

**KEITHLEY**

Keithley Instruments, Inc.  
28775 Aurora Road  
Cleveland, Ohio 44139  
(216) 248-0400  
Telefax: 248-6168

# Certificate of Calibration

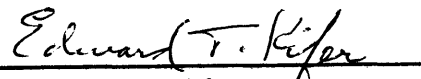
Model 617 Serial No. 537418 Date 11-25-92

This notification serves to certify that the unit described above has been inspected and tested in accordance with specifications published by Keithley Instruments, Inc.

The accuracy and calibration of this instrument are traceable through reference standards that are compared, at planned intervals, to national standards maintained by the National Institute of Standards and Technology (NIST), by comparison to natural physical constants or self-calibrating ratio type measurements.

The measurement standards which support this calibration are calibrated on a schedule to maintain required accuracy level. Applicable NIST Test Report numbers are listed below:

DC Voltage: 250045  
AC Voltage: 238764  
Resistance: 247956  
Temperature: 246568  
Capacitance: 246592  
Frequency: WWVB

  
Edward T. Kifer  
Quality Assurance Manager

S O U T H W E S T   R E S E A R C H   I N S T I T U T E

Department of Quality Assurance  
Calibration Laboratory

CERTIFICATE OF CALIBRATION

Issued to: DIV20 B168 NARASI SRIDHAR

Device No: 1044

Manufacturer: KEITHLEY

Model: 617

Nomenclature: PROGRAMMABLE ELECTROMETER

Serial Number: 537418

SwRI No: NONE

Remarks

Accuracy: MFGR SPECS

Procedure: MFG

ENVIRONMENT

Temperature: 73   Humidity: 31   Location: ROTHE DEVELOPMENT, SAN ANTONIO

CONCLUSION

Tolerance/Remarks:   Received into the system, introduced or reactivated

Rothe Calibration Certificate # 28319

Calibration was in accord with requirements of MIL-STD-45662A. Measurements  
are traceable to the National Institute of Standards and Technology.  
Inspection and test data are on file and available for inspection.

Signed



Calibration Date: 12/24/92

Record Number: 00010423

Next Calibration Due: 12/24/93



# Rothe Development, Inc.

4614 SINCLAIR RD. SAN ANTONIO, TEXAS 78222-2099

512-648-3131 FAX: 512-648-4091

METROLOGY SERVICES DIVISION  
PRECISION MEASUREMENT EQUIPMENT LABORATORY  
TRACEABLE TO NIST

CHARGE # 107

CONTROL # 114 - 15901

WORK ORDER # 35791

RECEIVED FROM **Southwest Research Institute** (5) DATE **12/22/92**

ADDRESS **6220 Culebra, Bldg. 69/Division 5** PHONE# **684-5111 \* 2702**  
**San Antonio, TX 78284**

CONTACT (NAME) **Mr. Jim Patterson** FAX# **684-3133**

PURCHASE ORDER # **03602/ST#214501/205704041**

CUSTOMER COMMENTS **N/T BEFORE & AFTER DATA OUT OF SPEC ITEM**

MFG **Keithley**

MODEL **167**

SERIAL # **537418**

TYPE **Programmable Electrometer**

ACCES. RCVD. **INPUT CABLE, MANUAL! Power Cord**

- REPAIR
- OPERATIONAL CHECK
- CALIBRATION

CALIBRATION DATE 24 DEC 92

DATE DUE 24 DEC 93

- CALIBRATION INTERVAL 2 Y
- RECEIVED IN SPECS.
  - RECEIVED INOPERATIVE
  - RECEIVED OUT OF SPECS.

THIS IS NOT AN INVOICE

| CKT REF # | QTY. | MFG PART # | DESCRIPTION | COST | ROTHE TECH.       | OUR P.O. #   |
|-----------|------|------------|-------------|------|-------------------|--------------|
|           |      |            |             |      | <b>E-</b>         |              |
|           |      |            |             |      | REPAIR LABOR HRS. | SERVICE CODE |
|           |      |            |             |      |                   | <b>J</b>     |
|           |      |            |             |      | PARTS TOTAL       |              |
|           |      |            |             |      | REPAIR LABOR      |              |
|           |      |            |             |      | SHIPPING          |              |
|           |      |            |             |      | TEAR DOWN CHARGE  |              |
|           |      |            |             |      | CALIBRATION       | <b>51.00</b> |
|           |      |            |             |      | TAX               |              |
|           |      |            |             |      |                   | <b>51.00</b> |

TR #'s **20, 13**

COMMENTS

WORK PERFORMED

\*\*\*\* Need Manual \*\*\*\*

CAL'D

TEMP. 73 °F

R.H. 31 %

RDI 2002

SHIP VIA: \_\_\_\_\_ DATE: \_\_\_\_\_ RECEIVED BY: \_\_\_\_\_



# Rothe Development Inc.

## Metrology Services Division

4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 210-648-3131 FAX 210-648-4091

# Certificate of Calibration

# 28319

CAL DATE: 12/24/92

DUE DATE: 12/24/93

ISSUED TO: Southwest Research Institute  
6220 Culebra, Bldg. 68/Division 5  
San Antonio, TX 78284  
684-5111 \* 2702

(5)

