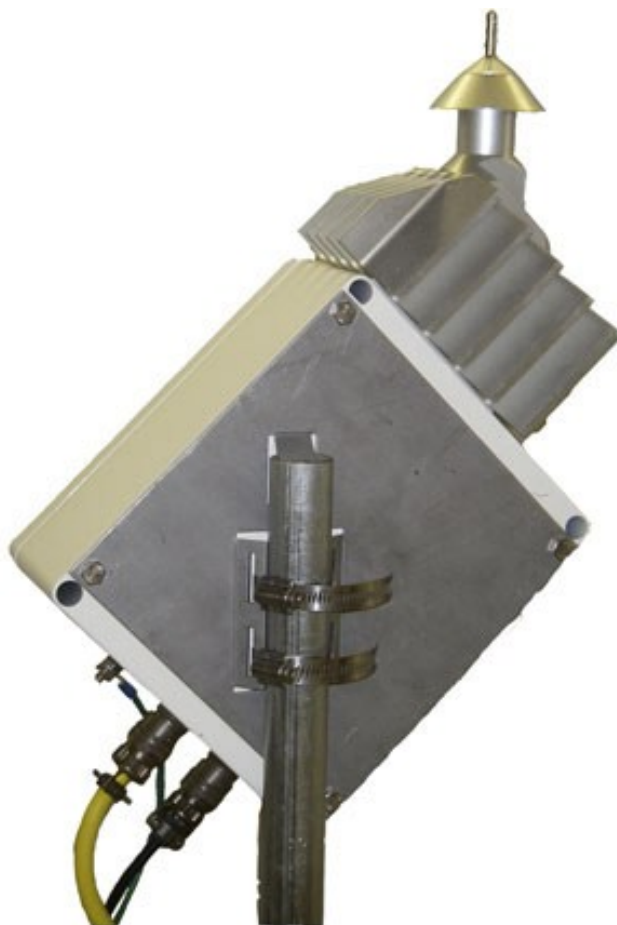




0872F1

Ice Detector



Please read first

About this manual

Please note that this manual was produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this. In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to Europe, Middle East, and Africa (EMEA) or Asia Pacific (APAC) users. Differences include the U.S. standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for EMEA or APAC use. Please note, however, *that when a power supply adapter is ordered from Campbell Scientific it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials (antennas) may also not be applicable according to your locality. Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the EMEA or APAC market; in some cases alternatives are offered.

Recycling information for countries subject to WEEE regulations 2012/19/EU



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the product's life should be removed from the product and also be sent to an appropriate recycling facility, per [The Waste Electrical and Electronic Equipment \(WEEE\) Regulations 2012/19/EU](#). Campbell Scientific can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories. For further support, please contact Campbell Scientific, or your local agent.

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1. Introduction

This manual provides information for installing, operating, and maintaining the 0872F1 Ice Detector.

The 0872F1 Ice Detector is a pole-mounted, outdoor sensor designed to detect ice accretion on an exposed sensing probe. The unit operates continuously in adverse weather conditions and provides ice-condition information to a host system through an **RS-232** or digital current loop data link.

The detector is intended for field use with minimal routine service. Under normal conditions, periodic verification and calibration are the primary maintenance requirements. If a fault occurs, the procedures in this manual can be used to isolate the problem.

Under normal operating conditions, the 0872F1 requires no scheduled preventive maintenance other than periodic verification and calibration as required.

CCA	Circuit card assembly
Bit	Built-in test
EPROM	Electrically programmable read only memory
ESD	Electrostatic discharge
FRU	Field replacement unit
IDS	Ice detection sensor

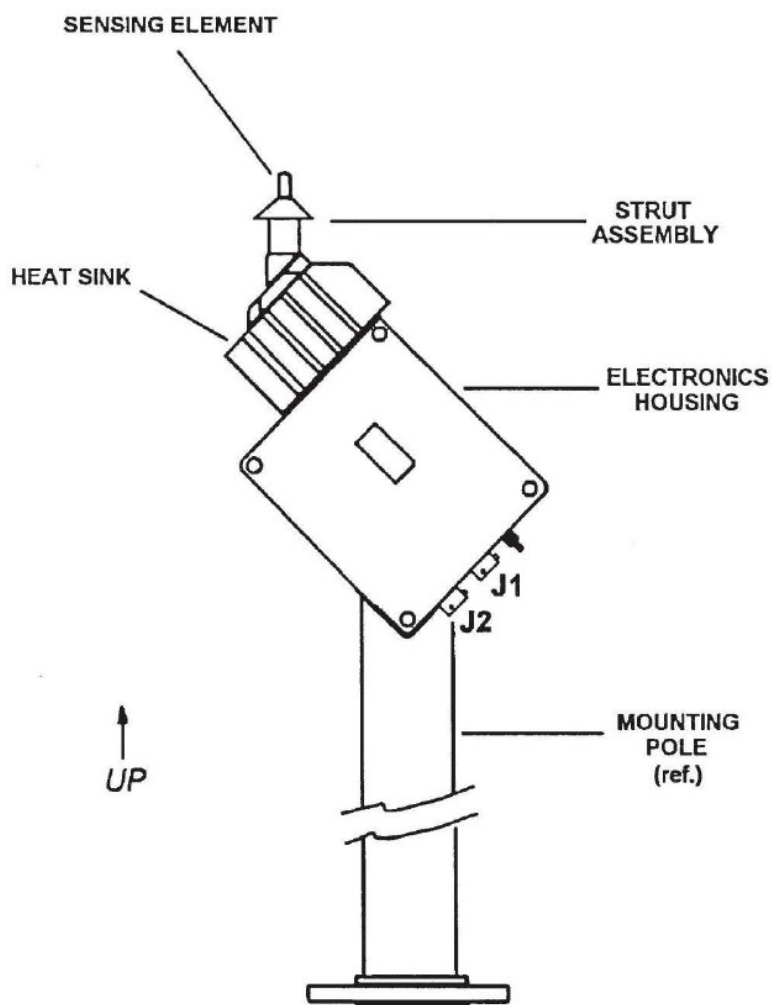


Figure 1-1. Model 0872F1 Ice Detector

2. Precautions

Throughout this text, a **Danger** (black text box) refers to an operation or maintenance procedure, practice, condition, statement etc., which, if not strictly observed, could result in injury, death, or long term health hazards to personnel. A **Warning** (red text box) refers to an operating or maintenance procedure, practice, condition, statement etc., which, if not strictly observed, could result in damage/destruction of equipment or loss of mission effectiveness.

The following sections summarize general safety considerations to be observed when installing, operating, or uninstalling this equipment.

2.1 General precautions

The following are general safety precautions that are not related to any specific procedure and therefore do not appear elsewhere in this manual. These are recommended precautions that personnel shall understand and apply during many phases of operation and maintenance.

2.2 Cleaners/chemicals

Keep in approved safety containers and in minimum quantities. Some cleaners/chemicals may have an effect on skin, eyes, and respiratory tract. Observe manufacturer's WARNING labels and current safety directives. Use only in authorized areas. Discard soiled cleaning cloths into safety cans. Unless otherwise indicated in the text, using the chemicals as described in this manual should not result in any immediate health concerns. Consult the local Bioenvironmental Engineer for specific protective equipment and ventilation requirements.

2.3 Compressed air

Use of compressed air can create an environment of propelled foreign particles. Air pressure should not exceed 15 psi and the compressed air should be used with effective chip guarding and personal protective equipment.

2.4 Keep away from live circuits

Operating personnel must observe safety regulations at all times. Do not replace components or make adjustments inside the equipment with the voltage supply turned on.

2.4.1 Do not service or adjust alone

Do not attempt internal service or adjustment unless another person capable of rendering aid and resuscitation is present.

2.5 Resuscitation

Personnel working with or near dangerous voltage shall be trained in modern methods of resuscitation. Information and training sources may be obtained from the Director of Base Medical Services.

2.6 Electrostatic discharge (ESD)

Certain circuit card assemblies and their components are susceptible to electrostatic discharge/damage. Care must be exercised during handling or repair of these items. Use electrostatic discharge (ESD) precautionary procedures.

