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RS-06-106

10 CFR 50.90

August 4, 2006

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

LaSalle County Station, Units 1 and 2
Facility Operating License Nos. NPF-11 and NPF-18
NRC Docket Nos. 50-373 and 50-374

Subject: Additional Information Supporting the License Amendment Request to Technical Specification 3.7.3, "Ultimate Heat Sink"

References:

1. Letter from K. R. Jury (Exelon Generation Company, LLC) to U.S. NRC, "Request for a License Amendment to Technical Specification 3.7.3, Ultimate Heat Sink," dated March 13, 2006

2. U.S. NRC to C. M. Crane (Exelon Generation Company, LLC), "LaSalle County Power Station, Units 1 and 2 – Request for Additional Information Related to Ultimate Heat Sink License Amendment Request," dated June 15, 2006

3. Letter from J. A. Bauer (Exelon Generation Company, LLC), "Additional Information Supporting the License Amendment Request to Technical Specification 3.7.3, "Ultimate Heat Sink," dated July 13, 2006

In Reference 1, Exelon Generation Company, LLC, (EGC), requested an amendment to Appendix A, Technical Specifications (TS), of Facility Operating License Nos. NPF-11 and NPF-18 for LaSalle County Station (LSCS) Units 1 and 2 respectively. Specifically, the proposed change increases the temperature limit of the cooling water supplied to the plant from the Core Standby Cooling System (CSCS) pond (i.e., the Ultimate Heat Sink (UHS)) from ≤ 100°F to ≤ 101.5°F. This increase is achieved by reducing the temperature measurement uncertainty by replacing the existing thermocouples with higher precision temperature measuring equipment.

In Reference 2, the NRC requested additional information to complete the review of the proposed license amendment. In Reference 3, EGC provided the additional information requested.

In an email dated July 19, 2006, from Stephen Sands, NRC Project Manager to Alison Mackellar, EGC Licensing Engineer; additional information was requested to complete the review of the proposed license amendment. A telephone conference was held on July 20, 2006, between the NRC and EGC to discuss the additional questions. At that meeting EGC agreed to provide the following information to the NRC.

1. Vendor data sheets for the newly installed equipment used to measure the UHS temperature

2. A more detailed calculation of the uncertainty error

Attachment 1 provides the detailed calculation requested including vendor supplied technical data.

Note that the purpose of the detailed calculation is to confirm that the original uncertainty calculation, provided in Reference 3, remains bounding. The detailed calculation was performed in accordance with EGC methodology for instrument uncertainty for safety related indicating loops.

EGC has reviewed the information supporting a finding of no significant hazards consideration that was previously provided to the NRC in Attachment 1 of Reference 1. The supplemental information provided in this submittal does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration.

Should you have any questions concerning this letter, please contact Ms. Alison Mackellar at (630) 657-2817.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 4th day of August 2006.

Respectfully,

Darin M Benyak

Darin M. Benyak
Manager – Licensing

Attachment 1: LSCS Calculation L-003230, "CW Inlet Temperature Uncertainty Analysis"

## Attachment 1

## LaSalle County Station Calculation L-003230

## CW Inlet Temperature Uncertainty Analysis

## ATTACHMENT 1
## Design Analysis Cover Sheet

Last Page No. 14

**Analysis No.** L-003230 **Revision** 000
**EC/ECR No.** 361689 **Revision** 000
**Title:** CW Inlet Temperature Uncertainty Analysis

| | | Component(s) | |
|---|---|---|---|
| **Station(s)** | LaSalle | | |
| **Unit No.:** | 1, 2 | 1TE-CW010 | 2TE-CW010 |
| **Discipline** | I & C | 1TE-CW011 | 2TE-CW011 |
| **Description Code/ Keyword** | I04 | 1TT-CW010 | 2TT-CW010 |
| **Safety Class** | NSR | 1TT-CW011 | 2TT-CW011 |
| **System Code** | CW | U1 Computer Point F285 | U2 Computer Point F285 |
| **Structure** | N/A | U1 Computer Point F286 | U2 Computer Point F286 |

**CONTROLLED DOCUMENT REFERENCES**

| Document No. | From/To | Document No. | From/To |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Is this Design Analysis Safeguards?** Yes ☐ No ☒
**Does this Design Analysis Contain Unverified Assumptions?** Yes ☐ No ☒ ATI/AR#
**Is a Supplemental Review Required?** Yes ☐ No ☒ If yes, complete Attachment 3

| | Print Name | Sign Name | Date |
|---|---|---|---|
| Preparer | T. J. Van Wyk | [signature] | 8/2/06 |
| Reviewer | V. R. Shah | [signature] | 8/2/06 |

Method of Review ☒ Detailed Review ☐ Alternate Calculations ☐ Testing
Review Notes:

| | Print Name | Sign Name | Date |
|---|---|---|---|
| Approver | L. L. Lehman | [signature] | 8-2-06 |

(For External Analyses Only)

| | Print Name | Sign Name | Date |
|---|---|---|---|
| Exelon Reviewer | N/A | | |
| Approver | N/A | | |

Description of Revision (list affected pages for partials):

**THIS DESIGN ANALYSIS SUPERCEDES:**

## CALCULATION TABLE OF CONTENTS

| CALCULATION NO. L-003230 | Revision 000 | PAGE NO. 2 |
|---|---|---|
| SECTION: | PAGE NO. | SUB-PAGE NO. |

## 1 PURPOSE / OBJECTIVE

1.1 The purpose of this calculation is to evaluate the loop uncertainty for the CW Inlet Temperature Indication Loops. These are revised instrument loops that were implemented by EC359060 for Unit 1 and EC359114 for Unit 2.

1.2 These instrument loops provide Ultimate Heat Sink (UHS) temperature indication via the Plant Process Computer (PPC). These new loop configurations replaced the existing thermocouples 1(2)CW010/011 (the sensing elements for computer points F285/F286) with new RTD temperature sensing elements and new temperature compensators (transmitters), and relocated the computer inputs to the appropriate Input/Output (I/O) analog input cards.

## 2 METHODOLOGY AND ACCEPTANCE CRITERIA

2.1 The methodology used for this calculation is based on NES-EIC-20.04 "Analysis of Instrument Channel Setpoint Error and Instrument Loop Accuracy", Rev. 4 (Reference 5.1.2). Additionally, for calculating the average uncertainty using up to four indicating loops, the multiple test criterion of ASME PTC 19.1 (Ref. 5.1.4), Section 3.2 was used.

2.2 The instrumentation evaluated in this calculation provides indication (via the Plant Process Computer) for Ultimate Heat Sink Temperature. This is a non-safety indication loop, but the indication is used to verify the Technical Specification SR 3.7.3.1 is met. In accordance with Reference 5.1.2, Appendix D, a Level 3 evaluation is appropriate for this analysis. However, in response to questions during the NRC review of the License Amendment Request to increase the UHS temperature surveillance requirement value, this analysis will evaluate all uncertainty terms and determine the total uncertainty value using methodology consistent with safety-related indicating loops (Reference 5.1.2, Appendix D, Level 2).

2.3 Temperature, humidity and pressure errors, when available from the manufacturer, are to be evaluated with respect to the conditions specified in the station EQ Zones. If not provided, an evaluation must be made to ensure that the environmental conditions are bounded by the manufacturer's specified operational limits. If the environmental conditions are bounded, these error effects are considered to be included in the manufacturer's reference accuracy.

2.4 Published instrument vendor specifications are considered to be based on sufficiently large samples so that the probability and confidence level meets the $2\sigma$ criteria, unless stated otherwise by the vendor (Reference 5.1.2, Appendix A, Section 8.0).

2.5 For normal error analysis, normal vibrations and seismic effects are considered negligible or capable of being calibrated out in accordance with Appendix I of Reference 5.1.2.

2.6 The calibration standard error is considered negligible; the calibration standard error (STD) is more accurate than the M&TE by a ratio of at least 4:1 (Reference 5.1.2, Appendix A, Section 5.1.4).

2.7 The insulation resistance error is considered negligible unless the instrumentation is expected to operate in an abnormal or harsh environment (Reference 5.1.2, Appendix A, Section 7.0).

2.8 Reference 5.1.2, Appendix I states that the effects of normal radiation are small and accounted for in the periodic calibration process. Outside of containment during normal operation, the uncertainty introduced by radiation effects on components is considered to be negligible.

## 3 ASSUMPTIONS AND LIMITATIONS

3.1 Evaluation of M&TE errors for the digital multimeter is based on the assumption that the test equipment listed in Section 4.5 is used.

3.2 It is assumed that the calibration standard of the equipment utilized is more accurate than the M&TE equipment by a ratio of at least 4:1 such that the calibration standard errors can be considered negligible with respect to the M&TE specification per Section2.6. This is considered a reasonable assumption since M&TE equipment is certified to its required accuracy under laboratory conditions.