MFG Keithley

MODEL 167

SERIAL # 537418

CONTROL: 114 - 15981

TYPE Programmable Electrometer

PROCEDURE/TOL: MFG PROCEDURE/MFG SPECS  
WORK ORDER #: 35791  
CUSTOMER PO #: 03602/ST#214501/205704041

RECEIVED IN-SPECS   
OUT-OF-SPECS

All Calibration measurements performed at ROTHE DEVELOPMENT INC. METROLOGY SERVICES meet the requirements of MIL-STD-45662A, and are traceable to the National Institute of Standards and Technology through Primary NIST Calibration or Secondary Calibration performed by other Metrological facilities. Ambient conditions: Temperature 73oF , Relative Humidity 31%

### Test Report Number and Calibration Standards Used

| Ref # | Model # | Mfr   | Serial # | Description | Cal Date | Int | Cal Due  |
|-------|---------|-------|----------|-------------|----------|-----|----------|
| TR 20 | 5700A   | FLUKE | 4605002  | CALIBRATOR  | 11/11/92 | 3   | 02/11/93 |
| TR 13 | 8860A   | FLUKE | 3335024  | DMM         | 08/20/92 | 6   | 02/20/93 |

----- Test Report Numbers -----  
 DCV FLUKE CERT# DH70  
 ACV FLUKE CERT# DP30  
 OHM NIST TEST# 250839  
 TEMP NIST TEST# 248798  
 Hz WWVB Transmission

INSPECTED BY Jour Mendga  
COMMENTS:



# Rothe Development, Inc.

4614 SINCLAIR RD. SAN ANTONIO, TEXAS 78222-2099

210-648-3131 FAX: 210-648-4091

METROLOGY SERVICES DIVISION  
PRECISION MEASUREMENT EQUIPMENT LABORATORY  
TRACEABLE TO NIST

CHARGE # 107

CONTROL # 114 - 15981

WORK ORDER # 38992

RECEIVED FROM **Southwest Research Institute** (5) DATE **07/15/93**

ADDRESS **6220 Culebra, Bldg. 68/Division 5** PHONE# **684-5111 \* 2702**  
**San Antonio, TX 78284**

CONTACT (NAME) **Mr. Jim Patterson** FAX# **684-3133**

PURCHASE ORDER # **03602/ST# 1**

CUSTOMER COMMENTS **N/T BEFORE & AFTER DATA OUT OF SPEC ITEM**

MFG **Keithley**

MODEL **47-617**

SERIAL # **537418**

TYPE **Programmable Electrometer**

ACCES. RCVD.

- REPAIR
- OPERATIONAL CHECK
- CALIBRATION

CALIBRATION DATE 28 JUL 93

DATE DUE 28 JUL 94

CALIBRATION INTERNAL

- RECEIVED IN SPECS.
- RECEIVED INOPERATIVE
- RECEIVED OUT OF SPECS.

| CKT REF # | QTY. | MFG PART # | DESCRIPTION | COST | ROTHE TECH.       | OUR P.O. #   |
|-----------|------|------------|-------------|------|-------------------|--------------|
|           |      |            |             |      | E-                |              |
|           |      |            |             |      | REPAIR LABOR HRS. | SERVICE CODE |
|           |      |            |             |      |                   | J            |
|           |      |            |             |      | PARTS TOTAL       |              |
|           |      |            |             |      | REPAIR LABOR      |              |
|           |      |            |             |      | SHIPPING          |              |
|           |      |            |             |      | TEAR DOWN CHARGE  |              |
|           |      |            |             |      | CALIBRATION       | 51.00        |
|           |      |            |             |      | TAX               |              |
|           |      |            |             |      | TOTAL             | N/C          |

TR #'s 20, 13, 75, 235

COMMENTS

WORK PERFORMED:

\*\*\*\* Need Manual \*\*\*\* NO.

Unable to find any problems w/ unit.  
 Verified all readings at least twice.  
 Suggest checking shielding, noise, EMI, etc... in environment unit is used.

TEMP. 72 °F

R.H. 39 %

CAL'D

RDI 2002

SHIP VIA: \_\_\_\_\_ DATE: \_\_\_\_\_ RECEIVED BY: \_\_\_\_\_

S O U T H W E S T   R E S E A R C H   I N S T I T U T E

Department of Quality Assurance  
Calibration Laboratory

CERTIFICATE OF CALIBRATION

Issued to: DIV20 B57 NARASI SRIDHAR

Device No: 1044

Manufacturer: KEITHLEY

Model: 617

Nomenclature: PROGRAMMABLE ELECTROMETER

Serial Number: 537418

SwRI No: NONE

Cal interval 12 Mo.

Remarks

Accuracy: MFGR SPECS

Procedure: MFG

ENVIRONMENT

Temperature: 72    Humidity: 39    Location: ROTHE DEVELOPMENT, INC.

CONCLUSION

Tolerance/Remarks:    Received in tolerance, no adjustments made

Calibrated by Rothe Development Inc.

Rothe Development Calibration Certificate #31194

Calibration was in accord with requirements of MIL-STD-45662A. Measurements are traceable to the National Institute of Standards and Technology. Inspection and test data are on file and available for inspection.

