

# SOUTHWEST RESEARCH INSTITUTE

## Calibration Laboratory

### WORK ORDER

Processed by RCRUZ at 2:49:57PM on 11/16/00



**Work Order 444041445**

Arrived 11/16/00

Asset No. 008422 Manufacturer DURO-SENSE

Model J-00

Instrument Type/Class RTD

Serial No. 322

Accessory No. \_\_\_\_\_ Calibration Procedure \_\_\_\_\_

Location B57

Div/Client DIV20

Custodian DARRELL DUNN

Mail Stop B57

Tel. 6090

Charge/Project No. 20.00751.006

Delivered By / Telephone \_\_\_\_\_

**IN4CAL**

Special Instructions \_\_\_\_\_

### WORK NOTES

Date	Hours	Remarks/Notes
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

### REPAIR PARTS

Date	Hours	Part Name	Part Number	Failure Description	Cost
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

### WORK SUMMARY

Failure Description \_\_\_\_\_

Repair Action \_\_\_\_\_

Calibration Procedure Customer Temp 68 F Hum 11 %

Tech AMU Totals Cal Hours 1 Repair Hours \_\_\_\_\_ Parts Cost \_\_\_\_\_

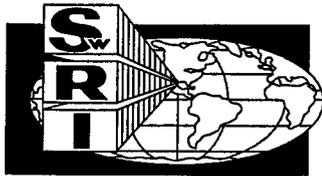
Standards Used 000219, 1505

Date Picked Up 12/14/2000

Picked Up By [Signature]

**444041445**





**CNWRA** *A center of excellence in earth  
sciences and engineering*

6220 Culebra Road · San Antonio · Texas, U.S.A. 78228-5166

## **MEMORANDUM**

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Date: November 16, 2000  
From: Darrell S. Dunn *DD*  
To: SwRI Calibration Laboratory  
Subject: Calibration of Thermocouples and RTDs

I would like to check the calibration of the Duro-Sense Corporation thermocouples (serial numbers 326 to 335) and RTDs (serial numbers 322 to 325) using temperatures of 0 and 150 °C. The calibration check for the thermocouples should be conducted with 12 inches of the thermocouple exposed to controlled temperature bath. The output of the thermocouples in mV should be recorded at these temperatures. Similarly, the entire length of the RTDs should be exposed to the controlled temperature bath and the resistance of the RTDs should be recorded at these temperatures.

Following calibration at 0 and 150 °C, the thermocouples and RTDs need to be appropriately marked. A 6 month interval for checking the calibration of the thermocouples and RTDs is suggested. The vendor documentation is attached for your reference. Please call me at extension 6090 if you have any questions.

Sincerely,

Darrell S. Dunn



Southwest Research Institute  
6220 Culebra Road  
San Antonio, TX 78238  
(210) 522-5215  
Department of Quality Assurance  
Calibration Laboratory



Certificate #  
0972-01

## Certificate of Calibration

6 December 2000

**Issued to:** DARRELL DUNN DIV20 B57  
**Manufacturer/Model:** DURO-SENSE J-00  
**Description:** RTD  
**Serial Number:** 322  
**Asset Number:** 008422

This certifies the above item was calibrated in compliance with MIL-STD-45662A and ANSI/NCSL Z540-1-1994. The results of this calibration relate only to the individual item as described above. Standards used in this calibration, described in the referenced calibration procedure with associated uncertainties or tolerances, are traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to traceability is on file and available for examination upon request. This certificate is not to be reproduced, except in full, without the written approval of the Southwest Research Institute Department of Quality Assurance Calibration Laboratory.

This laboratory is accredited by the American Association for Laboratory Accreditation (A2LA) and the results of this calibration certificate were determined in accordance with the terms of accreditation unless stated otherwise below.

The uncertainty of the calibration was sufficient to determine that the item met the manufacturer's published specifications unless stated otherwise below.