## 4 DESIGN INPUTS

4.1 The new instrument loops will consist of the following components: high accuracy RTD temperature elements, temperature transmitters, precision input resistors at the field input to the I/O card, and the D/A conversion in the PPC I/O equipment. The loop components evaluated in this document have the following specifications:

4.1.1 New Minco RTDs in the existing thermowells (replacing the existing thermocouples). The new RTDs have the following performance specifications (Ref. 5.4.1):

Repeatability: ±0.2°F

[The RTDs are designed to EN60751 Class A specifications with high precision and repeatability requirements. Thus, this specification could be considered to be at a 3$\sigma$ confidence level. However, for conservatism, this specification will be used as a 2$\sigma$ value.]

Drift: ±0.1°F/year (Ref. 5.4.3)

[The study in Reference 5.5.3 shows that RTDs are inherently stable, and after the first few months following installation RTDs attain a stable condition from which it may not drift sufficiently to exceed accuracy limits. RTD cross-calibration is performed to identify if an element has experienced significant drift. Although the RTDs are not separately calibrated, for conservatism the vendor's drift value will be expanded using the loop calibration interval of 4 years (+ 1 year late factor).]

4.1.2 The resistance value equivalent to the temperature value of interest (101.5°F) for the RTDs was obtained from the Minco calibration reports for the RTDs installed at LaSalle (Ref. 5.4.10). The highest of the four resistance values was 115.013Ω. This value will be used to determine the M&TE error for the indicating loop (applied to Module 2). The change in resistance per 1°F change in temperature (0.214Ω/°F) was also obtained using the actual resistance values in the calibration reports for 101.5°F and 102.5°F.

4.1.3 New ifm® efector600 TR2432 temperature transmitter modules. These new modules have the following performance specification (Ref.5.4.4, 5.4.5):

Accuracy (includes drift): ±0.54°F / 2 years
"Temperature Drift": ±0.1% of measured range/ 10°C

[Note: Ref. 5.4.5 indicates that the accuracy specification includes drift error and is warranted to hold the accuracy and drift within the specified value for 2 years. It further states that testing is performed on 100% of the devices after production to verify conformance with these specifications. Therefore, these values are 3$\sigma$ confidence level. It also states that the accuracy specification includes the resolution error and electronic component drift, and that there are no other environmental influences that will affect the accuracy specification.]

4.1.4 PPC I/O input card. The I/O input cards have the following performance specification (Ref.5.4.9): [2$\sigma$]

Accuracy: ±0.025% of full scale (30°F to 120°F)

4.2 RTD extension wire has the identical conductor types as the RTD, and therefore there is no emf drop or change in conductor size at the point of connection on the RTD (Ref. 5.4.2).

4.3 The Instrument Loop power supply is a SOLA® SDN 2.5-24-100P (Ref. 5.4.8), which has the following performance specifications: [2σ]

| | |
|---|---|
| Output tolerance: | ± 2% overall (combined Line, load, time, and temperature related changes) |
| Temperature range: | -10°C to 60°C |
| Humidity: | < 90% RH, non-condensing |

4.4 The precision signal resistor at the input terminals of the I/O card (Module 3) is a high-precision resistor with a tolerance of ± 0.02% (Reference 5.3.2) [2σ]

4.5 The loop is calibrated using a variable resistance input (to simulate the RTD input), measured with either a Fluke 45 DMM or an HP 34401A, and reading the indicated temperature at the PPC. The calibration procedures (Ref. 5.2.1 and 5.2.2) each specify that one loop will be calibrated using either the Fluke 45 OR the HP 34401A. The other loop must be calibrated using the other DMM.

4.5.1 Reference Accuracy for the Fluke 45 (medium speed) on the 300Ω range is:

(± 0.05% reading + 2 LSD + 0.02Ω) (Ref. 5.4.6) [2σ]

4.5.2 Reference Accuracy for the HP 34401A on the 1kΩ range is:

± (0.01% reading + 0.001% range) (Ref. 5.4.7) [2σ]

Temperature coefficient for the HP 34401A on the 1kΩ range is (for 0°C to 18°C and 28°C to 55°C):

± (0.0006% of reading + 0.0001% of range /°C) (Ref. 5.4.7) [2σ]

4.6 LOCAL SERVICE ENVIRONMENTS (Ref. 5.5.2)

**Table 4.6**

| | RTDs | Ifm efector600 TR2432 | Plant Process Computer |
|---|---|---|---|
| EQ Zone | H7 | | C1A |
| Location | Turbine Bldg | | Control Room (Computer Room) |
| Temperature | 83°F to 102°F | | 50 to 104°F (Normal: 65 to 85°F) |
| Pressure | 0 "wc | | 0.125 to +3.0 "wc |
| Humidity | 39 to 47% RH | | 2.6 to 90% RH [see note below] |

[Note: Per reference 5.5.2, the normal expected humidity in this zone is 20 to 50% RH]

4.7 Calibration Tolerance

The calibration tolerance for these indication loops is ± 0.54°F. Per Ref. 5.1.2, this is a 3σ value.

# 5 REFERENCES

## 5.1 METHODOLOGY

5.1.1 ANSI/ISA-S67.04-Part 1-1994, "Setpoints for Nuclear Safety Related Instrumentation"

5.1.2 NES-EIC-20.04, "Analysis of Instrument Channel Setpoint Error and Instrument Loop Accuracy," Revision 4

5.1.3 ANSI/ISA TR67.04.09, "Graded Approaches to Setpoint Determination," dated 10/15/05

5.1.4 ASME PTC 19.1, Part 1, "Measurement Uncertainty," 1985

## 5.2 PROCEDURES

5.2.1 LIP-CW-501 [New loop-specific calibration procedure in development; tracked by CAP process]

5.2.2 LIP-CW-601 [New loop-specific calibration procedure in development; tracked by CAP process]

## 5.3 LASALLE STATION DRAWINGS

5.3.1 1 E-1(2)-4022ZC "Schematic Diagram, Circulating Water System CW Pt. 3," as revised by EC359060 and EC359114.

5.3.2 1 E-1(2)-4707AA, "Wiring Diagram Analog Input Cabinet 1(2)C91-P607 AITs 1,2,3,4 Left Side," as revised by EC359060 and EC359114.

## 5.4 VENDOR PRODUCT INFORMATION

5.4.1 Minco® Quotation 160056-2, January 26, 2006

5.4.2 Minco® Drawing S100995, dated 4/27/99

5.4.3 E-mail from Keith Johnson or Minco® to Vikram Shah of LaSalle dated 7/25/06

5.4.4 ifm efector600® TR2432 Operating Instructions, 701724/01, dated 02/04

5.4.5 Letter from Ameera Shah of ifm efector to Vikram Shah of LaSalle dated 7/26/06

5.4.6 Fluke® 45 Dual Display Multimeter Users Manual, Revision 4, dated 07/97

5.4.7 HP 34401A Multimeter User's Guide, Edition 4, printed February 1996

5.4.8 SOLA® SDN Power Supplies Specifications for SDN 2.5-24-100P

5.4.9 RTP® 8436 Series Analog Input Cards Technical Manual, 981-0021-211A, Rev. A, dated 04-96

5.4.10 Minco Report of Calibration for Platinum RTD, Model S100995PD, Serial No. P/N366

## 5.5 OTHER REFERENCES

5.5.1 LaSalle Technical Specifications, Sections 3.7.3, B 3.7.3, Amendments 178/164

5.5.2 LaSalle UFSAR, Rev. 16, Tables 3.11-18 and 3.11-24

5.5.3 EPRI TR-103099, "Effects of Resistance Temperature Detector Aging on Cross-Calibration Techniques," Final Report dated June 1994

## 6 CALCULATIONS

### 6.1 RTD ERRORS (MODULE 1)

6.1.1 Random Errors **$\sigma 1$**

6.1.1.1 RTD Reference Accuracy **RA1**

The RTD Reference Accuracy is ±0.2°F (Section 4.1.1). This is a $2\sigma$ value.

$RA1_{2\sigma}$ = ± 0.2°F / 2

**RA1 = ± 0.1°F**

6.1.1.2 RTD Calibration Error **CAL1**

The RTDs are not separately calibrated. Therefore, there is no calibration tolerance for this module. (The loop calibration tolerance is applied to Module 2, which is the module that is adjusted during loop calibration.)

**CAL1 = 0**

6.1.1.3 RTD Setting Tolerance ST1

The RTDs are not separately calibrated. Therefore, there is no setting tolerance for this module. (The loop calibration tolerance is applied to Module 2, which is the module that is adjusted during loop calibration.)