2.7 Environmental limitations

The 0872F1 is designed for outdoor use in areas with inclement weather. Its operation limit is as follows:

Environmental conditions	Operational test limit
High temperature	50 °C
Low temperature	-50 °C
Humidity	74% RH @ 35 °C 100% RH @ 25 °C
Wind (steady)	Up to 30 kts
Wind (gust)	Up to 46 kts
Rain	3 in/hr with 30 kts wind
Freezing rain	Ice accretion to 1 inch with 20 kt wind at a rate of 1/2 inch per hour
Dust	Exposure to dust-laden environment
Low pressure	to 15.7 in Hg
Ingress protection	IPX4

3. Initial inspection

- Upon receipt of the 0872F1, inspect the packaging and contents for damage. File damage claims with the shipping company.
- The model number and cable length are printed on a label at the connection end of the cable. Check this information against the shipping documents to ensure the expected product and cable length were received.

4. Overview

The 0872F1 Ice Detector is a sensor used to detect ice accretion on an exposed probe. It is intended for continuous operation in environmental monitoring and control applications where timely indication of icing conditions is required.

The 0872F1 is constructed as four major assemblies:

- Main circuit card assembly (CCA)
- Output interface CCA
- Filter assembly
- Strut and probe assembly

The sensor operates by monitoring the resonant frequency of an ultrasonic vibrating probe. As ice accumulates on the probe, the added mass changes the probe frequency. This change is measured by the detector electronics and reported to the connected host system through an RS-232 or digital current loop interface.

The 0872F1 is designed for pole mounting and exposed outdoor installation. All electrical connections and electronic assemblies are contained within the detector housing. Access for inspection and field-level maintenance is provided through the hinged cover. For proper operation, the unit should be installed in a location free from obstructions that could shield the sensing element from freezing rain or other icing precipitation.

5. Specifications

Power requirements: 115 VAC, $\pm 10\%$, 50 to 60 Hz

NOTE:

The sensor is specified to operate at 115 VAC $\pm 10\%$, which corresponds to an input range of 103.5 to 126.5 VAC. 115 VAC and 120 VAC are used interchangeably in this manual.

Power consumption

Sensing mode: 10 Watts (0.087 Amps)

De-icing mode: 385 Watts (3.35 Amps)

Output format:	RS-232 or RS232 Current Loop (2400 BAUD) RS232 Configuration: 8 Data Bits, 1 Stop Bit, No parity, Full Duplex, Configured as Data Terminal Equipment (DTE)
Output commands	
Send data:	Z1
De-ice:	Z3XX, where XX is time in seconds (max – 60 sec)
Extended diagnostics:	Z4
Field calibration:	F5
Measurement range:	0 to 2.5 mm (0 to 0.10 in) of ice
Minimum measurement threshold:	0.13 mm (0.005 in) of ice
Resolution:	±4Hz
Environmental limitations	
Operating temperature:	–50 °C to 50 °C
Operating humidity limits:	74% RH @ 35 °C to 100% RH @ 25 °C
Wind:	Steady – up to 55.5 km (30 knots); Gust – up to 85.2 km (46 knots)
Rain:	76.2 mm (3 in) per hour with 55.5 km (30 knots) wind
Freezing rain:	Ice accretion to 25.4 mm (1 in) with a 37 km (20 knot) wind with a rate of 12.7 mm (1/2 in) per hour
Ingress progress:	IPX4
Maximum cable length:	30 meters
Mating connectors	
Connector 1 (J1):	PT06J-12-13S
Connector 2 (J2):	PT06J-12-10S
Cable type	
0872E3CBL1-L (J1):	3 conductor, 16 AWG, Super Vu-Tron III jacket
0872E3CBL2-L (J2):	Multiconductor, 2-pair, 22 AWG, Shielded, Santoprene jacket
Weight:	5.7 kg (12.55 lb)

Dimensions

Electrical housing: 230 mm by 200 mm by 110 mm (L x W x H)

Sensing element and heat sink: 164 mm by 173 mm by 110 mm (overall L x W x D)

Compliant standards: CE and TUV (C/US)

6. Installation

6.1 Siting

The 0872F1 should be mounted to a sturdy pole located away from buildings or other obstacles that could shadow the sensing element from freezing rain. The 0872F1 should be installed so the sensing probe is a minimum 35 inches above the ground. The 0872E3 MNT mounting bracket (shown in [Figure 6-1](#) [p. 8]) is ideal for mounting the 0872F1 to the pole.

6.2 Mounting

WARNING:

The ground stud must ALWAYS be connected to a ground cable when connecting J1(IDS) or applying power to the unit.

1. Position the 0872F1 on the mounting pole with the sensing probe pointing upward. Tighten band clamps as shown in [Figure 6-1](#) (p. 8).
2. Remove one ground stud nut.
3. Position ground wire on ground stud.
4. Replace and tighten ground nut stud.
5. Connect cables to connectors J1(IDS) and J2(IDS).
6. Remove protective tube from strut and probe.

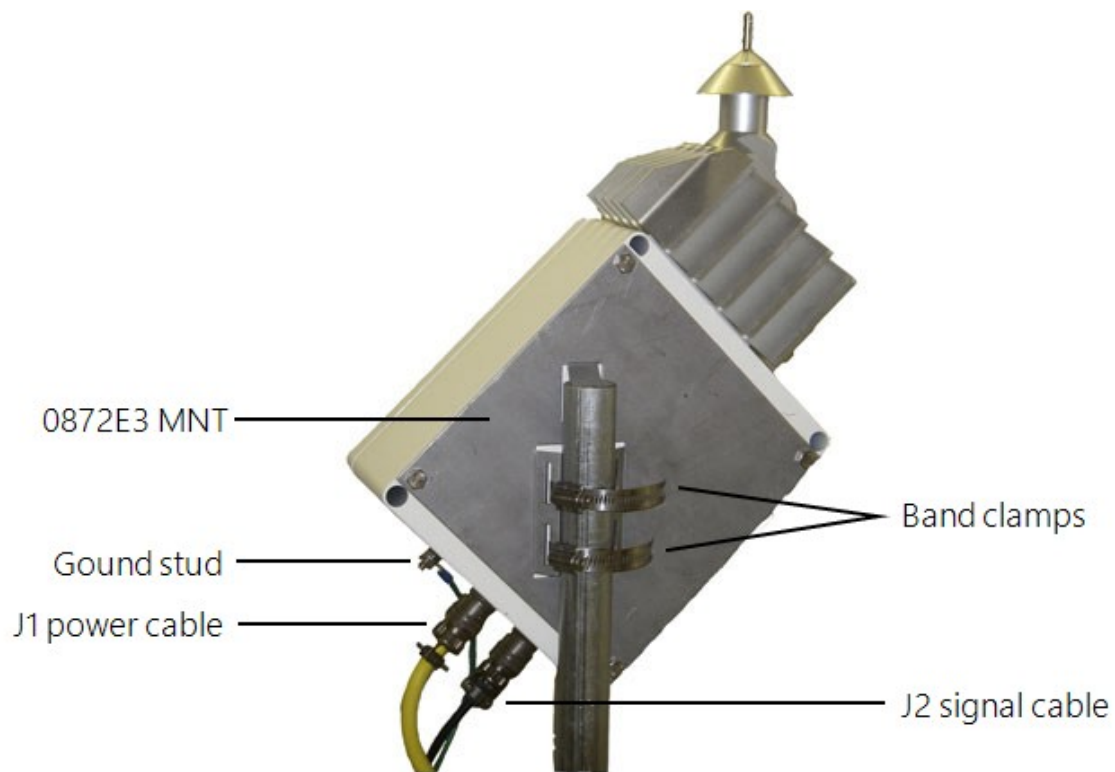


Figure 6-1. Mounting

6.3 Wiring

Table 6-1: J1 power cable wiring			
Ice detector connections	Wire color	Description	120 VAC supply
J1 (pin A)	Black	120 VAC line	Line
J1 (pin B)	White	120 VAC neutral	Neutral
J1 (pin C)	Green	120 VAC ground	Ground
Ground stud	Green	Ground earth	Ground

Ice detector connections	Wire color	Description	Data logger connections
J2 (pin B)	Green	RS-232 Rx	C1
J2 (pin A)	White	RS-232 Tx	C2
J2 (pin C)	Black	RS-232 Signal Gnd	G
J2	Clear	Shield	G

NOTE:

The sensor is specified to operate at 115 VAC $\pm 10\%$, which corresponds to an input range of 103.5 to 126.5 VAC. 115 VAC and 120 VAC are used interchangeably in this manual.