Signed

Vincent Morale for J.B.P

Calibration Date: 07/28/93

Cal interval: 12 Months

Record Number: 00011700

Next Calibration Due: 07/28/94



# Rothe Development Inc.

## Metrology Services Division

4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 210-648-3131 FAX 210-648-4091

# Certificate of Calibration

# 31194

CAL DATE: 07/28/93

ISSUED TO: Southwest Research Institute  
6220 Culebra, Bldg. 68/Division 5  
San Antonio, TX 78284  
684-5111 + 2702

DUE DATE: 07/28/94

(5)

MFG Keithley

MODEL 617

SERIAL # 537418

CONTROL: 114 - 15981

TYPE Programmable Electrometer

PROCEDURE/TOL:MFG PROCEDURE/MFG SPECS

WORK ORDER #: 38992

CUSTOMER PO #:03602/ST# /

RECEIVED IN-SPECS   
OUT-OF-SPECS

All Calibration measurements performed at ROTHE DEVELOPMENT INC. METROLOGY SERVICES meet the requirements of MIL-STD-45662A, and are traceable to the National Institute of Standards and Technology through Primary NIST Calibration or Secondary Calibration performed by other Metrological facilities. Ambient conditions: Temperature 72oF , Relative Humidity 39%

### Test Report Number and Calibration Standards Used

| Ref #  | Model # | Mfr       | Serial # | Description    | Cal Date | Int | Cal Due  |
|--------|---------|-----------|----------|----------------|----------|-----|----------|
| TR 20  | 5700A   | FLUKE     | 4605002  | CALIBRATOR     | 05/07/93 | 3   | 08/07/93 |
| TR 13  | 8860A   | FLUKE     | 3335024  | DMM            | 07/27/93 | 6   | 01/27/94 |
| TR 75  | NMN     | JRL       | 75       | RESISTANCE BOX | 05/28/93 | 12  | 05/28/94 |
| TR 235 | 6500A   | GUILDLINE | 59660    | TERAOhMETER    | 07/01/93 | 12  | 07/01/94 |

### Test Report Numbers

DCV FLUKE CERT# DH70  
ACV FLUKE CERT# DP30  
OHM NIST TEST# 250839  
TEMP NIST TEST# 248798  
Hz MWB Transmission

INSPECTED BY \_\_\_\_\_

COMMENTS:

# ROTHER DEVELOPMENT METROLOGY SERVICES

## CALIBRATION DATA : KEITHLEY 617

|  |                         |
|--|-------------------------|
| CUSTOMER : <u>Southwest Research Inst.</u> | DATE : <u>28 JUL 93</u> |
| WO NUMBER : <u>38992</u>                   | TECH : <u>E-</u>        |
| SERIAL : <u>537418</u>                     | INST NO : <u>15981</u>  |

|                |                       |
|----------------|-----------------------|
| CAL DATA TAKEN | INCOMING <u>  x  </u> |
|                | OUTGOING _____        |

|           |                           |
|-----------|---------------------------|
| CONDITION | IN TOLERANCE <u>  x  </u> |
|           | OUT OF TOLERANCE _____    |

### INPUT CURRENT VERIFICATION

|  |                             |
|--|-----------------------------|
| SET-UP: 2PA RANGE, INPUT CAPPED, TOLERANCE <66 C | READING<br><u>  .0031  </u> |
|--|-----------------------------|

### CURRENT ACCURACY

| RANGE  | INPUT      | MIN    | READING          | MAX    |
|--------|------------|--------|------------------|--------|
| 20 MA  | ZERO CHECK | -0.001 | <u>  0.000  </u> | +0.001 |
|        | 19 MA      | 18.970 | <u> 18.996 </u>  | 19.030 |
| 2 MA   | 1.9 MA     | 1.8967 | <u> 1.8996 </u>  | 1.9033 |
| 200 UA | 190 UA     | 189.70 | <u> 189.96 </u>  | 190.30 |
| 20 UA  | 19 UA      | 18.970 | <u> 18.997 </u>  | 19.030 |

| RANGE  | NOMINAL | ACTUAL          | TOLERANCE  | READING               |
|--------|---------|-----------------|------------|-----------------------|
| 2 UA   | 1.9 UA  | <u> 1.9000 </u> | ±.15% +4C  | Ⓟ / F <u> 1.8995 </u> |
| 200 NA | 190 NA  | <u> 190.00 </u> | ±.25% +1C  | Ⓟ / F <u> 189.98 </u> |
| 20 NA  | 19 NA   | <u> 18.989 </u> | ±.25% +1C  | Ⓟ / F <u> 18.982 </u> |
| 2 NA   | 1.9 NA  | <u> 1.8989 </u> | ±.25% +5C  | Ⓟ / F <u> 1.8970 </u> |
| 200 PA | 190 PA  | <u> 190.06 </u> | ±1.6% +1C  | Ⓟ / F <u> 189.86 </u> |
| 20 PA  | 19 PA   | <u> 19.060 </u> | ±1.6% +7C  | Ⓟ / F <u> 19.136 </u> |
| 2 PA   | 1.9 PA  | <u> 1.9240 </u> | ±1.6% +66C | Ⓟ / F <u> 1.9520 </u> |

### COULOMB ACCURACY

| RANGE | INPUT         | MIN   | READING        | MAX   |
|-------|---------------|-------|----------------|-------|
| 2NC   | 1V / 1000 PFD | 0.995 | <u> 0.999 </u> | 1.005 |