**Ambient Conditions:** Temperature: 68.0 Degrees Fahrenheit Humidity: 41 % RH

**Calibration Date:** 6 Dec 00 **Calibration Procedure:** CUSTOMER

**Condition as Received:** SEE REMARKS

**Condition as Released:** SEE REMARKS

**Remarks:** CALIBRATION DATA ATTACHED

**Approved by:**

Jim Patterson, Supervisor, or Walt Hill, Metrologist

Certificate # 444041445

m:\a2la.rpt Rev date 22 May 00

**Measurements performed by:**

Mack Wood, Technician

# SOUTHWEST RESEARCH INSTITUTE

## Calibration Laboratory

### WORK ORDER

Processed by RCRUZ at 2:49:32PM on 6/8/01



Work Order **444043980**

Arrived 6/8/01

Asset No. 008422 Manufacturer DURO-SENSE

Model J-00

Instrument Type/Class RTD

Serial No. 322

Accessory No. Calibration Procedure CUSTOMER

Location B57

Div/Client DIV20

Custodian DARRELL DUNN

Mail Stop B57

Tel. 6090

Charge/Project No. 00751.006 1.20

Delivered By / Telephone

**IN4CAL**

Special Instructions \_\_\_\_\_

### WORK NOTES

Date	Hours	Remarks/Notes
<u>6/12</u>	<u>1.0</u>	<u>Cal</u>
<u>6/13</u>	<u>1.0</u>	<u>Cal</u>

### REPAIR PARTS

Date	Hours	Part Name	Part Number	Failure Description	Cost
<u>n/a</u>					

### WORK SUMMARY

Failure Description n/a

Repair Action n/a

Calibration Procedure Customer Temp 73 F Hum. 53 %

Tech R Dyksh Totals Cal Hours 2.0 Repair Hours \_\_\_\_\_ Parts Cost \_\_\_\_\_

Standards Used 5242, 7001, 219

Date Picked Up 6/15/01

Picked Up By Darrell Dunn

43980



This spreadsheet calculates temperatures or resistance based on the IEC 751 Standard (for 385 RTD probes)  
 It also computes the tolerance in degrees C and Ohms

To use just enter a value for resistance or for temperature. Answer is to the right (uncertainty +/-0/01 C)

**Note: Spreadsheet is good only for the range -40C to 850C (limited negative range)**

**(1) Know Resistance. Want temperature**

Enter Measured res:

Equivalent temp is:

	degrees	ohms
Class A tolerance is:	0.45	0.17
Class B tolerance is:	1.05	0.39

**(2) Know Temperature. Want resistance**

Enter Temperature in degrees C:

Equivalent resistance is:

	degrees	ohms
Class A tolerance is:	0.449884	0.17
Class B tolerance is:	1.04971	0.39

**Temperature conversion:**

Enter degrees C:	<input type="text" value="100"/>	deg F =	<input type="text" value="212.00"/>
Enter degrees F:	<input type="text" value="212"/>	deg C =	<input type="text" value="100.00"/>

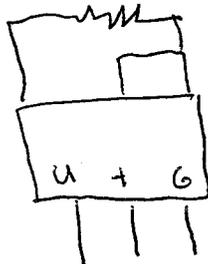
**To validate, compare to standard table**

A.F

class A

157.319 ohms ✓

157.3035 +/- 0.17 ohms



G - t	.25394 Ω	.27610 Ω
t - U	100.27676 Ω	157.5903 Ω
G - U	100.27414 Ω	157.6031 Ω

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**Note:** Spreadsheet is good only for the range -40C to 850C (limited negative range)

**(1) Know Resistance. Want temperature**

Enter Measured res:

Equivalent temp is:

	degrees	ohms
Class A tolerance is:	0.45	0.17
Class B tolerance is:	1.05	0.39

**(2) Know Temperature. Want resistance**

Enter Temperature in degrees C

Equivalent resistance is:

	degrees	ohms
Class A tolerance is:	0.15	0.06
Class B tolerance is:	0.3	0.11

**Temperature conversion:**

Enter degrees C:	<input type="text" value="100"/>	deg F =	<input type="text" value="212.00"/>
Enter degrees F:	<input type="text" value="212"/>	deg C =	<input type="text" value="100.00"/>