The use of 120 VAC in wiring references reflects the North American nominal standard, while 115 VAC describes the instrument operating specification. No difference in required supply voltage is intended.

6.4 Example program – CR1000X

CRBasic Example 1: CR1000X example program

```
'CR1000X Series Data Logger

'Declare Public Variables
Public MainString As String * 30
Public Freq_Str As String
Public Frequency As Float
Public CSum As String
Public Status As String
Public Ice 'Default units are in inches
Public Ice_mm 'Ice accumulation in millimeters
Public T109
Public HeatTime
Const Threshold = 0.02 'The icing threshold can be changed based on requirements.
'Note: The recommended min threshold for de-icing is 0.02 inches of ice, and the
'max is 0.16inches of ice.

'Define Data Tables
  DataTable (IceAcc,True,-1)
  Sample (1,Ice_mm,IEEE4)
  Sample (1,Ice,IEEE4)
EndTable

'Main Program
BeginProg
```

CRBasic Example 1: CR1000X example program

```
SerialOpen (ComC1,2400,0,0,1000)
Scan (10,Sec,0,0)

'Clear buffer before sending commands
SerialFlush (ComC1)

'Send serial out command to request frequency information
SerialOut (ComC1,"Z1", "",0,0)

'Send serial in command to read information from data logger buffer.
SerialIn (MainString,ComC1,100,0,100)

'The following instructions are used to parse the received string.
Freq_Str = Left (MainString,11)
Freq_Str = Right (Freq_Str,5)
Status = Left (MainString,6)
Status = Right (Status,3)
CSum = Left (MainString,13)
CSum = Right (CSum,2)
Frequency = Freq_Str

'Formula used to convert the Frequency into Ice Thickness (inches).
Ice = -0.00015*Frequency + 6

'Convert ice accumulation from inches to millimeters
Ice_mm = Ice * 25.4

'Used to make sure we do not have negative Ice thicknesses in data
If Ice < 0 Then Ice = 0
If Ice_mm < 0 Then Ice_mm = 0

'Measure Temperature Sensor to make sure the temperature is less than
'5 degrees Celsius
Therm109 (T109,1,1,Vx1,0,60,1.0,0)

'Check to see the temperature is less than 5 degrees Celsius & ice is greater
'than threshold. If so, turn on heaters long enough to remove any
'ice accumulation.
If T109 <= 5 AND Ice >= Threshold Then
    HeatTime = 214.29 * Ice + 5.7142
    HeatTime = INT (HeatTime)

'If the heat time is calculated higher than 45 seconds, heat for only
'45 seconds.
'NOTE: The heater time is limited to 45 seconds based on the time required
'to melt
```

```
EndIf  
CallTable IceAcc  
NextScan  
EndProg
```

7. Operation

7.1 Operational verification

Before deploying this unit in the field, please perform this operational check to verify its integrity. The operational verification can be performed using the following steps:

1. With the unit removed from the packaging, connect the power and communications cables.
2. Connect the unit to the data logger using the wiring diagram provided in this manual.
3. After verifying everything is connected correctly, remove the protective sleeve and probe cover and apply power to the unit and the data logger.

4. Using *LoggerNet* or a similar connection software, load the following program onto the data logger.

```
'CR1000X Series Datalogger
'Declare Public Variables
Public Frequency As String
Public IDS_Status As String
Public Heating As String

'Main Program
BeginProg
  SerialOpen (ComC1,2400,0,0,10000)

  Scan (30,Sec,0,0)

    'Send command for frequency data
    SerialOut (ComC1,"Z1", "",0,100)
    Delay (0,5,Sec)
    'Clear buffer
    SerialFlush (ComC1)
    'Accept data
    SerialIn (Frequency,ComC1,100,0,100)

    'Send diagnostic command
    SerialOut (ComC1,"Z4", "",0,100)
    Delay (0,15,Sec)
    'Clear buffer
    SerialFlush (ComC1)
    'Accept data
    SerialIn (IDS_Status,ComC1,100,0,100)

    'Send command to de-ice strut & probe for 2 seconds
    SerialOut (ComC1,"Z302", "",0,100)
    Delay (0,5,Sec)
    'Clear buffer
    SerialFlush (ComC1)
    'Accept data
    SerialIn (Heating,ComC1,100,0,100)

  NextScan
EndProg
```

If you are not using *LoggerNet*, apply power to the 0872F1. Wait a minimum of 30 seconds, then perform the following sequence of commands to ensure proper operation of the unit.

Command	Response	Wait (minimum)
Z1	Zpxxxxxyy	5 sec
Z4	ZP E3	15 sec
Z302	ZDOK51	5 sec

*xxxxx is frequency (39970 to 40030 Hz) and yy is the checksum.

- Using the numeric screens in *LoggerNet*, add the public variables to the display. To do this, click and drag public to the upper left cell in the display. This will paste all three public strings into the view. It will take up to 30 seconds to see the results.
- The following are the expected results for an operational unit. If you receive these results, the unit is ready for field installation.

Frequency	*ZPxxxxxyy
IDS_Status	ZP E3 – IDS passes extended checks
Heating	ZDOK51

*xxxxx is frequency (39970 to 40030 Hz) and yy is the checksum.

7.2 System operation

Ice is sensed from the mass loading on the probe. As ice bonds to the probe, the probe mass increases and its natural frequency decreases. The sensor outputs a normalized frequency (corresponding to the ice accretion level) that has been averaged over 1 minute. The 0872F1 will respond when interrogated by the host system with one of the four different requests listed below:

- Z1 – SEND FREQUENCY DATA
- Z3 – DE-ICE STRUT AND PROBE
- Z4 – PERFORM EXTENDED DIAGNOSTICS
- F5 – PERFORM FIELD CALIBRATION

8. Maintenance

8.1 Maintenance concept

The maintenance concept of 0872F1 consists of:

- BIT detecting and isolating a 0872F1 fault to one of three subassemblies.
- Replacement of the faulty subassembly (with 0872F1 attached to the mounting pole).
- Return failed subassembly to Campbell Scientific Canada for repair.

8.2 Calibration and preventative maintenance

The sensor is designed to require no adjustments, alignments, or scheduled or preventative maintenance. A field calibration feature is included in the design, but the calibration is not performed on a scheduled basis.

NOTE:

Probe calibration should only be done under the conditions specified in [Field calibration](#) (p. 21).

8.3 Fault isolation

Failures can be broken into two categories:

1. BIT detected failures
2. Non BIT failures

The failure types are explored in more detail in the following sections.

8.3.1 BIT detected failures

ZF1: Probe Failure

If a ZF1 failure is indicated in response to the **Z1** or **Z4** command, proceed as follows:

1. Perform steps 1-6 of [Removal of strut and probe assembly from heat sink](#) (p. 17) to electrically disconnect probe from Main CCA.

2. Connect a functional strut and probe assembly to **J3(MAIN)** and **J4(MAIN)** on the Main CCA. Install select capacitor for the functional strut at **C7**. The test strut and probe assembly can be temporarily placed on top of the 0872F1 housing.
3. Turn power to the 0872F1 ON and wait for 30 seconds. Issue the **Z4** command. If the **ZF1** failure code is still indicated, replace the Main CCA. If the failure is no longer indicated, replace the strut and probe assembly.

ZF2: Heater Failure

If a **ZF2** failure is indicated in response to the **Z1** or **Z4** command, or if a “no response” condition occurs after issuing the **Z3** command, proceed as follows:

1. Perform steps 1-6 of [Removal of strut and probe assembly from heat sink](#) (p. 17) to electrically disconnect probe from Main CCA.
2. Check resistance between **J4(S/P)-1** and **J4(S/P)-2** using an ohmmeter. Resistance must be 42 ± 5 ohms. If resistance is within range, replace Main CCA. If resistance is out of range, replace strut and probe assembly.