**ST1 = 0**

6.1.1.4 Random Input Errors $\sigma 1in$

The RTDs are the first modules in the loop. Therefore,

**$\sigma 1in$ = 0**

6.1.1.5 Drift Error D1

The RTD Drift value (IDE) specified by the vendor is ± 0.1°F/year. [$2\sigma$] The RTDs are not separately calibrated: RTD cross-calibration is performed to identify if an RTD has experienced significant drift. For conservatism the vendor's drift value will be expanded using the loop calibration interval (Section 4.1.1). The interval for these indicating loops is 4 years. The 25% late factor is 1year. (VDP is the vendor drift period, or 1 year in this case.)

$$
\begin{aligned}
D1_{2\sigma} &= [IDE] \times [(SI + LF)/VDP)]^{1/2} \\
&= [0.1°F] \times [(4 \text{ years} + 1\text{year})/1\text{year}]^{1/2} \\
&= 0.1°F \times 2.236 \\
&= 0.224°F
\end{aligned}
$$

**D1 = 0.112°F**

6.1.1.6 RTD Random Error **$\sigma 1$**

$$
\begin{aligned}
\sigma 1 &= \pm [(RA1n)^2 + (CAL1)^2 + (ST1)^2 + (\sigma 1in)^2 + (D1)^2]^{1/2} \\
&= \pm [(0.1°F)^2 + (0)^2 + (0)^2 + (0)^2 + (0.112)^2]^{1/2} \\
&= \pm 0.150 °F
\end{aligned}
$$

**$\sigma 1$ = ± 0.150 °F**

6.1.2 Non-Random Errors **Σe1**

RTDs are passive devices that produce a resistance signal proportional to temperature. As such, they are not affected by the following non-random effects.

| | |
|---|---|
| Humidity Effects: | eH1 = 0 |
| Static Pressure Effects: | eSP1 = 0 |
| Ambient Pressure Effects: | eP1 = 0 |
| Power Supply Effects: | eV1 = 0 |
| Seismic Effects: | eS1 = 0 |
| Radiation Effects: | eR1 = 0 |
| Process Effects: | ePr1 = 0 |

6.1.2.1 Insulation Resistance Errors **eIR1**

Insulation Resistance error is to be evaluated where actuation functions are expected to operate in an abnormal or harsh environment (Section 2.7). There are no terminal blocks in 100% relative humidity areas, therefore,

**eIR1 = 0**

6.1.2.2 Resistance Drop of the Extension Wire **eRD1**

Since the RTD extension wires are made of the same material as the RTD itself, there is no emf rise or drop across the RTD head terminals (Section 4.2)

**eRD1 = 0**

6.1.2.3 Temperature Errors **eT1**

RTDs are designed to exhibit a precise temperature effect that is used to develop the input signal to the loop. Since the RTDs are designed to function at temperatures well above the system design temperature, there is no temperature error other than the reference accuracy error. Therefore,

**eT1 = 0**

6.1.2.4 Non-Random Input Errors **e1in**

The RTD is the first module in the loop. Therefore,

**e1in = 0**

6.1.2.5 Non-Random Error **Σe1**

Σe1 = eH1 + eSP1 + eP1 + eV1 + eS1 + eR1 + eT1 + eIR1 + ePr1 + eIR1 + eRD1 + e1in
= 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 = 0°F

**Σe1 = 0°F**

**6.2 TEMPERATURE TRANSMITTER ERRORS (MODULE 2)**

6.2.1 Random Error $\sigma$**2**

6.2.1.1 Reference Accuracy **RA2**

Reference Accuracy is ± 0.54°F (Section 4.1.3). This is a 3$\sigma$ value.

RA2 = ± 0.54°F / 3 = ± 0.18°F

Per Reference 5.4.5, this accuracy includes drift and is warranted for 2 years. The calibration interval is 4 years. The 25% late factor is 1year. (VDP is the vendor drift period, or 2 years in this case.) The formula for applying the surveillance interval to Drift will be applied to the entire RA2 error term.

$$RA2 = \pm [IDE] \times [(SI + LF)/VDP)]^{1/2}$$
$$= \pm [0.18°F] \times [(4 years + 1 year)/2 years)]^{1/2}$$
$$= \pm [0.18°F] \times [1.581139]$$

**RA2 = ± 0.285°F**

6.2.1.2 Calibration Error **CAL2**

The loop is calibrated using a variable resistance input, measured with a Fluke 189 DMM, and reading the indicated temperature at the PPC.

6.2.1.2.1 Measurement & Test Equipment Error **MTE2**

HP 34401A

Reference Accuracy is the manufacturer's accuracy (± 0.01% reading + 0.001% of range for the 1kΩ) as a 2σ value (Section 5.4.6). The highest reading of interest is 101.5°F. The Minco calibration reports for the RTDs show that the highest resistance value for this temperature is 115.013Ω. (Section 4.1.2)

$$RAMTE_{2\sigma} = \pm 0.01\% \times 115.013\Omega + (0.00001 \times 1000\Omega)$$
$$= \pm 0.0115\Omega + 0.01\Omega = 0.0215\Omega$$
$$= \pm 0.0215\Omega \times 1°F/0.214\Omega = 0.100°F$$

**RAMTE2 = ± 0.050°F**

The manufacturer also specifies a Temperature coefficient for this range (1kΩ) for 0°C to 18°C and 28°C to 55°C as 0.0006% of reading + 0.0001% of range per °C. The normal turbine building ambient temperature in the zone where the transmitter is installed varies from 83°F to 102°F(Ref. 5.5.2). For additional conservatism, this range is expanded to 75°F to 102°F (or 23.9°C to 38.9°C). The lower temperature (23.9°C) is within the range where the coefficient is not applicable, so the applicable $\Delta T$ is: (38.9°C - 28°C) or 10.9°C

$$TEMTE2_{2\sigma} = \pm(0.0006\% \times 115.013\Omega) + (0.000001 \times 1000\Omega)$$
$$= \pm 0.00069\Omega + 0.001\Omega = \pm 0.00169\Omega$$
$$= \pm 0.00169\Omega \times 1°F/0.214\Omega = 0.00789°F$$

**RAMTE2 = ± 0.00395°F**

The temperature error is a degradation of the specified accuracy and is not considered an additional random error. Therefore, the total M&TE error for the HP 34401A is:

$$MTE2 = \pm [(0.050°F)^2 + (0.00395°F)^2]^{1/2}$$

**MTE2 = ± 0.0502°F**

Fluke 45 (medium speed)

Reference Accuracy is the manufacturer's accuracy [± (0.05% reading + 2 LSD + 0.02Ω)] as a 2σ value (Section 5.4.6). [The LSD for the Fluke 45 is 0.01Ω.] The highest reading of interest is 101.5°F. The Minco calibration reports for the RTDs show that the highest resistance value for this temperature is 115.013Ω. (Section 4.1.2)

$$RA_{2\sigma} = \pm(0.05\% \times 115.013\Omega) + [(2 \times 0.01\Omega) + 0.02\Omega]$$

$= \pm 0.0575\Omega + 0.04\Omega = 0.0975\Omega$

$= \pm 0.0975\Omega \times 1°F/0.214\Omega = 0.456°F$

**MTE2 = ± 0.228°F**

The Fluke 45 (med. speed) M&TE error is bounding and will be used to evaluate total loop uncertainty.

6.2.1.2.2 Calibration Standard Error **STD2**

The calibration standard error is evaluated as negligible (Section 3.2).

**STD2 = 0**

6.2.1.2.3 Loop Calibration Tolerance **ST2**

The calibration tolerance for this indicating loop is ± 0.54°F (Section 4.7). [3σ]

ST2 = ± 0.54°F / 3

**ST2 = ± 0.18°F**

6.2.1.2.4 Calibration Error **CAL2**

The total calibration error for the M&TE is:

$$CAL2 = \pm [(MTE2)^2 + (STD2)^2 + (ST2)^2]^{1/2}$$
$$= \pm [(0.228°F)^2 + (0)^2 + (018)^2]^{1/2}$$

**CAL2 = ± 0.29°F**

6.2.1.3 Ambient Temperature Error **σT2**

The vendor states the "temperature drift" error for the temperature transmitter as 0.1% of measuring range / 10°C (Ref. 4.1.3) [3σ]. This is applied in this calculation as an ambient temperature error. Measuring range: 30 to 120°F = 90°F.