To validate, compare to standard table

Serial # 322

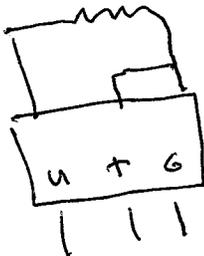
A.F

class A

100.022 ohms /

100 +/- .06

~~15~~





Southwest Research Institute  
6220 Culebra Road  
San Antonio, TX 78238  
(210) 522-5215  
Department of Quality Assurance  
Calibration Laboratory

## Certificate of Calibration

13 June 2001

**Issued to:** DARRELL DUNN DIV20 B57  
**Manufacturer/Model:** DURO-SENSE J-00  
**Description:** RTD  
**Serial Number:** 322  
**Asset Number:** 008422  
**Work Order Number:** 444043980

This certifies the above item was calibrated in compliance with MIL-STD-45662A and ANSI/NC SL Z540-1-1994. Standards used in this calibration, described in the referenced calibration procedure with associated uncertainties or tolerances, are traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to traceability is on file and is available for examination upon request. This certificate is not to be reproduced, except in full, without the written approval of the Southwest Research Institute Department of Quality Assurance Calibration Laboratory.

The uncertainty of the calibration was sufficient to determine that the item met the manufacturer's published specifications unless stated otherwise below.

**Ambient Conditions:** Temperature: 73.0 Degrees Fahrenheit Humidity: 58 % RH

**Calibration Date:** 13 Jun 01 **Calibration Procedure:** CUSTOMER

**Condition as Received:** SEE REMARKS

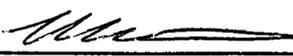
**Condition as Received:** SEE REMARKS

**Remarks:** CALIBRATION DATA SHEET ATTACHED.

**Approved by:**

  
\_\_\_\_\_  
Walt Hill, Supervisor  
Institute Calibration Laboratory

**Measurements performed by:**

  
\_\_\_\_\_  
Roger Dykstra, Technician

# SOUTHWEST RESEARCH INSTITUTE

## Calibration Laboratory

### WORK ORDER

Received by JIBARRA, 1/8/02 11:36:03AM



Arrived 1/8/02

Work Order **444046673**

Asset No. 008422 Manufacturer DURO-SENSE

Model J-00

Equipment Type RTD

Serial No. 322

Accessory No.

Interval 6 M

Calibration Procedure CUSTOMER

Location B57

Div/Client DIV20

Custodian DARRELL DUNN

Mail Stop B57

Tel 6090

**IN4CAL**

Special Instructions \_\_\_\_\_

Notify before adjustments or repairs. (  ) Provide data with certificate (  ) Certificate Typ. \_\_\_\_\_

Charge/Project No. 00751.006 1.20

Requester / Telephone DARRELL DUNN/ X6090

This information is correct for the work requested. *Darrell Dunn*

### WORK NOTES

Date	Hours	Remarks/Notes
<u>1/11/02</u>	<u>1.0</u>	<u>cal</u>

Date	Hours	Part Name	Part Number	Failure Description	Cost
<u>n/a</u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>

### WORK SUMMARY

Failure Description n/a

Repair Action n/a

Tech R Dyken Cal Hrs. 1.0 Repair Hrs   Parts Cost   Temp 76 F Hum. 27 %

Standards Used 0219, 7001

Date Picked Up 1/21/02

Picked Up By *Darrell Dunn*

**444046673**



Measurement uncertainty Budget for DURO-SENSE RTD model J-00.

The following are assumptions and estimates used in the measurement uncertainty budget.

a.) The 1 yr specifications for 3458A

100 Ohm range +/- (12ppm of reading + 5 ppm of range)

1 K ohm range +/- (10 ppm of reading + 0.5 ppm of range)

b.) The uncertainty of the bath and temperature standard are not significant.