### DC VOLTAGE ACCURACY

| RANGE  | INPUT   | MIN    | READING        | MAX    |
|--------|---------|--------|----------------|--------|
| 200 MV | +190 MV | 189.87 | <u>190.01</u>  | 190.13 |
|        | -190 MV | 189.87 | <u>-189.99</u> | 190.13 |
| 2 V    | +1.9 V  | 1.8990 | <u>1.8998</u>  | 1.9010 |
|        | -1.9 V  | 1.8990 | <u>-1.8998</u> | 1.9010 |
| 20 V   | +19 V   | 18.990 | <u>18.997</u>  | 19.010 |
|        | -19 V   | 18.990 | <u>-18.997</u> | 19.010 |
| 200 V  | +190 V  | 189.86 | <u>189.97</u>  | 190.14 |
|        | -190 V  | 189.86 | <u>-189.97</u> | 190.14 |

### RESISTANCE ACCURACY

| RANGE          | ACTUAL INPUT  | TOLERANCE                                     | READING       |
|----------------|---------------|---|---------------|
| 2 K $\Omega$   | <u>1.8999</u> | $\pm 0.2\%$ +4C $\text{\textcircled{P}}$ / F  | <u>1.9001</u> |
| 20 K $\Omega$  | <u>18.999</u> | $\pm 0.15\%$ +1C $\text{\textcircled{P}}$ / F | <u>18.998</u> |
| 200 K $\Omega$ | <u>189.99</u> | $\pm 0.25\%$ +1C $\text{\textcircled{P}}$ / F | <u>189.98</u> |
| 2 M $\Omega$   | <u>1.9000</u> | $\pm 0.25\%$ +1C $\text{\textcircled{P}}$ / F | <u>1.8993</u> |
| 20 M $\Omega$  | <u>18.997</u> | $\pm 0.25\%$ +1C $\text{\textcircled{P}}$ / F | <u>18.996</u> |
| 200 M $\Omega$ | <u>100.24</u> | $\pm 0.3\%$ +1C $\text{\textcircled{P}}$ / F  | <u>100.14</u> |
| 2 G $\Omega$   | <u>1.0013</u> | $\pm 1.5\%$ +1C $\text{\textcircled{P}}$ / F  | <u>1.0022</u> |
| 20 G $\Omega$  | <u>9.969</u>  | $\pm 1.5\%$ +1C $\text{\textcircled{P}}$ / F  | <u>9.978</u>  |
| 200 G $\Omega$ | <u>98.77</u>  | $\pm 1.5\%$ +1C $\text{\textcircled{P}}$ / F  | <u>98.49</u>  |

### OUTPUT VOLTAGE SOURCE ACCURACY

| OUTPUT SETTING | MIN    | READING        | MAX     |
|----------------|--------|----------------|---------|
| 00.00 V        | -0.050 | <u>0.032</u>   | +0.050  |
| +01.00 V       | +0.948 | <u>1.015</u>   | +1.052  |
| -01.00 V       | -0.948 | <u>0.971</u>   | -1.052  |
| +10.00 V       | +9.930 | <u>10.01</u>   | +10.07  |
| -10.00 V       | -9.930 | <u>-9.97</u>   | -10.07  |
| +25.00 V       | +24.90 | <u>25.02</u>   | +25.10  |
| -25.00 V       | -24.90 | <u>-24.97</u>  | -25.10  |
| +50.00 V       | +49.85 | <u>50.02</u>   | +50.15  |
| -50.00 V       | -49.85 | <u>-49.98</u>  | -50.15  |
| +100.00 V      | +99.75 | <u>100.04</u>  | +100.25 |
| -100.00 V      | -99.75 | <u>-100.01</u> | -100.25 |



Rothe Development, Inc.

4614 SINCLAIR RD. SAN ANTONIO, TEXAS 78222-2099

210-648-3131 FAX: 210-648-4091

METROLOGY SERVICES DIVISION  
PRECISION MEASUREMENT EQUIPMENT LABORATORY  
TRACEABLE TO NIST

CHARGE # 107

CONTROL # 114 - 15981

WORK ORDER # 44410

RECEIVED FROM **Southwest Research Institute** (30) DATE **08/11/94**  
ADDRESS **6220 Culebra, Blds. 64/Division 30** PHONE# **684-5111 # 2702**  
**San Antonio, TX 78284**  
CONTACT (NAME) **Mr. Jim Patterson** FAX# **684-3133**  
PURCHASE ORDER # **03602/STW236378/20-5704-041/16-0760-04-0760**  
CUSTOMER COMMENTS **N/T BEFORE & AFTER DATA OUT OF SPEC ITEM**

MFG **Keithley**  
MODEL **617**  
SERIAL # **337416**  
TYPE **Programmable Electrometer**  
ACCES. RCVD.