ZF3: Electronic Failure

If a **ZF3** failure is indicated in response to the **Z1** or **Z4** command, replace the Main CCA. No further troubleshooting is required.

8.3.2 Non BIT failures

Non-BIT failures result when the BIT does not recognize the failure.

If the sensor fails to respond to commands, proceed as follows:

1. Verify AC power is on and the main **J1(IDS)** and **J2(IDS)** connectors are connected to the IDS.
2. Switch to **RS-232** mode. If the 0872F1 communicates in **RS-232** mode, but not in current loop mode, replace the Output Interface CCA. If the 0872F1 fails to communicate in either mode, continue with step 3.
3. Switch AC power off. Disconnect connector **J1(IDS)**. Using an ohmmeter, measure the resistance between connector **J1(IDS)-A** and **J1(IDS)-B**. If resistance is less than 200 ohms, replace Main CCA. If not, loosen four cover screws and open cover. Remove plastic guard covering **J1(MAIN)** terminal block by depressing three white clips on each side of guard. Measure resistance between **J12(MAIN)** pins 1 and 2. If resistance is less than 200 ohms, replace Filter Assembly. If greater than 200 ohms, replace Main CCA.

8.4 Removal of 0872F1

Most repairs can be accomplished without removing the 0872F1 from the mounting pole. If removal is required, proceed as follows:

1. Switch 115 VAC power to 0872F1 OFF.
2. Place protective tube over strut and probe.
3. Disconnect connectors **J1(IDS)** and **J2(IDS)**. Place ESD protective caps over connectors.
4. Remove ground nut and wire from ground strut. Put nut back on to finger tightness.
5. Loosen mounting bolts and remove unit from mounting pole.

8.5 Disassembly

8.5.1 Removal of Output Interface CCA

Refer to [Figure 8-1](#) (p. 23) for removal of Output Interface CCA.

DANGER:

Remove power to unit prior to opening sensor cover or injuries could result from electric shock.

WARNING:

This is a Class 1 ESDS item. ESD precautions must be taken prior to opening sensor cover or equipment damage could result.

1. Switch 115 VAC power to the 0872F1 OFF. Disconnect **J1(IDS)**.
2. Loosen captive screws on sensor cover.
3. Open sensor cover. Cover is hinged to housing. Pull cover up and then back to open.
4. Carefully disconnect **J1(I/O)** and **J2(I/O)** plugs from Output Interface CCA.
5. Remove green ground wire from case.
6. Remove Output Interface CCA by gently pulling off from Main CCA.

8.5.2 Removal of Main CCA

Refer to [Figure 8-1](#) (p. 23) and [Figure 8-2](#) (p. 24) for removal of Main CCA.

DANGER:

Remove power to unit prior to opening sensor cover or injuries could result from electric shock.

WARNING:

This is a Class 1 ESDS item. ESD precautions must be taken prior to opening sensor cover or equipment damage could result.

1. Switch 115 VAC power to the 0872F1 OFF. Disconnect J1(IDS).
2. Loosen captive screws on sensor cover.
3. Open sensor cover. Cover is hinged to housing. Pull cover up and then back to open.
4. Remove Output Interface CCA, as per [Removal of Output Interface CCA](#) (p. 16).
5. Remove plastic terminal block cover mounted on snap-on standoffs.
6. Remove terminal screws #1, #2, and #3 with a flat-tip screwdriver. The lugs on these wires are closed-ended.
7. Carefully remove select capacitor **C7**. Depress latch and pull capacitor straight upward. (This capacitor will be reinstalled on the replacement CCA.)
8. Carefully disconnect **J2(MAIN)**, **J3(MAIN)**, and **J4(MAIN)** plugs from main CCA.
9. Remove two remaining wires from terminal block (see [Figure 8-1](#) [p. 23] and [Figure 8-2](#) [p. 24]).
10. Remove Main CCA mounting screws.
11. Remove Main CCA from sensor housing.

8.5.3 Removal of strut and probe assembly from heat sink

Refer to [Figure 8-1](#) (p. 23) for removal of strut and probe assembly from heat sink.

DANGER:

Remove power to unit prior to opening sensor cover or injuries could result from electric shock.

WARNING:

This is a Class 1 ESDS item. ESD precautions must be taken prior to opening sensor cover or equipment damage could result.

NOTE:

Strut and probe replacement can be done at any ambient temperature; however, the unit should be field calibrated only when the ambient temperature is between -10°C and 10°C .

1. Switch 115 VAC power to the 0872F1 OFF. Disconnect **J1(IDS)**.
2. Place protective tube over strut and probe.
3. Loosen captive bolts on sensor cover.
4. Open sensor cover. Cover is hinged to housing. Pull cover up and then back to open.
5. Carefully remove select capacitor **C7**. Depress latch and pull capacitor straight out.
6. Carefully disconnect connectors **P3(I/O)** and **P4(I/O)** from **J3(MAIN)** and **J4(MAIN)**. Remove black grommet from hole in top of housing.

NOTE:

Some early units have a small amount of silicon RTV sealing the hole in the housing in place of the grommet. The RTV should be carefully removed prior to strut removal so the connectors can be routed through the housing and heat sink.

7. Remove four strut mounting screws securing strut to heat sink.
8. Remove strut and probe assembly from heat sink. Carefully feed connectors through the housing and heat sink as the strut is removed.
9. Remove and examine strut and probe O-ring.

8.5.4 Removal of programmed EPROM

DANGER:

Remove power to unit prior to opening sensor cover or injuries could result from electric shock.

WARNING:

This is a Class 1 ESDS item. ESD precautions must be taken prior to opening sensor cover or equipment damage could result.

1. Switch 115 VAC power to the 0872F1 OFF. Disconnect **J1(IDS)**.
2. Loosen captive bolts on sensor cover.
3. Open sensor cover. Cover is hinged to housing. Pull cover up and then back to open.
4. Remove Output Interface CCA per [Removal of Output Interface CCA](#) (p. 16).

5. The EPROM is located on the lower left corner of the Main CCA. It is distinguished from other components by the socket eject levers used to secure and remove the component from the socket. Push tabs on socket eject outward to lift and remove EPROM from Main CCA.

8.5.5 Removal of filter assembly

Refer to [Figure 8-1](#) (p. 23) and [Figure 8-2](#) (p. 24) for removal of Filter Assembly.

DANGER:

Remove power to unit prior to opening sensor cover or injuries could result from electric shock.

WARNING:

This is a Class 1 ESDS item. ESD precautions must be taken prior to opening sensor cover or equipment damage could result.

1. Switch 115 VAC power to the 0872F1 OFF. Disconnect **J1(IDS)** and **J2(IDS)**.
2. Loosen captive bolts on sensor cover.
3. Open sensor cover. Cover is hinged to housing. Pull cover up and then back to open.
4. Remove jam nut securing **J1(IDS)** connector to housing.
5. Disconnect wires from line filter at terminal block **J1(MAIN)** terminals 1 and 2.
6. Disconnect green/yellow wire (originating at line filter) from ground stud.
7. Remove two shoulder nuts securing line filter to housing.
8. Remove **J1(IDS)** connector and line filter from housing.

8.6 Assembly

Refer to [Figure 8-1](#) (p. 23) and [Figure 8-2](#) (p. 24) for installation of FRUs.

8.6.1 Installation of Main CCA

1. Ensure 115 VAC power to the 0872F1 is OFF and **J1(IDS)** is disconnected.
2. Install **Select Capacitor C7** into replacement Main CCA.
3. Position Main CCA into housing with terminal block to the bottom side (ground lug side) of the housing.

4. Install Main CCA mounting screws.
5. Install latching electrical connectors **J2(MAIN)**, **J3(MAIN)**, and **J4(MAIN)**.
6. Position wires on terminal block and tighten terminal screws.
 - Blue wire to terminal #1
 - White wire from terminal #1 to terminal #4
 - Brown wire to terminal #2
 - Black wire from terminal #2 to terminal #5
 - Green wire (from ground stud) to terminal #3
7. Torque terminal block screws to 9 in-lbs.
8. Snap elastic terminal block cover in place.
9. Install Output Interface CCA, as per [Installation of Output Interface CCA](#) (p. 20).
10. Position cover on housing.
11. Torque cover mounting screws to 28 in-lbs.
12. Perform System Verification ([System verification](#) [p. 22]).