100 Ohm range

	Units	Reading	Accuracy +/-	Resolution
	Ohms	100		0.00001
Source of uncertainty	Value +/- Ohms	Distribution	Divisor	Standard Uncertainty Ohms
Standard	0.0017	Rectangular	Sqrt 3	0.000981
Repeatability	0	Normal	1	0.000000
Instrument Resolution	0.00001	Rectangular	2*Sqrt 3	0.000009
Combined Uncertainty	RSS			0.0010
Expanded Uncertainty	K=2			0.002
Test Accuracy Ratio	TI Acc. / STD Tol.			
	0.0	to 1		
Test Uncertainty Ratio	TI Acc. / k=2.			
	0.00	to 1		

1000 Ohm range

	Units	Reading	Accuracy +/-	Resolution
	Ohms	150		0.0001
Source of uncertainty	Value +/- Ohms	Distribution	Divisor	Standard Uncertainty Ohms
Standard	0.002	Rectangular	Sqrt 3	0.001155
Repeatability	0	Normal	1	0.000000
Instrument Resolution	0.0001	Rectangular	2*Sqrt 3	0.000087
Combined Uncertainty	RSS			0.0012
Expanded Uncertainty	K=2			0.002
Test Accuracy Ratio	TI Acc. / STD Tol.			
	0.0	to 1		
Test Uncertainty Ratio	TI Acc. / k=2.			
	0.00	to 1		

This spreadsheet calculates temperatures or resistance based on the IEC 751 Standard (for 385 RTD probes)  
 It also computes the tolerance in degrees C and Ohms

To use just enter a value for resistance or for temperature. Answer is to the right (uncertainty +/-0/01 C)

**Note: Spreadsheet is good only for the range -40C to 850C (limited negative range)**

**(1) Know Resistance. Want temperature**

Enter Measured res:

Equivalent temp is:

	degrees	ohms
Class A tolerance is:	0.15	0.06
Class B tolerance is:	0.30	0.11

**(2) Know Temperature. Want resistance**

Enter Temperature in degrees C:

Equivalent resistance is:

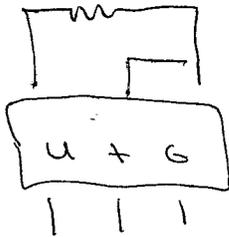
	degrees	ohms
Class A tolerance is:	0.449812	0.17
Class B tolerance is:	1.04953	0.39

**Temperature conversion:**

Enter degrees C:	<input type="text" value="100"/>	deg F =	<input type="text" value="212.00"/>
Enter degrees F:	<input type="text" value="212"/>	deg C =	<input type="text" value="100.00"/>

To validate, compare to standard table

Asset # 8A22



$$\begin{aligned}
 G-t &= 0.3480 \\
 +-0 &= 157.8825 \\
 0-G &= 157.7272 \\
 R &= \frac{(+0 + G-0)}{2} - (G-t) = 157.3869
 \end{aligned}$$

Meets Class A tol 157.29 +/- .17Ω

This spreadsheet calculates temperatures or resistance based on the IEC 751 Standard (for 385 RTD probes)

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**Note: Spreadsheet is good only for the range -40C to 850C (limited negative range)**

**(1) Know Resistance. Want temperature**

Enter Measured res:

Equivalent temp is:

	degrees	ohms
Class A tolerance is:	0.15	0.06
Class B tolerance is:	0.30	0.11

**(2) Know Temperature. Want resistance**

Enter Temperature in degrees C:

Equivalent resistance is:

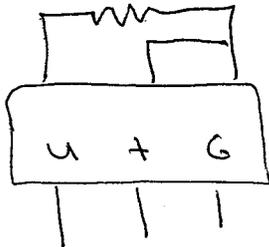
	degrees	ohms
Class A tolerance is:	0.15	0.06
Class B tolerance is:	0.3	0.11

**Temperature conversion:**

Enter degrees C:	<input type="text" value="100"/>	deg F =	<input type="text" value="212.00"/>
Enter degrees F:	<input type="text" value="212"/>	deg C =	<input type="text" value="100.00"/>

To validate, compare to standard table

Asset  
Serial # 8422



$$G + = 0.33777$$

$$+ - U = 100.3549$$

$$U - G = 100.3711$$

$$R = \frac{(+ - U + G - U)}{2} - (G - +) = 100.0252$$

meets class A 100 +/-0.06  $\Omega$

Measurement uncertainty Budget for DURO-SENSE RTD model J-00.