- REPAIR
- OPERATIONAL CHECK
- CALIBRATION

CALIBRATION DATE 20 Sep 94  
DATE DUE 20 Sep 95

- CALIBRATION INTERVAL
- RECEIVED IN SPECS.
  - RECEIVED INOPERATIVE
  - RECEIVED OUT OF SPECS.

| CKT REF # | QTY. | MFG PART # | DESCRIPTION | COST | ROTHE TECH.       | OUR P.O. #  |
|-----------|------|------------|-------------|------|-------------------|-------------|
|           |      |            |             |      | 955               |             |
|           |      |            |             |      | REPAIR LABOR HRS. | SERVICE COD |
|           |      |            |             |      |                   | K           |
|           |      |            |             |      | PARTS TOTAL       |             |
|           |      |            |             |      | REPAIR LABOR      |             |
|           |      |            |             |      | SHIPPING          |             |
|           |      |            |             |      | TEAR DOWN CHARGE  |             |
|           |      |            |             |      | CALIBRATION       | 97.5        |
|           |      |            |             |      | TAX               |             |
|           |      |            |             |      |                   | 97.5        |

THIS IS NOT AN INVOICE

TR #s 20, 13, 25, 75

COMMENTS

WORK PERFORMED  
\*\*\*\* Need Manual \*\*\*\*  
NO

Cal Data Taken - only out of tolerance was input current verification  
Adjusted unit -

CAL

TEMP. 73 °F

SPECS: MFG RDI

R.H. 36 %

PROCEDURE: MFG RDI OTHER

RDI 2002  
SHIP VIA: \_\_\_\_\_ DATE: \_\_\_\_\_ RECEIVED BY: \_\_\_\_\_



# Rothe Development Inc.

## Metrology Services Division

4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 210-648-3131 FAX 210-648-4091

# Certificate of Calibration

# 36177

CAL DATE: 09/20/94

DUE DATE: 09/20/95

ISSUED TO: Southwest Research Institute (30)  
6220 Culebra, Blds. 64/Division 30  
San Antonio, TX 78284  
684-5111 \* 2702

MFG Keithley

MODEL 617

SERIAL # 537418

CONTROL: 114 - 15981

TYPE Programmable Electrometer

SPECIFICATIONS: MFG

PROCEDURE: MFG

WORK ORDER #: 44410

CUSTOMER PO #: 03602/ST#236378/

RECEIVED IN-SPECS   
OUT-OF-SPECS

All Calibration measurements performed at ROTHE DEVELOPMENT INC. METROLOGY SERVICES meet the requirements of MIL-STD-45662A, and are traceable to the National Institute of Standards and Technology through Primary NIST Calibration or Secondary Calibration performed by other Metrological facilities. Ambient conditions: Temperature 73°F, Relative Humidity 36%

### Test Report Number and Calibration Standards Used

| Ref #  | Model # | Mfr       | Serial # | Description    | Cal Date | Int | Cal Due  |
|--------|---------|-----------|----------|----------------|----------|-----|----------|
| TR 20  | 5700A   | FLUKE     | 4605002  | CALIBRATOR     | 08/25/94 | 3   | 11/25/94 |
| TR 13  | 8860A   | FLUKE     | 3335024  | DMM            | 07/23/94 | 6   | 01/23/95 |
| TR 235 | 6500A   | GUILDLINE | 59660    | TERAOhMETER    | 08/24/94 | 12  | 08/24/95 |
| TR 75  | NMN     | JRL       | 75       | RESISTANCE BOX | 05/03/94 | 12  | 05/03/95 |

### ----- Test Report Numbers -----

DCV FLUKE CERT# DH70  
ACV FLUKE CERT# DP30  
OHM NIST TEST# 250839  
TEMP NIST TEST# 251316  
Hz WWVB Transmission

INSPECTED BY  
COMMENTS:

*Joe A. Mendoza*

ROTHE DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: KEITHLEY 617

CUSTOMER: SWRI  
 WO NUMBER: 44410  
 SERIAL: 537418

DATE: 8 Sep 94  
 TECH: PJS  
 INST NO: 15981

CAL DATA TAKEN

INCOMING   
 OUTGOING

CONDITION

IN TOLERANCE   
 OUT OF TOLERANCE

INPUT CURRENT VERIFICATION

SET-UP: ZPA RANGE, INPUT CAPPED, TOLERANCE < 66 C  
 READING 0.0391 \*

CURRENT ACCURACY

| RANGE  | INPUT      | MIN    | READING | MAX    |
|--------|------------|--------|---------|--------|
| 20 MA  | ZERO CHECK | -0.001 | 0.000   | +0.001 |
| 2 MA   | 19 MA      | 18.970 | 18.996  | 19.030 |
| 200 UA | 190 UA     | 189.70 | 189.96  | 190.30 |
| 20 UA  | 19 UA      | 18.970 | 18.998  | 19.030 |

| RANGE  | NOMINAL | ACTUAL | TOLERANCE | READING |
|--------|---------|--------|-----------|---------|
| 2 UA   | 1.9 UA  | 1.949  | ±.15%+4C  | 1.8994  |
| 200 NA | 190 NA  | 190.09 | ±.25%+1C  | 189.96  |
| 20 NA  | 19 NA   | 19.09  | ±.25%+1C  | 18.994  |
| 2 NA   | 1.9 NA  | 1.909  | ±.25%+5C  | 1.8996  |
| 200 PA | 190 PA  | 190.09 | ±.16%+1C  | 190.04  |
| 20 PA  | 19 PA   | 19.09  | ±.16%+7C  | 19.014  |
| 2 PA   | 1.9 PA  | 1.909  | ±.16%+66C | 1.9088  |