8.6.2 Installation of Output Interface CCA

1. Ensure 115 VAC power to 0872F1 is OFF.
2. Align four plastic standoffs with corresponding holes on Main CCA and snap in place.
3. Install green ground wire to internal ground stud.
4. Install plugs **J1(I/O)** and **J2(I/O)** in receptacles on Output Interface CCA.
5. Perform System Verification ([System verification](#) [p. 22]).

8.6.3 Installation of strut and probe assembly

1. Ensure 115 VAC power to the 0872F1 is OFF and **J1(IDS)** is disconnected.
2. Replacement **Select Capacitor** is provided with the spare strut and probe assembly. Install **Select Capacitor** into Main CCA location **C7**.
3. Install O-ring in channel to strut. Feed probe and heater wires through heat sink into housing.
4. Carefully position strut and probe assembly on heat sink, taking care not to pinch any wires.
5. Secure strut and probe assembly to heat sink with four screws. Torque to 12 in-lbs.

6. Connect probe electrical connectors **P3(I/O)** and **P4(I/O)** at **J3(MAIN)** and **J4(MAIN)**.
7. Route wires through grommet and press grommet into hole in top of housing (about two-thirds of grommet should be inside hole).

8.6.4 Installation of programmed EPROM

1. Ensure 115 VAC power to the 0872F1 is OFF and **J1(IDS)** is disconnected.
2. Orient replacement EPROM so the notch faces the same direction as other integrated circuits on the CCA. Push EPROM evenly into socket until it is fully seated and eject levers clamp into place.

NOTE:

It may be necessary to squeeze the eject levers together slightly to fully seat the EPROM.

3. Install Output Interface CCA, as per [Installation of Output Interface CCA](#) (p. 20).
4. Position cover on housing.
5. Torque cover mounting screws to 28 in-lbs.
6. Perform System Verification ([System verification](#) [p. 22]).

8.6.5 Installation of filter assembly

Refer to [Figure 8-1](#) (p. 23) and [Figure 8-2](#) (p. 24) for installation of filter assembly.

1. Install line filter onto housing studs so the side of the two leads is facing down.
2. Secure line filter to housing using lockwasher and shoulder nut (two places). Torque to 8 in-lbs.
3. Remove jam nut from connector. Insert connector through D-hole in housing and secure with jam nut.

NOTE:

Ensure connector O-ring remains in the groove. Torque jam nut to 80 in-lbs.

4. Perform System Verification ([System verification](#) [p. 22]).

8.7 Field calibration

Field calibration of the 0872F1 may be required after replacement of the Strut and Probe Assembly or Main CCA. Field calibration should be invoked if the **Z1** frequency of a clean and dry

probe at 0 ± 10 °C is less than 39970 Hz or greater than 40030 Hz. Calibration should not be performed under any of the following conditions:

- Temperature is greater than 10 °C or less than -10 °C.
- Freezing rain or snow has accreted on the sensing probe.
- Liquid water or other contaminants are visible on the probe.
- Within 20 minutes of a **Z3** (de-ice) command.
- **Z1** or **Z4** commands indicate a fail condition.

8.7.1 Calibration procedure

1. Ensure temperature is 0 ± 10 °C and the probe is clean and dry.
2. Type "**F5**".
3. Type "**Y**" when prompted.
4. Wait 1 minute.
5. Type "**Z1**". The 0872F1 should respond with "**ZPXXXXXY**". "XXXXX" represents the probe frequency and should be between 39995 and 40005.

8.8 System verification

1. Ensure connectors J1(IDS) and J2(IDS) are attached to the 0872F1 and 115 VAC power to the 0872F1 is ON.
2. Type "**Z1**". The 0872F1 should respond with "**ZPXXXXXY**". "XXXXX" represents the probe frequency. If the probe is clean and dry, and the ambient temperature is $0^\circ \pm 10$ °C, the probe frequency and should be between 39970 and 40030.
3. Type "**Z4**". The 0872F1 should respond with "**ZP E3**".
4. Type "**Z302**". The 0872F1 should respond with "**ZDOK51**".

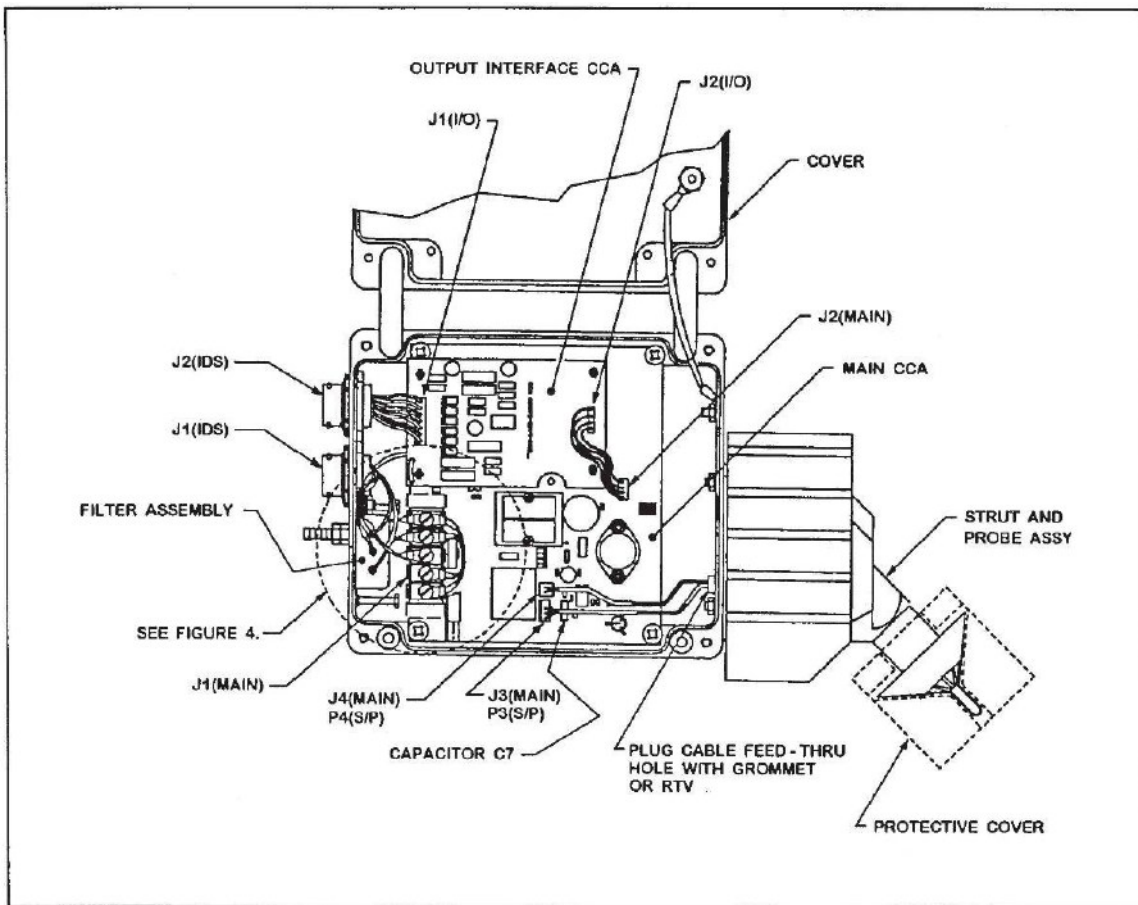


Figure 8-1. Assembly drawing

Table 8-1: Field replaceable assemblies		
Item name	Manufacturer's part number	CAGE code
Main CCA	00872-0150-0003	59885
Output Interface CCA	00872-0149-0002	59885
Strut and Probe Assembly	00872-0286-0002	59885
Filter Assembly	00872-0325-0001	59885
Programmed EPROM	00872-0151-0003	59885