The normal turbine building ambient temperature in the zone where the transmitter is installed varies from 83°F to 102°F(Ref. 5.5.2). For additional conservatism, this range is expanded to 75°F to 102°F (27°F difference).

$$\sigma T2_{3\sigma} = \pm (0.1\% * Span)$$
$$= \pm [(0.001 * 90°F)/10°C \times (27°F \times 5°F/8°C)$$
$$= \pm 0.1519\ °F / 3$$

**σT2 = ± 0.051°F**

6.2.1.4 Random Input Error **σ2in**

**σ2in** = σ1 = **± 0.150°F**

6.2.1.5 Power Supply Effects **σ2PS**

The transmitter specifications are valid for voltages between 20 and 30 vDC. The 24-volt power supply variability is less than ± 2% all errors combined (4.3). This is equal to 23.5vDC to 24.5vDC. Therefore,

**σ2PS = ± 0 °F**

6.2.1.6 Total Random Error **σ2**

$$\sigma 2 = \pm [(RA2)^2 + (CAL2)^2 + (\sigma T2)^2 + (\sigma 2in)^2 + (\sigma 2PS)^2]^{1/2}$$
$$\sigma 2 = \pm [(0.285°F)^2 + (0.290°F)^2 + (0.051°F)^2 + (0.150°F)^2 + (0°F)^2]^{1/2}$$

$$\boldsymbol{\sigma 2 = \pm 0.436°F}$$

6.2.2 Non-Random Error **Σe2**

6.2.2.1 Humidity Error **e2H**

No humidity effect errors are provided in the manufacturer's specifications, and the humidity conditions at the instrument location are within the operating limits of the module. Humidity errors are negligible during normal conditions. (Reference 5.1.2, Appendix I)

**e2H = 0**

6.2.2.2 Radiation Error **e2R**

No radiation errors are provided in the manufacturer's specifications. Per Section 2.8, it is reasonable to consider the normal radiation effect as negligible. Therefore,

**e2R = 0**

6.2.2.3 Seismic Error **e2S**

No seismic effect errors are provided in the manufacturer's specifications. A seismic event defines a particular type of accident condition. Therefore, there is no seismic error for normal operating conditions

**e2S = 0**

6.2.2.4 Static Pressure Offset Error **e2SP**

The transmitter is an electrical device and therefore not affected by static pressure.

**e2SP = 0**

6.2.2.5 Ambient Pressure Error **e2P**

The transmitter is an electrical device and therefore not affected by ambient pressure.

**e2P = 0**

6.2.2.6 Process Error **e2Pr**

The transmitter receives an analog input from an RTD. Any errors associated with the conversion of temperature to resistance have been accounted for as RTD errors. Therefore,

**e2Pr = 0**

6.2.2.7 Non-Random Input Error **e2in**

**e2in = Σe1 = 0**

6.2.2.8 Total Non-Random Error **Σe2**

$$\Sigma e2 = e2H + e2R + e2S + e2SP + e2P + e2Pr + e2in$$
$$= 0 + 0 + 0 + 0 + 0 + 0 + 0$$
$$\boldsymbol{\Sigma e2 = 0}$$

**6.3 PPC I/O MODULE ERRORS (MODULE 3)**

6.3.1 Random Error $\sigma$**3**

6.3.1.1 Reference Accuracy **RA3**

Reference Accuracy is ± 0.025% calibrated range (Ref. 5.4.9). The calibrated range is 30°F to 120°F (120°F – 30°F = 90°F).

$RA3_{2\sigma}$ = ±0.00025 x 90°F = 0.0225°F

**RA3 = ±0.0113°F**

6.3.1.2 Calibration Error **CAL3**

The I/O module is not separately calibrated; indication is verified during loop calibration.

**CAL3 = ±0°F**

6.3.1.3 Drift Error **D3**

The vendor does not specify a drift error specification for the I/O module.

**D3 = ± 0°F**

6.3.1.4 Random Input Error $\sigma$**3in**

$\sigma$**3in** = $\sigma$2 = **± 0.437°F**

6.3.1.5 Total Random Error $\sigma$**3**

$$\sigma 3 = \pm [(RA3)^2 + (CAL3)^2 + (\sigma D3)^2 + (\sigma 3in)^2 + (\sigma 3r)^2]^{1/2}$$
$$\sigma 3 = \pm [(0.0113°F)^2 + (0.0°F)^2 + (0°F)^2 + (0.436°F)^2]^{1/2}$$

$\sigma$**3 = ± 0.436°F**

6.3.2 Non-Random Error $\Sigma$**e3**

6.3.2.1 Humidity Error **e3H**

No humidity effect errors are provided by the manufacturer'; specified RH for PPC equipment is 20 to 80% RH. The I/O module is located in EQ Zone C1A, (Section 4.6), where expected RH levels are 20 to 50%. Humidity errors are negligible. (Reference 5.1.2, Appendix I)

**e3H = 0**

6.3.2.2 Radiation Error **e3R**

No radiation errors are provided in the manufacturer's specifications. Per Section 2.8, it is reasonable to consider the normal radiation effect as negligible. Therefore,

**e3R = 0**

6.3.2.3 Seismic Error **e2S**

No seismic effect errors are provided in the manufacturer's specifications. A seismic event defines a particular accident condition. Therefore, there is no seismic error for normal operating conditions

**e3S = 0**

6.3.2.4 Static Pressure Offset Error **e3SP**

The I/O module is an electrical device and therefore not affected by static pressure.

**e3SP = 0**

6.3.2.5 Ambient Pressure Error **e3P**

The I/O module is an electrical device and therefore not affected by ambient pressure.

**e3P = 0**

6.3.2.6 Process Error **e3Pr**

The I/O module receives an analog current input from the transmitter. Any errors associated with the conversions of temperature to resistance, and resistance to current have been accounted for as errors associated with modules 1 and 2. Therefore,

**e3Pr = 0**

6.3.2.7 Input Signal Resistor Error **e3SR**

e3SR = ± (0.02% ∗ Span) (Section 4.4)
= ± 0.0002 ∗ 90°F
= ± 0.018 °F

**e3SR = ± 0.018°F**

6.3.2.8 Non-Random Input Error **e3in**

**e3in = Σe2 = 0**

6.3.2.9 Total Non-Random Error **Σe3**

Σe3 = e3H + e3R + e3S + e3SP + e3P + e3Pr + e3SR + e3in
= 0 + 0 + 0 + 0 + 0 + 0 + 0.018 + 0

**Σe3 = 0.018**

### 6.4 SUMMARY AND CONCLUSION (TOTAL ERROR)

6.4.1 As discussed in Methodology Section 2.2, Level 2 methodology is applied for determining Total Error for this indication loop:

TE = σ3 + Σe3
= ± (0.436°F)+ 0.018°F
= ± 0.454°F

**TE = ± 0.454°F**

**In conclusion, the total uncertainty for the CW Inlet Temperature Indication loop is ± 0.454°F**

6.4.2 To obtain a more accurate value of the UHS temperature using these instruments, the average of the available values can be taken. This assumes that the four readings are sensing the same input temperature and that there is little effect between the input and the measurement point.

$$T_{CWAverage} = \frac{T_{1TE-CW010} + T_{1TE-CW011} + T_{2TE-CW010} + T_{2TE-CW011}}{4}$$

The accuracy of this process is considered the same as the accuracy of summing networks addressed in References 5.1.1 and 5.1.2, or by the multiple test criterion of Reference 5.1.4 Section 3.2.

In all of these cases the final random uncertainty (σ) is the square root sum of the squares of the individual channel random uncertainties considering the multiplier for each of the uncertainties is one divided by the number of channels that are being averaged. The non-random uncertainty (e) will remain the same as for a single loop (Ref. 5.1.4, Section 3.2).

$$\sigma_{Average} = \sqrt{\left(\frac{\sigma_1}{n}\right)^2 + \left(\frac{\sigma_2}{n}\right)^2 + \left(\frac{\sigma_3}{n}\right)^2 + \bullet \quad \bullet \quad \bullet \quad \bullet + \left(\frac{\sigma_n}{n}\right)^2}$$

If all of the instrument loops are identical then this equation will reduce to:

$$\sigma_{Average} = \frac{\sigma_i}{\sqrt{n}} + e$$

Thus for the CW temperatures, the accuracy of the average of the readings for **two loops** will be:

$$\sigma_{Average} = \frac{0.436}{\sqrt{2}} + e = 0.308 + 0.018 = 0.326\,°\text{F}$$

The accuracy of the average of the readings for **three loops** will be:

$$\sigma_{Average} = \frac{0.436}{\sqrt{3}} + e = 0.252 + 0.018 = 0.270\,°\text{F}$$

The accuracy of the average of the readings for **four loops** will be:

$$\sigma_{Average} = \frac{0.436}{\sqrt{4}} + e = 0.218 + 0.018 = 0.236\,°\text{F}$$

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L-003230 Rev. 0
Attachment A
Page A1 (final)

7300 Commerce Lane
Minneapolis, MN 55432 U.S.A.
Customer Service Telephone: 763-571-3123
Sales Inquiries Fax: 763-571-0927
Purchase Order Fax: 763-571-0942
E-Mail: custserv@minco.com