COULOMB ACCURACY

RANGE ZNC  
 INPUT 1V / 1000 PFD  
 MIN 0.995  
 READING 0.999  
 MAX 1.005

## DC VOLTAGE ACCURACY

| RANGE  | INPUT   | MIN    | READING       | MAX    |
|--------|---------|--------|---------------|--------|
| 200 MV | +190 MV | 189.87 | <u>190.00</u> | 190.13 |
|        | -190 MV | 189.87 | <u>189.99</u> | 190.13 |
| 2 V    | +1.9 V  | 1.8990 | <u>1.8999</u> | 1.9010 |
|        | -1.9 V  | 1.8990 | <u>1.8999</u> | 1.9010 |
| 20 V   | +19 V   | 18.990 | <u>18.996</u> | 19.010 |
|        | -19 V   | 18.990 | <u>18.997</u> | 19.010 |
| 200 V  | +190 V  | 189.86 | <u>189.96</u> | 190.14 |
|        | -190 V  | 189.86 | <u>189.96</u> | 190.14 |

## RESISTANCE ACCURACY

| RANGE              | ACTUAL INPUT    | TOLERANCE                    | READING       |
|--------------------|-----------------|------------------------------|---------------|
| 2 K $\Omega$ (19)  | <u>1.9000 K</u> | $\pm 0.2\% + 4C$ P / $\neq$  | <u>1.9000</u> |
| 20 K $\Omega$      | <u>18.999 K</u> | $\pm 0.15\% + 1C$ P / $\neq$ | <u>18.997</u> |
| 200 K $\Omega$     | <u>189.99 K</u> | $\pm 0.25\% + 1C$ P / $\neq$ | <u>189.96</u> |
| 2 M $\Omega$       | <u>1.9000 M</u> | $\pm 0.25\% + 1C$ P / $\neq$ | <u>1.8991</u> |
| 20 M $\Omega$      | <u>18.997 M</u> | $\pm 0.25\% + 1C$ P / $\neq$ | <u>18.997</u> |
| 200 M $\Omega$ (1) | <u>99.98 M</u>  | $\pm 0.3\% + 1C$ P / $\neq$  | <u>99.88</u>  |
| 2 G $\Omega$       | <u>1.0019 G</u> | $\pm 1.5\% + 1C$ P / $\neq$  | <u>1.0035</u> |
| 20 G $\Omega$      | <u>9.979 G</u>  | $\pm 1.5\% + 1C$ P / $\neq$  | <u>9.979</u>  |
| 200 G $\Omega$     | <u>98.81 G</u>  | $\pm 1.5\% + 1C$ P / $\neq$  | <u>98.38</u>  |

## OUTPUT VOLTAGE SOURCE ACCURACY

| OUTPUT SETTING | MIN    | READING       | MAX     |
|----------------|--------|---------------|---------|
| 00.00 V        | -0.050 | <u>+ .032</u> | +0.050  |
| +01.00 V       | +0.948 | <u>1.015</u>  | +1.052  |
| -01.00 V       | -0.948 | <u>.971</u>   | -1.052  |
| +10.00 V       | +9.930 | <u>10.01</u>  | +10.07  |
| -10.00 V       | -9.930 | <u>9.97</u>   | -10.07  |
| +25.00 V       | +24.90 | <u>25.02</u>  | +25.10  |
| -25.00 V       | -24.90 | <u>24.98</u>  | -25.10  |
| +50.00 V       | +49.85 | <u>50.02</u>  | +50.15  |
| -50.00 V       | -49.85 | <u>49.98</u>  | -50.15  |
| +100.00 V      | +99.75 | <u>100.04</u> | +100.25 |
| -100.00 V      | -99.75 | <u>100.01</u> | -100.25 |

# ROTHER DEVELOPMENT METROLOGY SERVICES

## CALIBRATION DATA : KEITHLEY 617

CUSTOMER : SWRT  
 WO NUMBER : 44410  
 SERIAL : 537418

DATE : 20 Sep 94  
 TECH : PJS  
 INST NO : 15981

CAL DATA TAKEN

INCOMING \_\_\_\_\_  
 OUTGOING ✓

CONDITION

IN TOLERANCE ✓  
 OUT OF TOLERANCE \_\_\_\_\_

### INPUT CURRENT VERIFICATION

SET-UP: 2PA RANGE, INPUT CAPPED, TOLERANCE <66 C

READING  
-0.0004

### CURRENT ACCURACY

| RANGE  | INPUT      | MIN    | READING       | MAX    |
|--------|------------|--------|---------------|--------|
| 20 MA  | ZERO CHECK | -0.001 | <u>0.000</u>  | +0.001 |
|        | 19 MA      | 18.970 | <u>18.999</u> | 19.030 |
| 2 MA   | 1.9 MA     | 1.8967 | <u>1.8999</u> | 1.9033 |
| 200 UA | 190 UA     | 189.70 | <u>190.01</u> | 190.30 |
| 20 UA  | 19 UA      | 18.970 | <u>19.000</u> | 19.030 |

| RANGE  | NOMINAL | ACTUAL        | TOLERANCE        | READING       |
|--------|---------|---------------|------------------|---------------|
| 2 UA   | 1.9 UA  | <u>1.9 ua</u> | ±.15% +4C P / F  | <u>1.8997</u> |
| 200 NA | 190 NA  | <u>190 na</u> | ±.25% +1C P / F  | <u>189.99</u> |
| 20 NA  | 19 NA   | <u>19 na</u>  | ±.25% +1C P / F  | <u>19.001</u> |
| 2 NA   | 1.9 NA  | <u>1.9 na</u> | ±.25% +5C P / F  | <u>1.9000</u> |
| 200 PA | 190 PA  | <u>190 pa</u> | ±1.6% +1C P / F  | <u>190.01</u> |
| 20 PA  | 19 PA   | <u>19 pa</u>  | ±1.6% +7C P / F  | <u>18.994</u> |
| 2 PA   | 1.9 PA  | <u>1.9 pa</u> | ±1.6% +66C P / F | <u>1.8946</u> |