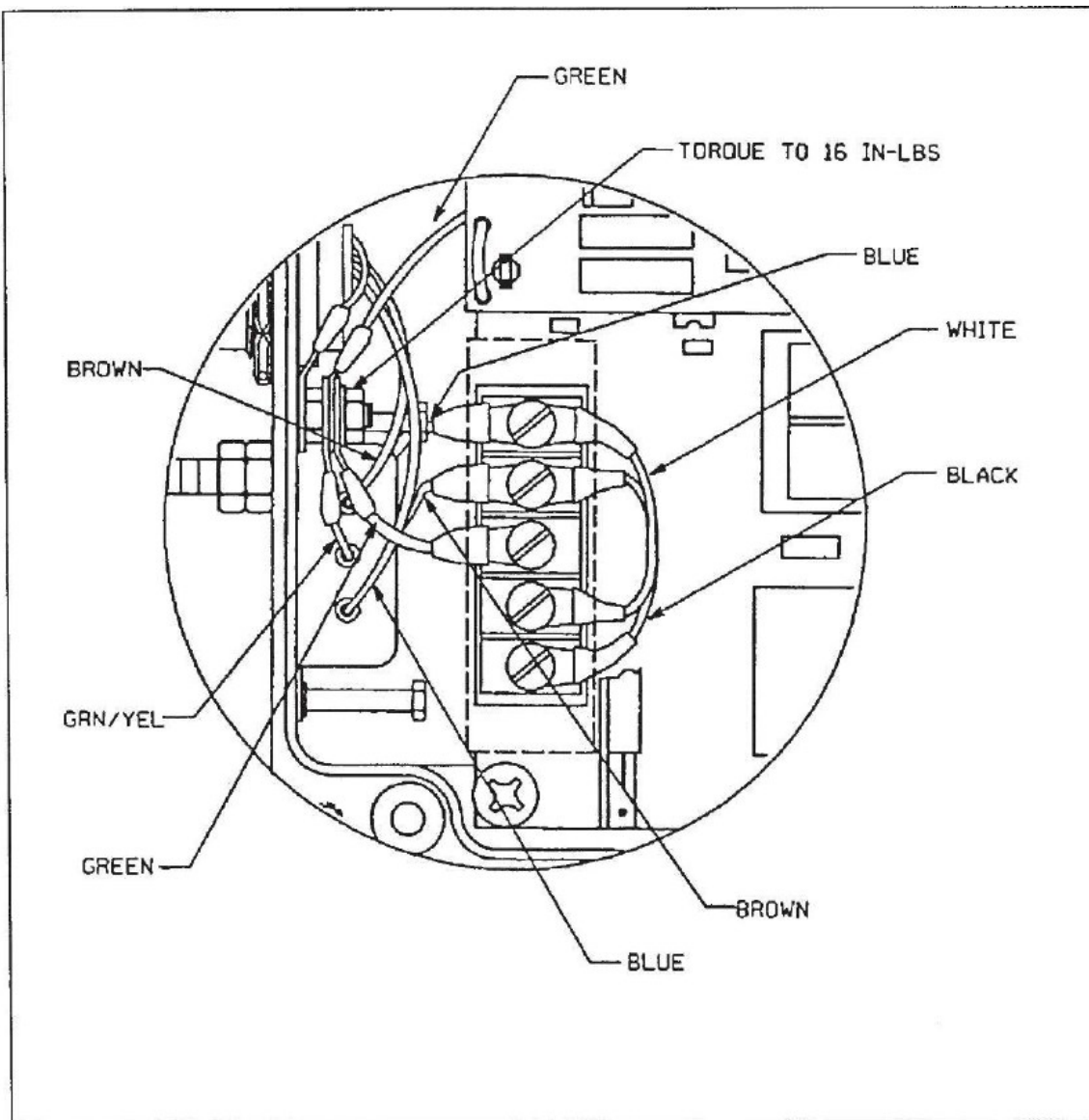


Figure 8-2. Detail assembly drawing

8.9 Output interface circuit

The Output Interface CCA contains all the necessary electronics to convert the RS-232 signal from the Main CCA to a current pulse output. Standard RS-232 output is also available.

8.10 Electrical connections

Electrical connections to the 0872F1 are made at the two main unit connectors located on the outside of the housing. Connector J1(IDS) connects power to the 0872F1. J2(IDS) connects the RS-232 and current loop signal lines to the 0872F1.

Table 8-2: J1(IDS) power connector	
Pin	Description
A	115 VAC Hot
B	115 VAC Neutral
C	Case Ground

Table 8-3: J2(IDS) signal connector	
Pin	Description
A	RS-232Tx
B	RS-232Rx
C	RS-232 Signal Gnd.
D	Unused
E	Unused
F	Current Loop Rx+
G	Current Loop Rx-
H	Current Loop Tx+
J	Current Loop Tx-
K	Unused

