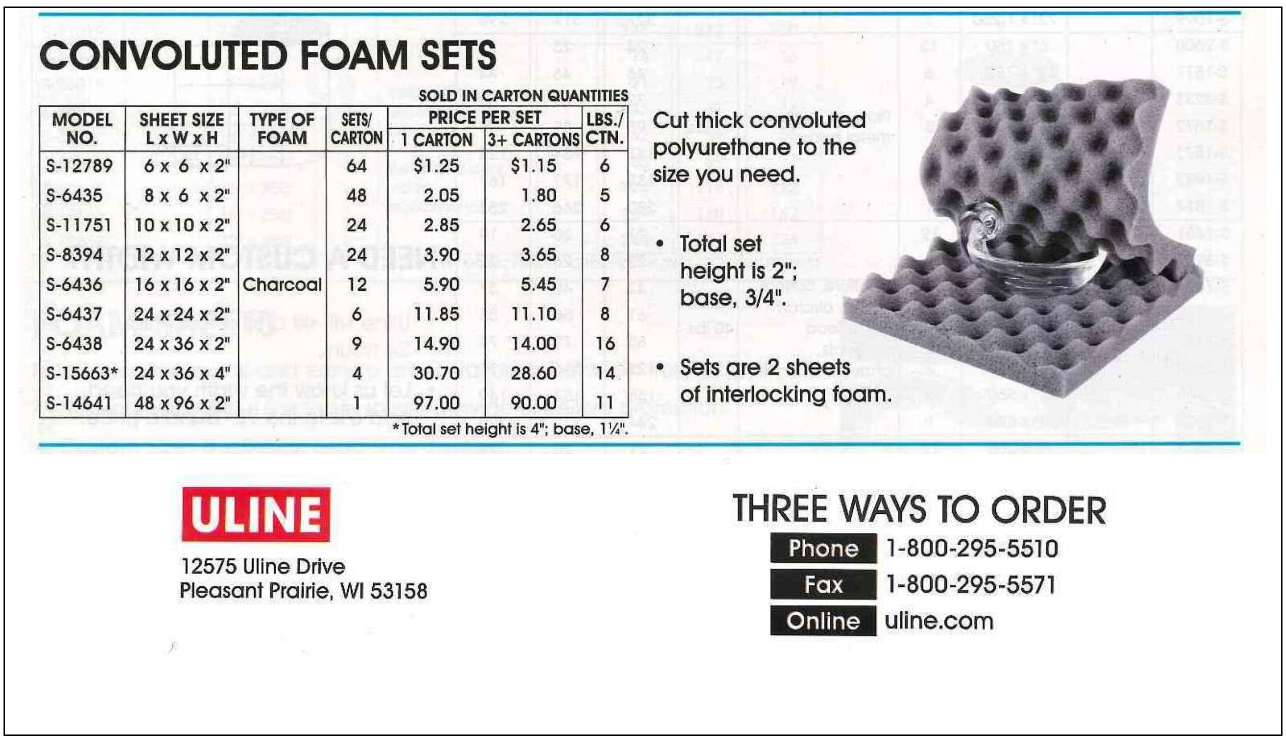


Figure 10 – Ordinary clean tap water simulates clear ice .

TESTING III: CASUAL FIELD TEST FOR RIME ICE WITH CHARCOAL PACKING FOAM.



<u>Figure 11 a, b, c</u> -- Field test for progressive rime ice by blocking the optical air gap with a piece of readily available charcoal packing foam -- soft, dry, resilient, opaque, non-reflective.



CONVOLUTED FOAM SETS

MODEL NO.	SHEET SIZE L x W x H	TYPE OF FOAM	SETS/ CARTON	SOLD IN CARTON QUANTITIES PRICE PER SET 1 CARTON	3+ CARTONS	LBS./ CTN.
S-12789	6 x 6 x 2"		64	$1.25	$1.15	6
S-6435	8 x 6 x 2"		48	2.05	1.80	5
S-11751	10 x 10 x 2"		24	2.85	2.65	6
S-8394	12 x 12 x 2"		24	3.90	3.65	8
S-6436	16 x 16 x 2"	Charcoal	12	5.90	5.45	7
S-6437	24 x 24 x 2"		6	11.85	11.10	8
S-6438	24 x 36 x 2"		9	14.90	14.00	16
S-15663*	24 x 36 x 4"		4	30.70	28.60	14
S-14641	48 x 96 x 2"		1	97.00	90.00	11

*Total set height is 4"; base, 1¼".