### COULOMB ACCURACY

| RANGE | INPUT         | MIN   | READING     | MAX   |
|-------|---------------|-------|-------------|-------|
| 2NC   | 1V / 1000 PFD | 0.995 | <u>.999</u> | 1.005 |

### DC VOLTAGE ACCURACY

| RANGE  | INPUT   | MIN    | READING       | MAX    |
|--------|---------|--------|---------------|--------|
| 200 MV | +190 MV | 189.87 | <u>190.00</u> | 190.13 |
|        | -190 MV | 189.87 | <u>189.99</u> | 190.13 |
| 2 V    | +1.9 V  | 1.8990 | <u>1.9000</u> | 1.9010 |
|        | -1.9 V  | 1.8990 | <u>1.9000</u> | 1.9010 |
| 20 V   | +19 V   | 18.990 | <u>19.001</u> | 19.010 |
|        | -19 V   | 18.990 | <u>19.002</u> | 19.010 |
| 200 V  | +190 V  | 189.86 | <u>190.01</u> | 190.14 |
|        | -190 V  | 189.86 | <u>190.01</u> | 190.14 |

### RESISTANCE ACCURACY

| RANGE              | ACTUAL INPUT    | TOLERANCE                   | READING       |
|--------------------|-----------------|-----------------------------|---------------|
| 2 K $\Omega$ (19)  | <u>1.9000 K</u> | $\pm 0.2\% + 4C$ P / $\Xi$  | <u>1.9000</u> |
| 20 K $\Omega$      | <u>18.999 K</u> | $\pm 0.15\% + 1C$ P / $\Xi$ | <u>18.999</u> |
| 200 K $\Omega$     | <u>189.99 K</u> | $\pm 0.25\% + 1C$ P / $\Xi$ | <u>189.99</u> |
| 2 M $\Omega$       | <u>1.9000 M</u> | $\pm 0.25\% + 1C$ P / $\Xi$ | <u>1.9001</u> |
| 20 M $\Omega$      | <u>18.997 M</u> | $\pm 0.25\% + 1C$ P / $\Xi$ | <u>18.997</u> |
| 200 M $\Omega$ (1) | <u>99.98 M</u>  | $\pm 0.3\% + 1C$ P / $\Xi$  | <u>99.98</u>  |
| 2 G $\Omega$       | <u>1.0019 G</u> | $\pm 1.5\% + 1C$ P / $\Xi$  | <u>1.0022</u> |
| 20 G $\Omega$      | <u>9.979 G</u>  | $\pm 1.5\% + 1C$ P / $\Xi$  | <u>9.977</u>  |
| 200 G $\Omega$     | <u>98.81 G</u>  | $\pm 1.5\% + 1C$ P / $\Xi$  | <u>98.43</u>  |

### OUTPUT VOLTAGE SOURCE ACCURACY

| OUTPUT SETTING | MIN    | READING       | MAX     |
|----------------|--------|---------------|---------|
| 00.00 V        | -0.050 | <u>+0.032</u> | +0.050  |
| +01.00 V       | +0.948 | <u>1.015</u>  | +1.052  |
| -01.00 V       | -0.948 | <u>.971</u>   | -1.052  |
| +10.00 V       | +9.930 | <u>10.01</u>  | +10.07  |
| -10.00 V       | -9.930 | <u>9.97</u>   | -10.07  |
| +25.00 V       | +24.90 | <u>25.02</u>  | +25.10  |
| -25.00 V       | -24.90 | <u>24.98</u>  | -25.10  |
| +50.00 V       | +49.85 | <u>50.02</u>  | +50.15  |
| -50.00 V       | -49.85 | <u>49.98</u>  | -50.15  |
| +100.00 V      | +99.75 | <u>100.04</u> | +100.25 |
| -100.00 V      | -99.75 | <u>100.01</u> | -100.25 |

SOUTHWEST RESEARCH INSTITUTE  
Department of Quality Assurance  
Calibration Laboratory

OUT OF TOLERANCE NOTICE

09/22/94

The following asset was found to be out of tolerance when submitted for calibration. Please be aware measurements made with this may be inaccurate.

INSTRUMENT INFORMATION

Issued to: NARASI SRIDHAR DIV20 B57 Asset Number: 001044  
Manufacturer: KEITH Model Number: 617  
Nomenclature: PROGRAMMABLE ELECTROMETER  
Serial Number: 537418 SwRI Capital Number: NONE  
Accuracy: MFGR SPECS Calibration Interval: 12 months

DEVIATION

Out of Tolerance Date: 09/08/94 Last Valid Calibration Date: 07/28/93

REMARKS

UNIT OUT OF TOLERANCE WHEN RECEIVED FOR CALIBRATION. SEE ATTACHED ROTHE DEV. REPORT FOR SPECIFIC CONDITIONS.