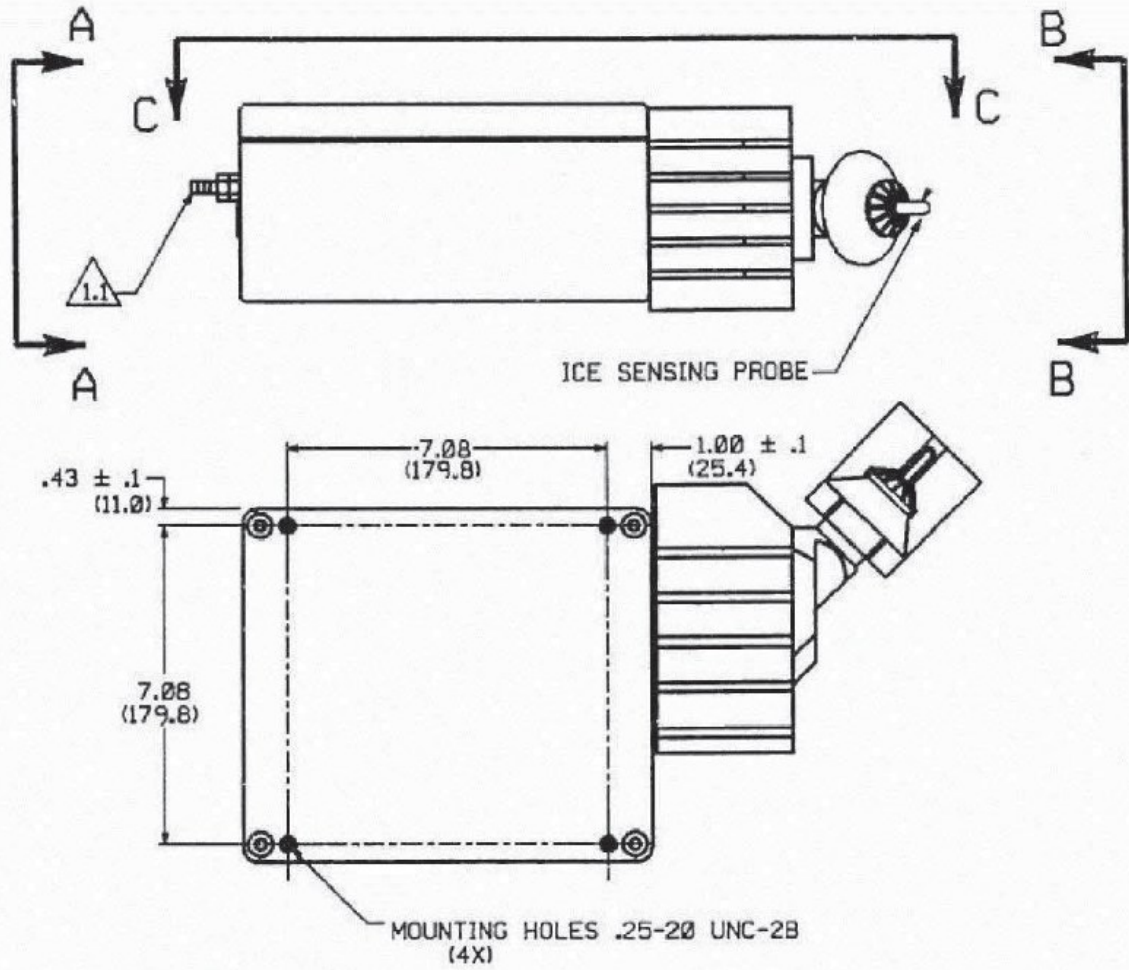


Figure 8-3. Dimensional diagram for the 0872F1

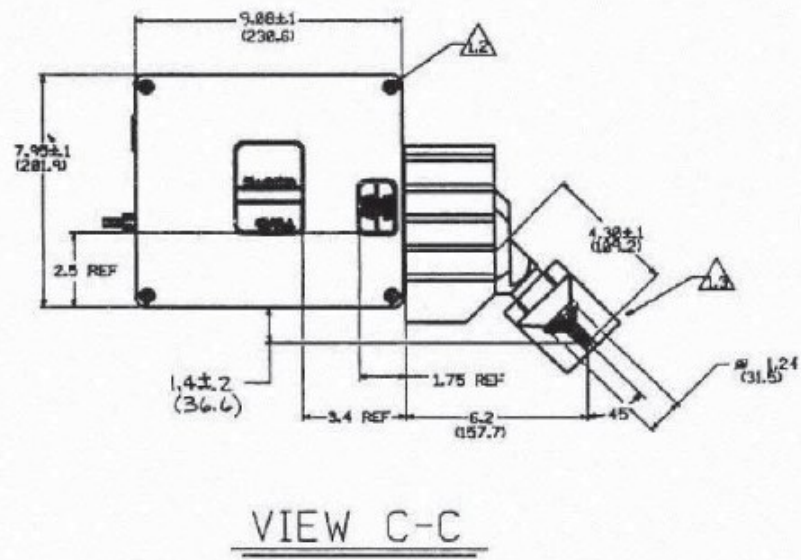
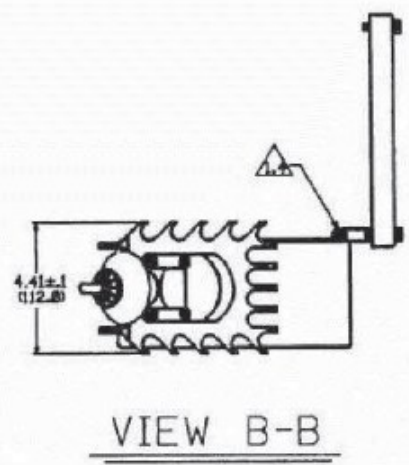
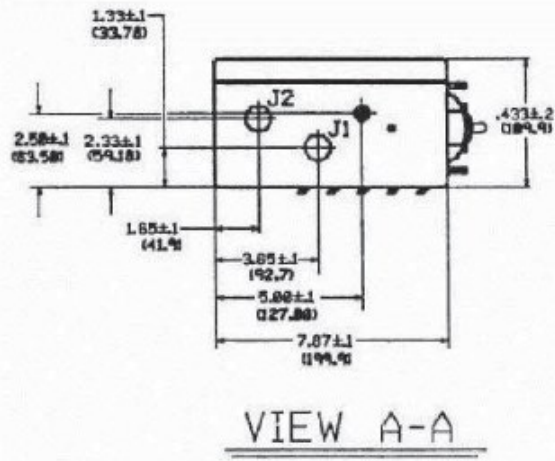


Figure 8-4. Dimensional drawing for the 0872F1

Appendix A. 0872F1 background operational information

A.1 Data link

The 0872F1 is interrogated once a minute by the host system. The host system sends ASCII characters to the 0872F1 and awaits the appropriate response. Control characters and control procedures are compatible with ANSI X3.28 and ANSI X3.66, respectively. The data format consists of the following:

- 1 Start Bit
- 8 Data Bits
- 1 Stop Bit
- No Parity
- 2400 Baud
- Full Duplex
- Serial Asynchronous
- Configured as Data Terminal Equipment (DTE)

Either RS-232 or digital current loop interface can be used to communicate with the 0872F1.

A.2 System commands

NOTE:

All system commands must be in UPPER CASE.

Z1 – Typing Z1 commands the 0872F1 to 'Send Routine Data'. The exceeded output from the 0872F1 is:

ZPXXXXXCC Normal Operation

ZDXXXXXCC De-icing Cycle

"XXXXX" is the probe frequency (averaged over one minute) and "CC" is the checksum.

The probe frequency must be between 38400 and 41500 Hz. Three failure response outputs are also possible after a **Z1** command:

ZF1XXXXXCC Probe Failure
ZF2XXXXXCC Heater Failure
ZF3XXXXXCC Electronics Failure

Z3 – Typing “**Z3XX**” commands the 0872F1 to turn the strut and probe heaters on for “**XX**” seconds, where “**XX**” is a two digit number between 01 and 60. The expected output for the 0872F1 is:

ZDOK51 Confirmation of Heater Activation

If a heater failure is detected or if “**XX**” is not a valid input, the 0872F1 will not acknowledge “**Z3**” request.

DANGER:

Probe will become hot during and shortly after heater activation. Severe burns may result if probe is contacted during this time.

WARNING:

Heater activation during test must not exceed 5 seconds if the ambient temperature is greater than 5 °C, or damage to the probe may result.

Z4 – Typing “**Z4**” commands the 0872F1 to perform extended diagnostics. The possible outputs from the 0872F1 are:

- **ZP E3:** 0872F1 Passes
- **ZD D7:** 0872F1 in De-ice Mode
- **ZF1 EA:** Probe Failure
- **ZF2 EB:** Heater Failure
- **ZF3 EC:** Electronics Failure

F5 – Typing “**F5**” commands the 0872F1 to recalibrate the probe frequency. The 0872F1 responds with:

Recalibrate? Y or N

Responding with “**Y**” will recalibrate the nominal probe frequency to 40000 Hz. Responding with “**N**” or no response within 10 seconds will cancel the **F5** request.

NOTE:

Probe calibration should only be done under the conditions specified in [Field calibration](#) (p. 21).

A.3 Failure detection

The 0872F1 continuously monitors the following functions:

- Power supply voltage
- Memory and storage checksums
- Probe frequency within operating range
- Timing
- I/O port operation

In addition, the heater control circuit is checked once every 10 hours and whenever a **Z3** or **Z4** command is received.

All failures are logged into a non-volatile RAM circuit and can be read out at the factory using a **RS-232** data request. After factory repair, this data is cleared from the non-volatile RAM memory.

A.4 Probe frequency variation

It is normal for the 0872F1 frequency (returned after a **Z1** command) to vary slightly due to the effects of temperature, even in non-icing conditions. The frequency can vary up to 15 Hz due to changing ambient temperature. Greater frequency variation is possible during and shortly after the heaters have been activated. The frequency will return to normal as the probe cools.