# QUOTATION

| | | | |
|---|---|---|---|
| To: | Vikram Shah<br>Exelon Corporation<br>LaSalle County Nuclear Station<br>2601 N 21st Marsailles Road<br>Marseilles IL 61341-9757 | Quote No:<br>Page:<br>Date:<br>RFQ: | 160056-2<br>1<br>January 26, 2006<br>RTD Assemblies |
| Phone:<br>Fax: | 815-415-3828 | CC: | Thermo/Cense, Inc.<br>942 Turret Court<br>Mundelein, IL 60060<br>Phone: 847-949-8070,8071<br>Fax: 847-949-8074 |
| | Fax Order to 763-571-0942 or<br>E-Mail Order to custserv@minco.com | | |

**Please Reference Above Quote Number When Placing Your Order.**

| Item | Description | Quantity | Unit Price U.S. $ |
|---|---|---|---|
| 1 | Minco Part # ASSEMBLY<br>Assembly Consisting Of:<br><br>CGASSY<br>CH359P2T6<br>FG113-1<br>FG750F8M12<br>XS853PD157X4<br><br>X = Class A sensor.<br><br>Single Element RTD assembly | 1 - 9 | 162.60 |
| 2 | Minco Part # XRT07<br>Test charge for a chart of temperature readings at .1F intervals from -272F to 932F | 1 - 9 | 425.00 |

Notes:

1. These assemblies will replace the existing head that is on the thermowell. This is due to not knowing how long the replacement probe would need to be. The drawing does not provide all of this information to determine the proper length. Lead time for these parts is also relatively short as compared to a special probe.
2. 1. Probe length is 15.6". This is the necessary length of the probe to fit in the thermowell and fit into the connection head.
   2. The probe diameter is .25", but will fit in the thermowell without any reduction in performance.
   3. Drift specifications on the S852 sensor is listed as +/- .2 F per year, repeatability is also +/- .2 F. This specification assumes cycling throughout the full temperature range of the sensor, from -50C to 260C. A smaller temperuture cycle will change the amount of drift.

WHEN ORDERING SPECIFY CASE LENGTH, NUMBER OF LEADS, AND LEAD LENGTH.

| S100995PD48Z36 ← EXAMPLE OF MODEL NUMBER | |
|---|---|
| S100995 | SPECIFICATIONS DRAWING NUMBER. |
| PD | SENSING ELEMENT:<br>PD = 100 OHM ±.06%, .00385 PLATINUM. |
| 48 | CASE LENGTH A IN .1" INCREMENTS (48 = 4.8").<br>MINIMUM A = 28 (2.8") [71];<br>MAXIMUM A = 480 (48.0") [1219]. |
| Z | NUMBER OF LEADS:<br>Y = 2 LEADS;<br>Z = 3 LEADS;<br>X = 4 LEADS. |
| 36 | LEAD LENGTH B IN INCHES. |

| REVISIONS | | | | | |
|---|---|---|---|---|---|
| REV | DESCRIPTION | DATE | ECO | DR | APPD |

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Attachment B
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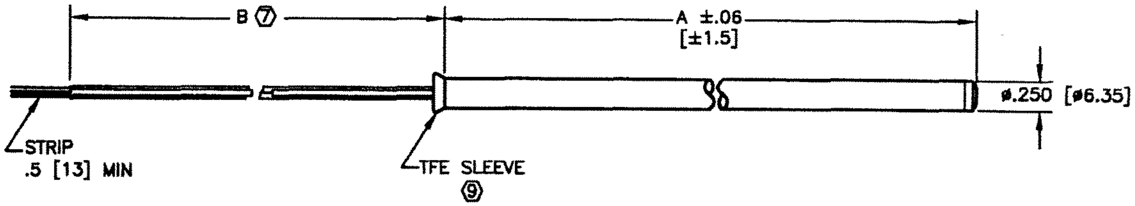
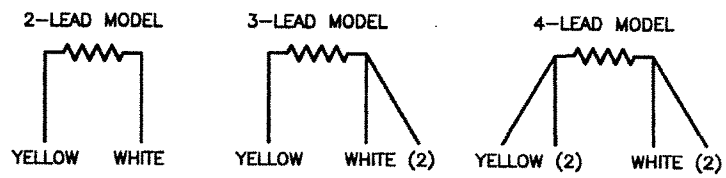



SCHEMATIC DIAGRAMS




1. ELEMENT: PLATINUM.
2. RESISTANCE: 100.00 OHMS ±.06% (100.06/99.94) AT 0°C (32°F), EXCLUDING LEADWIRE RESISTANCE; R/T TABLES #5-100 (°C) AND #6-100 (°F).
3. RESISTANCE-TEMPERATURE COEFFICIENT: .00385 OHM/OHM/°C NOMINAL FROM 0°C TO 100°C.
4. TEMPERATURE RANGE: -50°C TO 260°C (-58°F TO 500°F).
5. INSULATION RESISTANCE: 1000 MEGOHMS MINIMUM AT 500 VOLTS DC, LEADS TO CASE.
6. LEADS: AWG #22, STRANDED, TFE INSULATED.
7. TOLERANCE ON LEAD LENGTH:
   71" [1803] AND UNDER: +2/-0" [+51/-0];
   72" TO 119" [1829 TO 3023]: +4/-0" [+102/-0];
   120" [3048] AND OVER: +6/-0" [+152/-0].
8. CASE: STAINLESS STEEL, COPPER ALLOY TIP.
9. CASE MAY BE CUT TO SHORTER LENGTH. USE CARE NOT TO DAMAGE LEADWIRE INSULATION. LOCATE THE SLIP-FIT TFE SLEEVE IN END OF CUT-OFF CASE TO PROTECT LEADWIRE INSULATION AT POINT OF EMERGENCE. MINIMUM A FOR CUT-OFF CASE IS 28 (2.8") [71].
10. THE RESISTANCE THERMOMETER WILL MEET THE RESISTANCE-TEMPERATURE RELATIONSHIP AND TOLERANCES SPECIFIED IN IEC 751, CLASS A.

UNLESS OTHERWISE SPECIFIED DIMENSIONS AND TOLERANCES IN INCHES DIMENSIONS IN [ ] ARE IN MILLIMETERS
ONE PLACE (.0) ±.020 [±0,51]
TWO PLACE (.00) ±.010 [±0,25]
THREE PLACE (.000) ±.005 [±0,13]
ANGLES:

MATERIAL:

FINISH:

| | INITIALS | DATE |
|---|---|---|
| DR | WAB | 04-13-99 |
| CHK | PHP | 04-27-99 |
| APP | | |
| ENGR | DLW | 04-27-99 |
| QA | | |
| PRD | | |
| NEXT ASSY | | INIT. JOB 5– |
| USED ON | | |

| ITEM | REQD | PART/STOCK NO | MATERIAL DESCRIPTION |
|---|---|---|---|

TITLE: RESISTANCE THERMOMETER
PROBE TYPE, TIP-SENSITIVE
S100995 SERIES

CGP Transferred 04/27/99 WAB

SCALE: NONE | STOCK NO | DWG SIZE B

MINCO PRODUCTS, INC.
MINNEAPOLIS, MN, USA
COMPANY CONFIDENTIAL
PROPRIETARY INFORMATION OF MINCO PRODUCTS, INC.
DO NOT DUPLICATE

CAGE IDENT. 09359 | THIRD ANGLE PROJECTION

S100995 | REV –

SHEET 1 OF 1

Print Date: 07/28/2006 10:12

## VanWyk, Thomas J.

**From:** Keith Jensen [Keith.Jensen@minco.com]
**Sent:** Wednesday, July 26, 2006 9:22 AM
**To:** Shah, Vikram R.
**Subject:** Fwd: Exelon Corporation

100995.pdf

```
>>> Keith Jensen 7/25/2006 3:50 PM >>>
Vikram Shah  815-415-3828
Exelon Corporation
Marsailles IL
vikram.shah@exelon.com

XS853PD157X4     RFQ 160056-2

The S100995 probe meets the EN60751 Class A +/- 0.06% @ 0C sensor
accuracy requirements

Minco estimates the drift per year over the range of 30F to 120F would
be expected to be around  0.1F or less (PHP)

The drawing is attached

Keith Jensen  763-586-2908
Applications Engineer
MINCO PRODUCTS INC.
Minneapolis MN
keith.jensen@minco.com
```