Cut thick convoluted polyurethane to the size you need.

- Total set height is 2"; base, 3/4".
- Sets are 2 sheets of interlocking foam.

ULINE
12575 Uline Drive
Pleasant Prairie, WI 53158

THREE WAYS TO ORDER
Phone 1-800-295-5510
Fax 1-800-295-5571
Online uline.com

<u>Figure 12</u> -- Opaque charcoal test foam is readily available. A useful sample is supplied with each 9732 shipment..

NOMENCLATURE

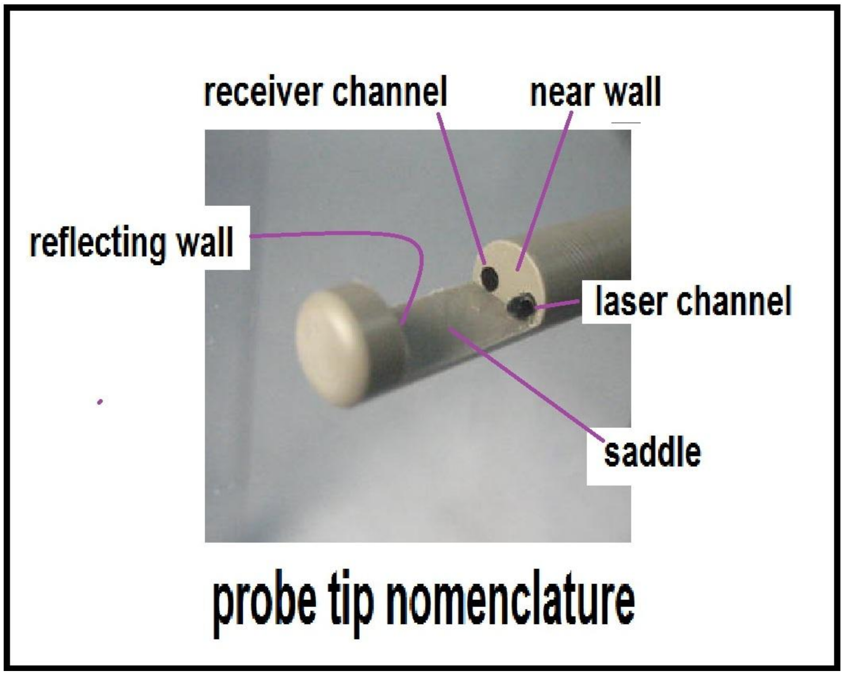


Figure 13 Probe tip nomenclature.

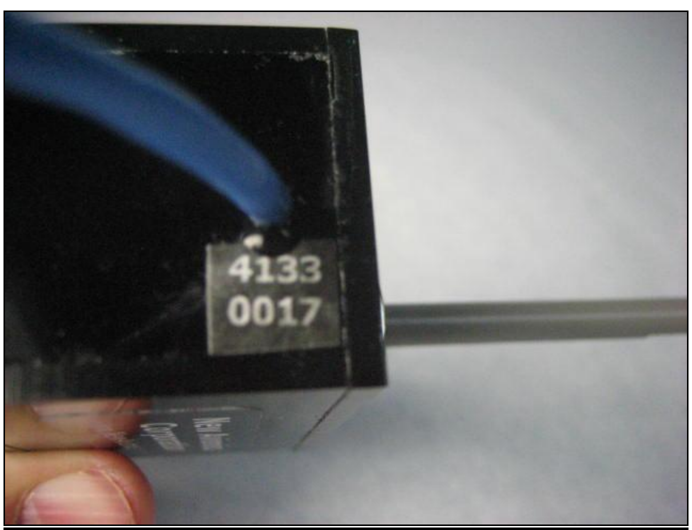


Figure 14 Serial number is located next to lightweight blue cable exit.