A.5 Electrical design

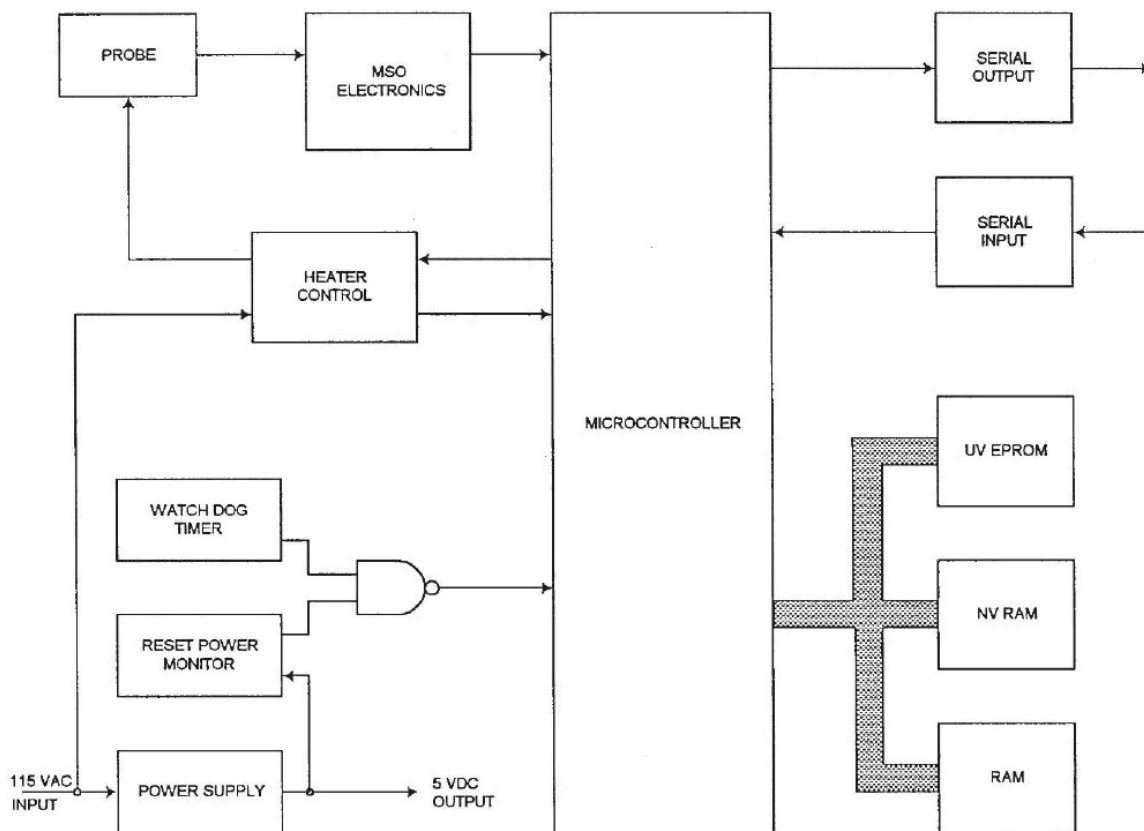
A.5.1 Electrical input requirements

The ice detector utilizes 115 VAC (103.5 to 126.5 VRMS) with 50 to 60 Hz input power. Normal operation continues for power interruptions of less than 10 milliseconds. Power interruptions of greater than 10 milliseconds causes the 0872F1 to go into a reset condition. Under this condition, the 0872F1 will resume operation automatically after the power is reapplied, going through the power up test sequence.

A.5.2 Power consumption

Power consumption under the stated supply voltage conditions:

Mode	Maximum power consumption
Monitoring	10 Watts
Detection (no heater power)	10 Watts
De-Icing	385 Watts
Failure	10 Watts



Internal electronics block	Function
Micro controller	Performs the ice detection and BIT functions
Heater Control	Activates probe/strut de-icing
Watch Dog Timer/Reset Power Monitor	Monitors internal power supply voltages and power disruptions. Checks micro controller for operation.
Solid-State Power Supply	Provides +5 VDC to unit
Serial Output	Provides RS-232 and digital current pulse
Serial Input	Receives RS-232 and digital current pulse
EPROM/NV-RAM/RAM	Various memories needed for operation of micro controller

NOTE:

The sensor is specified to operate at 115 VAC $\pm 10\%$, which corresponds to an input range of 103.5 to 126.5 VAC. 115 VAC and 120 VAC are used interchangeably in this manual.

The use of 120 VAC in wiring references reflects the North American nominal standard, while 115 VAC describes the instrument operating specification. No difference in required supply voltage is intended.

Appendix B. EC declaration certificate

EC DECLARATION OF CONFORMITY

Rosemount Aerospace, Inc. a wholly-owned subsidiary of the Goodrich Corporation,
operating as Goodrich Sensors and Integrated Systems

of 14300 Judicial Road; Burnsville MN 55306

declares that:

Ice Detector Model No. **0872F1 Mod 1** and
Ice Detector Model No. **0872E3 Mod 1** and
Ice Detector Model No. **0872C3 Mod 1**

in accordance with the following Directives

2004/108/EC Directive

has been designed and manufactured to the following specifications:

EN 61326: 1997 Electrical Equipment for Measurement, Control and
Laboratory Use. - EMC Requirements. Includes:
 Amendment A1: 1998
 Amendment A2: 2001
 Amendment A3: 2003

Rosemount Aerospace, Inc. hereby declares that the equipment named above has
been designed to comply with the relevant sections of the above referenced
specifications. The unit complies with the requirements of the above referenced
Directives as qualified per test reports NC708354.

Ice Detector Manager – Darren Jackson

Darren Jackson

Date 3-9-09

Quality Assurance – Bill Burkhardt

Bill Burkhardt

Date 3-12-09

CE08

TRANSMITTAL OF TECHNICAL DATA (EAR)

These commodities, technology, or software are controlled by the U.S. Export Administration Regulations
(EAR). Diversion contrary to U. S. law is prohibited.

ECCN: 7E994.


Limited warranty

Covered equipment is warranted/guaranteed against defects in materials and workmanship under normal use and service for the period listed on your sales invoice or the product order information web page. The covered period begins on the date of shipment unless otherwise specified. For a repair to be covered under warranty, the following criteria must be met:

1. There must be a defect in materials or workmanship that affects form, fit, or function of the device.
2. The defect cannot be the result of misuse.
3. The defect must have occurred within a specified period of time; and
4. The determination must be made by a qualified technician at a Campbell Scientific Service Center/ repair facility.

The following is not covered:

1. Equipment which has been modified or altered in any way without the written permission of Campbell Scientific.
2. Batteries; and
3. Any equipment which has been subjected to misuse, neglect, acts of God or damage in transit.


Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of [regional offices](#) or visit www.campbellsci.com/contact  to determine which Campbell Scientific office serves your country. For directions on how to return equipment, see [Assistance](#).

Other manufacturer's products, that are resold by Campbell Scientific, are warranted only to the limits extended by the original manufacturer.

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Campbell Scientific will, as a default, return warranted equipment by surface carrier prepaid. However, the method of return shipment is at Campbell Scientific's sole discretion. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This warranty and the Company's obligation thereunder is in lieu of all other

warranties, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

In the event of any conflict or inconsistency between the provisions of this Warranty and the provisions of Campbell Scientific's Terms, the provisions of Campbell Scientific's Terms shall prevail. Furthermore, Campbell Scientific's Terms are hereby incorporated by reference into this Warranty. To view Terms and conditions that apply to Campbell Scientific, Logan, UT, USA, see [Terms and Conditions](#). To view terms and conditions that apply to Campbell Scientific offices outside of the United States, contact the [regional office](#) that serves your country.

Assistance

Products may not be returned without prior authorization. Please inform us before returning equipment and obtain a **return material authorization (RMA) number** whether the repair is under warranty/guarantee or not. See [Limited warranty](#) for information on covered equipment.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of [regional offices](#) or visit www.campbellsci.com/contact  to determine which Campbell Scientific office serves your country.

When returning equipment, a RMA number must be clearly marked on the outside of the package. Please state the faults as clearly as possible. Quotations for repairs can be given on request.

It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment. In support of this policy, when equipment is returned to Campbell Scientific, Logan, UT, USA, it is mandatory that a "[Declaration of Hazardous Material and Decontamination](#)" form be received before the return can be processed. If the form is not received within 5 working days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. For details on decontamination standards specific to your country, please reach out to your [regional Campbell Scientific](#) office.

NOTE:

All goods that cross trade boundaries may be subject to some form of fee (customs clearance, duties or import tax). Also, some regional offices require a purchase order upfront if a product is out of the warranty period. Please contact your [regional Campbell Scientific](#) office for details.

Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a hardhat and eye protection, and take other appropriate safety precautions while working on or around tripods and towers.
- Do not climb tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- You can be killed or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in contact with overhead or underground utility lines.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, whichever is greater, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.

- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

Use and disposal of batteries

- Where batteries need to be transported to the installation site, ensure they are packed to prevent the battery terminals shorting which could cause a fire or explosion. Especially in the case of lithium batteries, ensure they are packed and transported in a way that complies with local shipping regulations and the safety requirements of the carriers involved.
- When installing the batteries follow the installation instructions very carefully. This is to avoid risk of damage to the equipment caused by installing the wrong type of battery or reverse connections.
- When disposing of used batteries, it is still important to avoid the risk of shorting. Do not dispose of the batteries in a fire as there is risk of explosion and leakage of harmful chemicals into the environment. Batteries should be disposed of at registered recycling facilities.

Avoiding unnecessary exposure to radio transmitter radiation

- Where the equipment includes a radio transmitter, precautions should be taken to avoid unnecessary exposure to radiation from the antenna. The degree of caution required varies with the power of the transmitter, but as a rule it is best to avoid getting closer to the antenna than 20 cm (8 inches) when the antenna is active. In particular keep your head away from the antenna. For higher power radios (in excess of 1 W ERP) turn the radio off when servicing the system, unless the antenna is installed away from the station, e.g. it is mounted above the system on an arm or pole.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

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