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Attachment D
Page D1

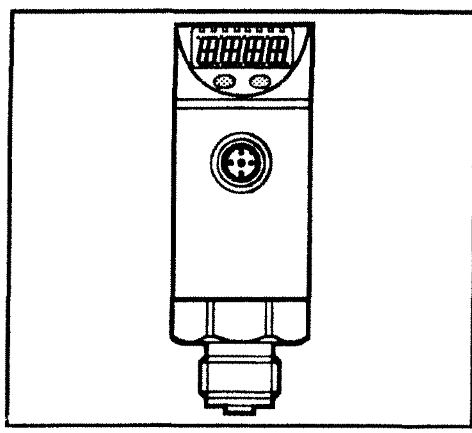
CE

ifm electronic

# Bedienungsanleitung
# Operating instructions
# Notice utilisateurs

efector500

## Auswerteelektronik für Temperatursensoren
## Control monitor for temperature sensors
## Amplificateur pour sondes de température
## TR2432



DEUTSCH

ENGLISH

FRANÇAIS

Sachnr. 701724/01 02/04

## Technical data

| | |
|---|---|
| Operating voltage [V] | 20 ... 30 DC [1] |
| Current rating [mA] | 250 |
| | Short-circuit prot., reverse polarity prot. / overload prot., watchdog |
| Voltage drop [V] | < 2 |
| Current consumption [mA] | < 55[2] |
| Constant current sensor [mA] | 0.2 (Pt 1000 element) |
| Constant current sensor [mA] | 2.0 (Pt 100 element) |
| Power-on delay time [s] | 1.5 |
| Response time switching output [ms] | 130 |
| Analogue output (measuring range scaleable) | 4 ... 20 mA / 0 ... 10 V |
| Max. load current output [Ω] | $(U_B - 10) \times 50$; 700 at $U_B = 24$ V |
| Min. load with voltage output [Ω] | 2000 |
| Response time analogue output [ms] | 384 |
| Accuracy | |
| Switching output [°C/°F] | ± 0.3 / ± 0.54 |
| Analog output [°C/°F] | ± 0.3 / ± 0.54 |
| Display [°C/°F] | ± (0.3 / ± 0.54 + ½ Digit) |
| Resolution | |
| Switching output [°C/°F] | 0.1 / 0.1 |
| Analogue output [°C/°F] | 0.1 / 0.1 |
| Display [°C/°F] | 0.1 / 0.1 |
| Temperature drift [% of value of measuring range/10 K] | ± 0.1 |
| Housing material | stainless steel (304S15); EPDM/X (Santoprene); PC (Macrolon); Pocan; FPM (Viton) |
| Operating temperature [°C] | -25 ... +70 |
| Storage temperature [°C] | -40 ... +85 |
| Protection | IP 67, III |
| Insulation resistance [MΩ] | > 100 (500 V DC) |
| Shock resistance [g] | 50 (DIN / IEC 68-2-27, 11ms) |
| Vibration resistance [g] | 20 (DIN / IEC 68-2-6, 10 - 2000 Hz) |
| EMC | |
| EN 61000-4-2 ESD: | 4 / 8 KV |
| EN 61000-4-3 HF radiated: | 10 V/m |
| EN 61000-4-4 Burst: | 2 KV |
| EN 61000-4-6 HF conducted: | 10 V |

[1] to EN50178, SELV, PELV;
referring to UL: see page 21 (Electrical connection).
[2] 41 mA when the display is switched off;
the values apply to the operating voltage = 24 V and unloaded outputs.

ENGLISH

**ifm efector inc.**
782 Springdale Drive, Exton, PA 19341 • 800-441-8246 • Fax: 800-329-0436 • www.ifmefector.com

July 26, 2006

Mr. Vikram Shah
Exelon Corporation
2601 N 21st Rd.
Marseilles, Illinois 61341

Dear Vikram:

This letter is in response to your concern about the specifications of the **ifm efector** TR2432 temperature sensor. The following points should clarify the questions that you had:

- After production, 100% of the sensors are verified and tested to the specifications listed on our datasheet.
- The analog accuracy specification of (+/- 0.54°F) already includes the analog resolution value of (0.1°F), and is inclusive of any electronic component drift.
- The temperature drift specification is the electronic drift that occurs for every 10°C change in temperature that occurs in the application. This drift is in addition to the accuracy specification.
- There are no other environmental influences that will affect the accuracy specification.
- These sensors have a warranty period of 2 years.

Please contact me if you have any further questions, or if you require any additional information.

Best regards,

Ameera Shah

Ameera Shah
Product Support Engineer
Fluid Sensors Team

## Attachment F: Fluke 45 Accuracy Specifications

### OHMS

| Range | Resolution | | | Accuracy | Typical Full Full Scale Voltage | Max Current Through the Unknown |
|---|---|---|---|---|---|---|
| | Slow | Medium | Fast | | | |
| 300Ω | — | 10 mΩ | 100 MΩ | 0.05% + 2 + 0.02Ω | 0.25 | 1 mA |
| 3 kΩ | — | 100 MΩ | 1Ω | 0.05% + 2 | 0.24 | 120 μA |
| 30 kΩ | — | 1Ω | 10Ω | 0.05% + 2 | 0.29 | 14 μA |
| 300 kΩ | — | 10Ω | 100Ω | 0.05% + 2 | 0.29 | 1.5 μA |
| 3 MΩ | — | 100Ω | 1 kΩ | 0.06% + 2 | 0.3 | 150 μA |
| 30 MΩ | — | 1 kΩ | 10 kΩ | 0.25% + 3 | 2.25 | 320 μA |
| 300 MΩ* | — | 100 kΩ | 1 MΩ | 2% | 2.9 | 320 μA |
| 100Ω | 1 mΩ | — | — | 0.05% + 8 + 0.02Ω | 0.09 | 1 mA |
| 1000Ω | 10 mΩ | — | — | 0.05% + 8 + 0.02Ω | 0.10 | 120 μA |
| 10 kΩ | 100 mΩ | — | — | 0.05% + 8 | 0.11 | 14 μA |
| 100 kΩ | 1Ω | — | — | 0.05% + 8 | 0.11 | 1.5 μA |
| 1000 kΩ | 10Ω | — | — | 0.06% + 8 | 0.12 | 150 μA |
| 10 MΩ | 100Ω | — | — | 0.25% + 6 | 1.5 | 150 μA |
| 100 MΩ* | 100 kΩ | — | — | 2 % + 2 | 2.75 | 320 μA |

*Because of the method used to measure resistance, the 100 MΩ (slow) and 300 MΩ (medium and fast) ranges cannot measure below 3.2 MΩ and 20 MΩ, respectively. "UL" (underload) is shown on the display for resistances below these nominal points, and the computer interface outputs "+1E-9".

**Open Circuit Voltage**

3.2 volts maximum on the 100Ω, 300Ω, 30 MΩ, 100 MΩ, and 300 MΩ ranges, 1.5 volts maximum on all other ranges.

**Input Protection**

500V dc or rms ac on all ranges

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Attachment G
Page G1 (final)