CAVEATS

Figure 15 -- ice formation on sensor probe is by nature rough, imprecise, "fuzzy".

NOT A PNEUMATIC BOOT CONTROLLER

9732 is an absolute ICE sensor-indicator. It indicates the real time presence of ICE on any host airframe and its relative rate of increase.

It is not a replacement for BFGoodrich 871 resettable pneumatic boot controllers, which are specifically designed for that purpose.

NOT A MEASURING INSTRUMENT

The in-flight velocity of airborne super-cooled drizzle drops impinging on the probe's air gap necessarily creates a rough, imprecise "fuzzy" surface and a thickness of ice that is not easily quantified.

Even though ice thickness may be difficult to measure, 9732's optical rate-of-ice- formation sensing accounts for surface irregularities. It detects and reports ice's indistinct and imprecise "fuzzy" nature.

For this reason, Model 9732 functions as a digital go/no-go ice sensor only. It has no specific calibration, and is in no way to be used an analog measuring instrument of any kind.

SPECIFICATIONS

SENSITIVITY TO ICE:

Better than 0.010" of ice
Conforms to SAE AS 5498 ¶ 5.2.1.1.1
Listed in SAE AIR 4367 ¶ 4.11

OPERATING / STORAGE TEMPERATURE:

-40 deg C to + 50 deg C.
Not warranted to detect ice above 0 deg C
nor in non-icing conditions.

ELECTRICAL INPUT:

24 VDC
200 mA max
red wire = + volts DC
shield drain wire = instrumentation ground, - 0 volts DC

ELECTRICAL OUTPUT

ICE ALERT = white wire
MORE ICE = green wire
SATURATION = black wire

FALSE < 0.5 volt
TRUE > 3.0 volts

CONNECTING CABLE

0.1 inch diameter lightweight five-conductor ground-shielded cable, stripped, tinned, and ready for customer's connector.

LENGTH: 10 feet

Red, shield wires:	$\pm$ VDC in
White, green, black wires:	data out

WEIGHT: 6 ounces, exclusive of cable.

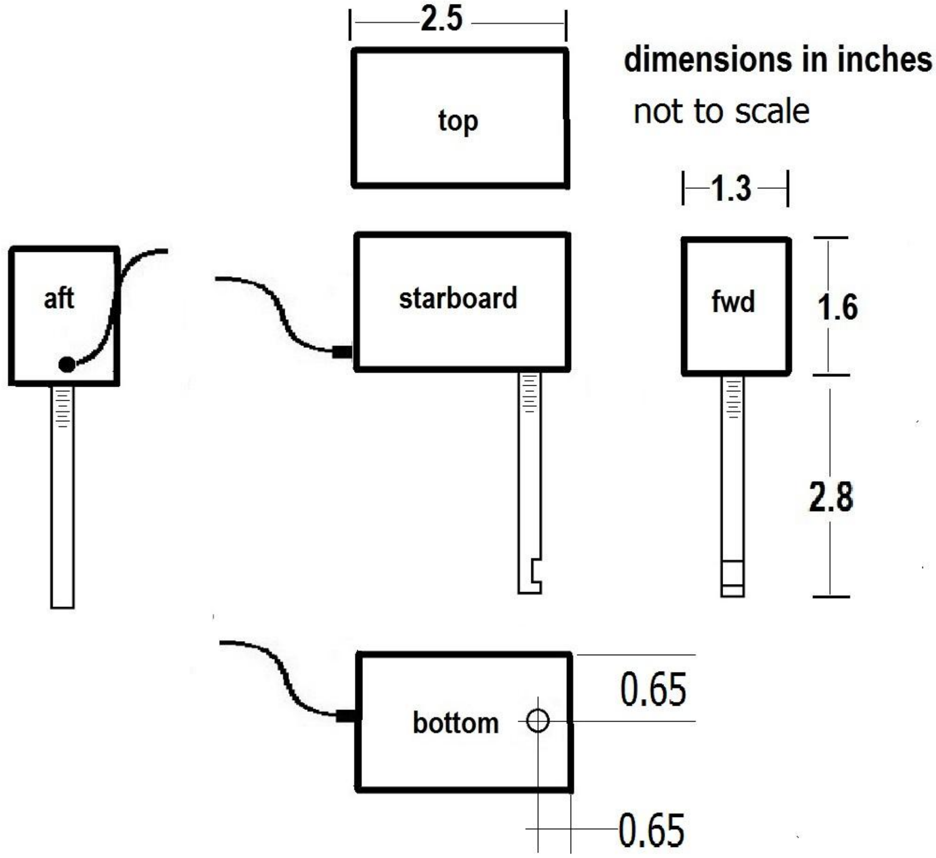
DIMENSIONS:

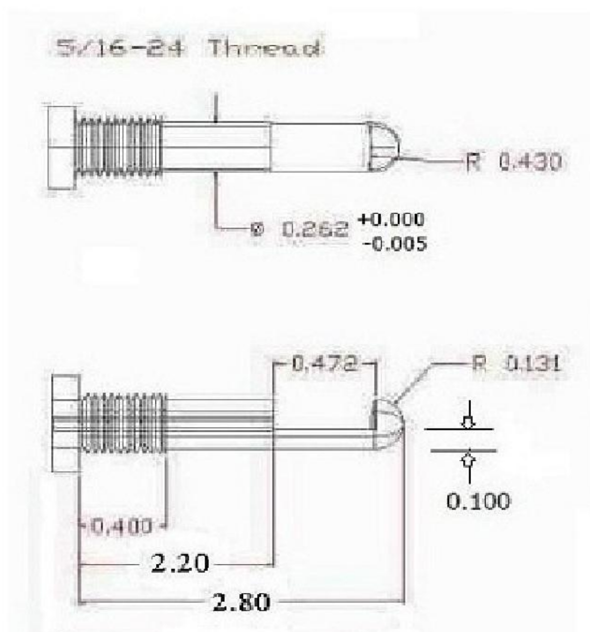
Housing height:	1.6 inches
Housing width:	1.3 inches
Housing length:	2.5 inches
Probe diameter:	0.26 inch
Probe extension:	2.8 inches

MOUNTING HARDWARE:

5/16-24 thread on delrin probe shaft, with stainless steel hex nut

DIMENSIONS





probe detail

Figure 16 -- dimensions

DISCLAIMERS

1. Specifications and other contents are subject to change at any time without notice.

2. This document is not contractual. Nothing in it constitutes or implies a warranty or guaranty of any kind, explicit or implicit. Warranty information is given only in separate "warranty" statement.

3. Plastic optical probe is made of acrylic and delrin plastics. It should be protected from mechanical abuse, abrasion and harsh chemicals. Damage to the probe optics voids the warranty. Flying in volcano ash or pumice voids the warranty.

4. No warranty is given as to the suitability of this product for any particular application.

5. Initial thermal shocking of the sensor may cause condensation to form on the optics and register as "ice". For best results, allow unit to soak under power and at ambient temperature before evaluating.

6. This unit is not an analog measuring instrument. It provides no specific calibration.

7. For best results, test under airborne icing conditions -- subdued light, no incandescent lamps, soak under power and ambient temperature. See STANDARD TEST CONDITIONS page 6.

8. Customer acknowledges there is no FAA TSO issued for in-flight ice detectors. This product does not conform to any FAA TSO, and is not certified for installation in any FAA certified aircraft.

9. This device functions as a digital go/no-go ice sensor only. It has no specific calibration, and is in no way an analog measuring instrument of any kind. See CAVEATS page 11.

10. This device is not a replacement for BFGoodrich Model 871 pneumatic boot controller. See CAVEATS page 11.

NOTES

1. Ice*Meister™ is a trademark of New Avionics Corporation.
2. Ice*Meister™ is protected under one or both US Patents ooooooo & ooooooo.

Ice*Meister™ Model 9732-PLASTIC
Ice Detecting Sensor for Aircraft

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