The following are assumptions and estimates used in the measurement uncertainty budget.

a.) The 1 yr specifications for 3458A

100 Ohm range +/- (12ppm of reading + 5 ppm of range)

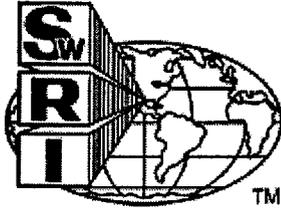
1 K ohm range +/- (10 ppm of reading + 0.5 ppm of range)

100 Ohm range

	Units	Reading	Accuracy +/-	Resolution
	Ohms	100		0.00001
Source of uncertainty	Value +/- Ohms	Distribution	Divisor	Standard Uncertainty Ohms
Standard	0.0017	Rectangular	Sqrt 3	0.000981
Repeatability	0	Normal	1	0.000000
Instrument Resolution	0.00001	Rectangular	2*Sqrt 3	0.000009
Combined Uncertainty	RSS			0.0010
Expanded Uncertainty	K=2			0.002
	TI Acc. / STD Tol.			
Test Accuracy Ratio	0.0	to 1		
	TI Acc. / k=2.			
Test Uncertainty Ratio	0.00	to 1		

1000 Ohm range

	Units	Reading	Accuracy +/-	Resolution
	Ohms	150		0.0001
Source of uncertainty	Value +/- Ohms	Distribution	Divisor	Standard Uncertainty Ohms
Standard	0.002	Rectangular	Sqrt 3	0.001155
Repeatability	0	Normal	1	0.000000
Instrument Resolution	0.0001	Rectangular	2*Sqrt 3	0.000087
Combined Uncertainty	RSS			0.0012
Expanded Uncertainty	K=2			0.002
	TI Acc. / STD Tol.			
Test Accuracy Ratio	0.0	to 1		
	TI Acc. / k=2.			
Test Uncertainty Ratio	0.00	to 1		



Southwest Research Institute  
6220 Culebra Road  
San Antonio, TX 78238  
(210) 522-5215  
Department of Quality Assurance  
Calibration Laboratory

## Certificate of Calibration

14 January 2002

**Issued to:** DARRELL DUNN DIV20 B57  
**Manufacturer/Model:** DURO-SENSE J-00  
**Description:** RTD  
**Serial Number:** 322  
**Asset Number:** 008422  
**Work Order Number:** 444046673

This certifies the above item was calibrated in compliance with MIL-STD-45662A and ANSI/NCSL Z540-1-1994. Standards used in this calibration, described in the referenced calibration procedure with associated uncertainties or tolerances, are traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to traceability is on file and is available for examination upon request. This certificate is not to be reproduced, except in full, without the written approval of the Southwest Research Institute Department of Quality Assurance Calibration Laboratory.

The uncertainty of the calibration was sufficient to determine that the item met the manufacturer's published specifications unless stated otherwise below.

**Ambient Conditions:** Temperature: 76.0 Degrees Fahrenheit Humidity: 27 % RH

**Calibration Date:** 11 Jan 02 **Calibration Procedure:** CUSTOMER

**Condition as Received:** SEE ATTACHED DATA

**Condition as Returned:** SEE ATTACHED DATA

**Remarks:** CUSTOMER PROVIDED READINGS ONLY.

**Approved by:**

  
\_\_\_\_\_  
Walt Hill, Supervisor  
Institute Calibration Laboratory

**Measurements performed by:**

  
\_\_\_\_\_  
Roger Dykstra, Technician