SOLA/ HEVI-DUTY

## SDN™ Specifications (Single Phase)

| Description | Catalog Number | | | | |
|---|---|---|---|---|---|
| | SDN 2.5-24-100P | SDN 4-24-100LP | SDN 5-24-100P | SDN 10-24-100P | SDN 20-24-100P |
| **Input** | | | | | |
| Nominal Voltage | 115/230 VAC auto select | | | | |
| -AC Range | 85-132/176-264 VAC | | | | |
| -DC Range[6] | 90-375 VDC | 210-375 VDC | | | N/A |
| -Frequency | 47 - 63 Hz | | | | |
| Nominal Current[1] | 1.3 A. / 0.7 A | 2.1 A / 1.0 A | 2.2 A / 1.0 A | 5 A / 2 A typ. | 9 A/ 3.9 A |
| -Inrush current max. | typ. < 25 A | typ. < 20 A | | typ. < 40 A | |
| Efficiency (Losses[2]) | > 87.5% typ (8.6 W) | > 88% typ (13.1 W) | > 88% typ (16.4 W) | > 88% typ (32.7 W) | > 90% typ (48 W) |
| Power Factor Correction | Units Fulfill EN61000-3-2 | | | | |
| **Output** | | | | | |
| Nominal Voltage | 24 VDC (22.5 - 28.5 VDC adj.) | 24 VDC (22.5 - 25.5 VDC adj.) | 24 VDC (22.5 - 28.5 VDC adj.) | | |
| -Tolerance | < ±2% overall (combination Line, load, time and temperature related changes) | | | | |
| -Ripple[3] | < 50 mVpp | | | | |
| Nominal Current | 2.5 A (60 W) | 3.8 A (92 W) | 5 A (120 W) | 10 A (240 W) | 20 A (480 W) |
| -Peak Current[4] | 1.6x Nominal Current < 2 sec. | 4.2 A max at 23.8V | 6 A 2x Nominal Current < 2 sec. | 12 A 2x Nominal Current < 2 sec. | 25 A 2x Nominal Current < 2 sec. |
| -Current Limit | Fold Forward (Current rises, voltage drops to maintain constant power during overload up to max peak current) | | | | |
| Holdup Time[5] | > 50 ms | > 100 ms | > 100 ms | | > 20 ms |
| Parallel Operation | Single or Parallel use is selectable via Front Panel Switch (SDN4 should not be used in parallel as Class 2 rating would be violated.) | | | | |
| **General** | | | | | |
| EMC: -Emissions | EN61000-6-3, -4; Class B EN55011, EN55022 Radiated and Conducted including Annex A. | | | | |
| -Immunity | EN61000-6-1, -2; EN61000-4-2 Level 4, EN61000-4-3 Level 3; EN61000-4-6 Level 3; EN61000-4-4 Level 4 input and Level 3 output; EN61000-4-5 Isolation Class 4, EN61000-4-11; Transient resistance according to VDE 0160/W2 over entire load range. | | | | |
| Approvals | EN60950; EN50178; EN60204; UL508 Listed, cULus; UL60950, cRUus, CE (LVD 73/23 & 93/68/EEC). EN61000-3-2, IEC60079-15 (Class 1, Zone 2, Hazardous Location, Groups A, B, C, D w/ T3A temp class up to 60°C Ambient.) SEMI F47 Sag Immunity. SDN2.5 & SDN4 - UL60950 testing to include approval as Class 2 power supply. | | | | |
| Temperature | Storage: -25°C...+85°C Operation. -10°-60°C full power with operation to 70°C possible with a linear derating to half power from 60°C to 70°C (Convection cooling, no forced air required). Operation up to 50% load permissable with sideways or front side up mounting orientation. The relative humidity is < 90% RH, noncondensing; IEC 68-2-2, 68-2-3. For operation below -10°C, contact Technical Services. | | | | |
| MTBF: | > 820,000 hours | > 640,000 hours | | > 600,000 hours | > 510,000 hours |
| - Standard | Bellcore Issue 6 Method 1 Case 3 @ 40C | | | | MIL217F @ 30C |
| Warranty | 5 years | | | | |
| General Protection/Safety | Protected against continuous short-circuit, overload, open-circuit. Protection class 1 (IEC536), degree of protection IP20 (IEC 529) Safe low voltage: SELV (acc.EN60950) | | | | |
| Status Indicators | Green LED and DC OK signal (N.O. Solid State Contact rated 200 mA / 60 VDC) | | | | |
| **Installation** | | | | | |
| Fusing -Input | Internally fused. External 10 A slow acting fusing for the input is recommended to protect input wiring. | | | | |
| -Output | Outputs are capable of providing high currents for short periods of time for inductive load startup or switching. Fusing may be required for wire/loads if 2x Nominal O/P current rating cannot be tolerated. Continuous current overload allows for reliable fuse tripping. | | | | |
| Mounting | Simple snap-on system for DIN Rail TS35/7.5 or TS35/15 or chassis-mounted (optional screw mounting set SDN-PMBRK2 required). | | | | |
| Connections | Input: IP20-rated screw terminals, connector size range: 16-10 AWG (1.5-6 mm2) for solid conductors. 16-12 AWG (0.5-4 mm2) for flexible conductors. Output: Two connectors per output, connector size range: 16-10 AWG (1.5 - 6 mm2) for solid conductors. | | | | |
| Case | Fully enclosed metal housing with fine ventilation grid to keep out small parts. | | | | |
| -Free Space | 25 mm above and below, 25 mm left and right, 10 mm in front | | 25 mm above and below, 25 mm left and right, 15 mm in front | 70 mm above and below, 25 mm left and right, 15 mm in front | |
| H x W x D (inches/mm) | 4.88 in. x 1.97 in. x 4.55 in. (124 mm x 50 mm x 116 mm) | 4.88 in. x 2.56 in. x 4.55 in. (124 mm x 65 mm x 116 mm) | | 4.88 in. x 3.26 in. x 4.55 in. (124 mm x 83 mm x 116 mm) | 4.88 in. x 6.88 in. x 4.55 in. (124 mm x 175 mm x 116 mm) |
| Weight (lbs/g) | 1 lb (460g) | 1.5 lbs (620g) | | 2.2 lbs (1100g) | 3 lbs (1520g) |

1 Input current ratings are conservatively specified with low input, worst case efficiency and power factor.
2 Losses are heat dissipation in watts at full load, nominal input line.
3 Ripple/noise is stated as typical values when measured with a 20 MHz, bandwidth scope and 50 Ohm resistor.
4 All peak current is calculated at 24 Volt levels.
5 Full load, 100 VAC Input @ $T_{amb}$ = +25°C
6 Not UL listed for DC input.

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Attachment H
Page H1 (final)

# 8436/32 8-Channel Isolated Low-Level Analog Input Card

The RTP8436/32 8-Channel Isolated Analog Input Card provides high accuracy low-level (±160 mV) analog measurements. Sampling transformers provide channel-to-channel isolation. Very high noise immunity is characteristic of the transformer multiplexer, achieving 160 dB of common mode rejection. Immunity to noise is further enhanced with a two-pole low pass filter, set to provide 70 dB of normal mode rejection at 60 Hz.

Analog to digital conversion is performed by a 16-bit switched capacitor successive approximation A/D converter. A precision voltage source provides a self-test function for the card's amplifiers and A/D converter. No field adjustments are necessary after the initial factory setup.

## Specifications

| | |
|---|---|
| Input Signal Range: | ± 160 mV |
| Multiplexer Type: | 8-channel solid state multiplexer with individual transformers for complete channel-to-channel isolation |
| Sample Rate: | 50 samples per second per channel |
| Accuracy: | 0.025% of Full Scale |
| Temperature Ranges: | –25° to +85°C (–13° to +185°F), storage<br>0° to +55°C (+32° to +131°F), standard operating<br>–20° to +60°C (–4° to +140°F), extended operating<br>**Note:** Input measurements may not meet the accuracy specification at the upper or lower ends of the extended operating range. |
| Isolation: | 600 VAC RMS or 400 VDC<br>1500 VAC @ 60 Hz for 60 seconds withstand |
| Common Mode Voltage: | 600 VAC RMS or 400 VDC continuous |
| Common Mode Rejection: | –160 dB at 60 Hz (100Ω unbalanced) |
| Common Mode Crosstalk: | –150 dB at 60 Hz |
| Normal Mode Rejection: | 2-pole low-pass filter, –70 dB at 60 Hz |
| Input Impedance: | 5 MΩ in parallel with 10 pF at 50 samples/second per channel |
| Input Bias Current: | 8 nA maximum at 50 samples/second per channel |
| Input Source Impedance: | 100Ω maximum to meet accuracy specification |

115200

L-003230 Rev. 0
Attachment I
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* * * Report of Calibration * * *
for
Platinum Resistance Thermometer
Model S100995PD
Serial No. P/N366

RTE-CW011

115200

| T(°F) | R(ohms) | T(°F) | R(ohms) | T(°F) | R(ohms) | T(°F) | R(ohms) |
|---|---|---|---|---|---|---|---|
| 100.0 | 114.692 | 105.0 | 115.762 | 110.0 | 116.832 | 115.0 | 117.901 |
| 100.1 | 114.713 | 105.1 | 115.784 | 110.1 | 116.854 | 115.1 | 117.922 |
| 100.2 | 114.735 | 105.2 | 115.805 | 110.2 | 116.875 | 115.2 | 117.944 |
| 100.3 | 114.756 | 105.3 | 115.827 | 110.3 | 116.896 | 115.3 | 117.965 |
| 100.4 | 114.777 | 105.4 | 115.848 | 110.4 | 116.918 | 115.4 | 117.986 |
| 100.5 | 114.799 | 105.5 | 115.869 | 110.5 | 116.939 | 115.5 | 118.008 |
| 100.6 | 114.820 | 105.6 | 115.891 | 110.6 | 116.961 | 115.6 | 118.029 |
| 100.7 | 114.842 | 105.7 | 115.912 | 110.7 | 116.982 | 115.7 | 118.051 |
| 100.8 | 114.863 | 105.8 | 115.934 | 110.8 | 117.003 | 115.8 | 118.072 |
| 100.9 | 114.884 | 105.9 | 115.955 | 110.9 | 117.025 | 115.9 | 118.093 |
| 101.0 | 114.906 | 106.0 | 115.976 | 111.0 | 117.046 | 116.0 | 118.115 |
| 101.1 | 114.927 | 106.1 | 115.998 | 111.1 | 117.067 | 116.1 | 118.136 |
| 101.2 | 114.949 | 106.2 | 116.019 | 111.2 | 117.089 | 116.2 | 118.157 |
| 101.3 | 114.970 | 106.3 | 116.041 | 111.3 | 117.110 | 116.3 | 118.179 |
| 101.4 | 114.992 | 106.4 | 116.062 | 111.4 | 117.132 | 116.4 | 118.200 |
| 101.5 | 115.013 | 106.5 | 116.083 | 111.5 | 117.153 | 116.5 | 118.221 |
| 101.6 | 115.034 | 106.6 | 116.105 | 111.6 | 117.174 | 116.6 | 118.243 |
| 101.7 | 115.056 | 106.7 | 116.126 | 111.7 | 117.196 | 116.7 | 118.264 |
| 101.8 | 115.077 | 106.8 | 116.148 | 111.8 | 117.217 | 116.8 | 118.286 |
| 101.9 | 115.099 | 106.9 | 116.169 | 111.9 | 117.238 | 116.9 | 118.307 |
| 102.0 | 115.120 | 107.0 | 116.190 | 112.0 | 117.260 | 117.0 | 118.328 |
| 102.1 | 115.142 | 107.1 | 116.212 | 112.1 | 117.281 | 117.1 | 118.350 |
| 102.2 | 115.163 | 107.2 | 116.233 | 112.2 | 117.303 | 117.2 | 118.371 |
| 102.3 | 115.184 | 107.3 | 116.255 | 112.3 | 117.324 | 117.3 | 118.392 |
| 102.4 | 115.206 | 107.4 | 116.276 | 112.4 | 117.345 | 117.4 | 118.414 |
| 102.5 | 115.227 | 107.5 | 116.297 | 112.5 | 117.367 | 117.5 | 118.435 |
| 102.6 | 115.249 | 107.6 | 116.319 | 112.6 | 117.388 | 117.6 | 118.456 |
| 102.7 | 115.270 | 107.7 | 116.340 | 112.7 | 117.410 | 117.7 | 118.478 |
| 102.8 | 115.291 | 107.8 | 116.362 | 112.8 | 117.431 | 117.8 | 118.499 |
| 102.9 | 115.313 | 107.9 | 116.383 | 112.9 | 117.452 | 117.9 | 118.520 |
| 103.0 | 115.334 | 108.0 | 116.404 | 113.0 | 117.474 | 118.0 | 118.542 |
| 103.1 | 115.356 | 108.1 | 116.426 | 113.1 | 117.495 | 118.1 | 118.563 |
| 103.2 | 115.377 | 108.2 | 116.447 | 113.2 | 117.516 | 118.2 | 118.585 |
| 103.3 | 115.399 | 108.3 | 116.469 | 113.3 | 117.538 | 118.3 | 118.606 |
| 103.4 | 115.420 | 108.4 | 116.490 | 113.4 | 117.559 | 118.4 | 118.627 |
| 103.5 | 115.441 | 108.5 | 116.511 | 113.5 | 117.580 | 118.5 | 118.649 |
| 103.6 | 115.463 | 108.6 | 116.533 | 113.6 | 117.602 | 118.6 | 118.670 |
| 103.7 | 115.484 | 108.7 | 116.554 | 113.7 | 117.623 | 118.7 | 118.691 |
| 103.8 | 115.506 | 108.8 | 116.576 | 113.8 | 117.645 | 118.8 | 118.713 |
| 103.9 | 115.527 | 108.9 | 116.597 | 113.9 | 117.666 | 118.9 | 118.734 |
| 104.0 | 115.548 | 109.0 | 116.618 | 114.0 | 117.687 | 119.0 | 118.755 |
| 104.1 | 115.570 | 109.1 | 116.640 | 114.1 | 117.709 | 119.1 | 118.777 |
| 104.2 | 115.591 | 109.2 | 116.661 | 114.2 | 117.730 | 119.2 | 118.798 |
| 104.3 | 115.613 | 109.3 | 116.683 | 114.3 | 117.751 | 119.3 | 118.819 |
| 104.4 | 115.634 | 109.4 | 116.704 | 114.4 | 117.773 | 119.4 | 118.841 |
| 104.5 | 115.655 | 109.5 | 116.725 | 114.5 | 117.794 | 119.5 | 118.862 |
| 104.6 | 115.677 | 109.6 | 116.747 | 114.6 | 117.816 | 119.6 | 118.883 |
| 104.7 | 115.698 | 109.7 | 116.768 | 114.7 | 117.837 | 119.7 | 118.905 |
| 104.8 | 115.720 | 109.8 | 116.789 | 114.8 | 117.858 | 119.8 | 118.926 |
| 104.9 | 115.741 | 109.9 | 116.811 | 114.9 | 117.880 | 119.9 | 118.947 |
| 105.0 | 115.762 | 110.0 | 116.832 | 115.0 | 117.901 | 120.0 | 118.969 |

# DC Characteristics

**Accuracy Specifications** ± ( % of reading + % of range ) [ 1 ]

| Function | Range [ 3 ] | Test Current or Burden Voltage | 24 Hour [ 2 ] 23°C ± 1°C | 90 Day 23°C ± 5°C | 1 Year 23°C ± 5°C | Temperature Coefficient /°C 0°C – 18°C 28°C – 55°C |
|---|---|---|---|---|---|---|
| **DC Voltage** | 100.0000 mV | | 0.0030 + 0.0030 | 0.0040 + 0.0035 | 0.0050 + 0.0035 | 0.0005 + 0.0005 |
| | 1.000000 V | | 0.0020 + 0.0006 | 0.0030 + 0.0007 | 0.0040 + 0.0007 | 0.0005 + 0.0001 |
| | 10.00000 V | | 0.0015 + 0.0004 | 0.0020 + 0.0005 | 0.0035 + 0.0005 | 0.0005 + 0.0001 |
| | 100.0000 V | | 0.0020 + 0.0006 | 0.0035 + 0.0006 | 0.0045 + 0.0006 | 0.0005 + 0.0001 |
| | 1000.000 V | | 0.0020 + 0.0006 | 0.0035 + 0.0010 | 0.0045 + 0.0010 | 0.0005 + 0.0001 |
| **Resistance** [ 4 ] | 100.0000 Ω | 1 mA | 0.0030 + 0.0030 | 0.008 + 0.004 | 0.010 + 0.004 | 0.0006 + 0.0005 |
| | 1.000000 kΩ | 1 mA | 0.0020 + 0.0005 | 0.008 + 0.001 | 0.010 + 0.001 | 0.0006 + 0.0001 |
| | 10.00000 kΩ | 100 μA | 0.0020 + 0.0005 | 0.008 + 0.001 | 0.010 + 0.001 | 0.0006 + 0.0001 |
| | 100.0000 kΩ | 10 μA | 0.0020 + 0.0005 | 0.008 + 0.001 | 0.010 + 0.001 | 0.0006 + 0.0001 |
| | 1.000000 MΩ | 5 μA | 0.002 + 0.001 | 0.008 + 0.001 | 0.010 + 0.001 | 0.0010 + 0.0002 |
| | 10.00000 MΩ | 500 nA | 0.015 + 0.001 | 0.020 + 0.001 | 0.040 + 0.001 | 0.0030 + 0.0004 |
| | 100.0000 MΩ | 500 nA // 10 MΩ | 0.300 + 0.010 | 0.800 + 0.010 | 0.800 + 0.010 | 0.1500 + 0.0002 |
| **DC Current** | 10.00000 mA | < 0.1 V | 0.005 + 0.010 | 0.030 + 0.020 | 0.050 + 0.020 | 0.002 + 0.0020 |
| | 100.0000 mA | < 0.6 V | 0.01 + 0.004 | 0.030 + 0.005 | 0.050 + 0.005 | 0.002 + 0.0005 |
| | 1.000000 A | < 1 V | 0.05 + 0.006 | 0.080 + 0.010 | 0.100 + 0.010 | 0.005 + 0.0010 |
| | 3.000000 A | < 2 V | 0.10 + 0.020 | 0.120 + 0.020 | 0.120 + 0.020 | 0.005 + 0.0020 |
| **Continuity** | 1000.0 Ω | 1 mA | 0.002 + 0.010 | 0.008 + 0.020 | 0.010 + 0.020 | 0.001 + 0.002 |
| **Diode Test** | 1.0000 V | 1 mA | 0.002 + 0.010 | 0.008 + 0.020 | 0.010 + 0.020 | 0.001 + 0.002 |
| **DC:DC Ratio** | 100 mV to 1000 V | | ( Input Accuracy ) + ( Reference Accuracy )<br>*Input Accuracy* = accuracy specification for the HI-LO input signal.<br>*Reference Accuracy* = accuracy specification for the HI-LO reference input signal. | | | |

**Transfer Accuracy ( typical )**

$$\frac{\text{( 24 hour \% of range error )}}{2}$$

**Conditions:**
- Within 10 minutes and ± 0.5°C.
- Within ±10% of initial value.
- Following a 2-hour warm-up.
- Fixed range between 10% and 100% of full scale.
- Using 6½ digit slow resolution ( 100 PLC ).
- Measurements are made using accepted metrology practices.