Signed \_\_\_\_\_

**OUT OF TOLERANCE**



**SOUTHWEST RESEARCH INSTITUTE**

**Department of Quality Assurance  
Calibration Laboratory**

**CERTIFICATE OF CALIBRATION  
09/22/94**

Issued to: NARASI SRIDHAR DIV20 ,B57  
Manufacturer: KEITH  
Nomenclature: PROGRAMMABLE ELECTROMETER  
Serial Number: 537418

Asset Number: 001044  
Model Number: 617  
SwRI Capital Number: NONE

**ENVIRONMENTAL CONDITIONS**

Temperature: 73.0F

Relative Humidity: 0 %

**CALIBRATION INFORMATION**

Location: ROTHE  
Procedure Number:  
Remarks: CAL BY ROTHE DEV. INC. RCVD OUT OF TOLERANC  
E. ADJUSTED TO MFG SPECS.

Technician: 8216  
Accuracy: MFGR.SPECS  
Received OUT Tolerance


**Calibration was in accordance with requirements of MIL-STD-45662A.  
Measurements are traceable to the National Institute of Standards and Tech-  
nology. Inspection and test data are on file and available for inspection.**

**STANDARDS USED FOR CERTIFICATION**

| Asset # | Serial # | Mfg | Model # | Nomenclature | Cal Date | Int. Cal Due |
|---------|----------|-----|---------|--------------|----------|--------------|
|---------|----------|-----|---------|--------------|----------|--------------|

VENDOR

Certified by :



Calibration Date: 09/20/94  
Interval: 12 months  
Next Calibration Due: 09/20/95

Work Order: 14848



# Rothe Development Inc.

## Metrology Services Division

4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 210-648-3131 FAX 210-648-4091

# Certificate of Calibration

# 40528

CAL DATE: 10/05/95

DUE DATE: 10/05/96

ISSUED TO: Southwest Research Institute (30)  
6220 Culebra, Bldg. 64/Division 30  
San Antonio, TX 78284  
684-5111 \* 2702

MFG Keithley

MODEL 617

SERIAL # 537418

CONTROL: 114 - 15981

TECHNICIAN #: 4

SPECIFICATIONS: MFG

PROCEDURE: MFG

WORK ORDER #: 50278

CUSTOMER PO #: 03602/ST271409/20-5704-

TYPE Programmable Electrometer

RECEIVED IN-SPECS   
OUT-OF-SPECS

All Calibration measurements performed at ROTHE DEVELOPMENT INC. METROLOGY SERVICES meet the requirements of MIL-STD-45662A, and are traceable to the National Institute of Standards and Technology through Primary NIST Calibration or Secondary Calibration performed by other Metrological facilities. Ambient conditions: Temperature 73°F, Relative Humidity 36%.

### Test Report Number and Calibration Standards Used

| Ref #  | Model # | Mfgr      | Serial # | Description    | Cal Date | Int | Cal Due  |
|--------|---------|-----------|----------|----------------|----------|-----|----------|
| TR 75  | NMN     | JRL       | 75       | RESISTANCE BOX | 07/11/95 | 12  | 07/11/96 |
| TR 20  | 5700A   | FLUKE     | 4605002  | CALIBRATOR     | 09/05/95 | 3   | 12/05/95 |
| TR 235 | 6500A   | GUILDLINE | 59660    | TERAOhMETER    | 09/01/95 | 12  | 09/01/96 |

### ----- Test Report Numbers -----

DCV FLUKE CERT# DH70  
ACV FLUKE CERT# DP30  
OHM NIST TEST# 250839  
TEMP NIST TEST# 251316  
Hz WWVB Transmission

INSPECTED BY Jose A Mendez  
COMMENTS:

ROTHER DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: KEITHLEY 617 ELECTROMETER

CUSTOMER: SWIFT DATE: 5 Oct 95  
 WO NUMBER: 5028 TECH: RS  
 SERIAL: 537418 INST NO: 15981

CALIBRATION DATA TAKEN INCOMING ✓  
 OUTGOING ✓

CONDITION OF EQUIPMENT IN TOLERANCE ✓  
 OUT OF TOLERANCE \_\_\_\_\_

INPUT CURRENT VERIFICATION

SET-UP: 2PA RANGE, INPUT CAPPED, TOLERANCE <66 C READING .0038

CURRENT ACCURACY

| RANGE  | INPUT      | MIN    | READING       | MAX    |
|--------|------------|--------|---------------|--------|
| 20 mA  | ZERO CHECK | -0.001 | <u>0.000</u>  | +0.001 |
|        | 19 mA      | 18.970 | <u>18.999</u> | 19.030 |
| 2 mA   | 1.9 mA     | 1.8967 | <u>1.8999</u> | 1.9033 |
| 200 uA | 190 uA     | 189.70 | <u>190.01</u> | 190.30 |
| 20 uA  | 19 uA      | 18.970 | <u>19.001</u> | 19.030 |

| RANGE  | NOMINAL | ACTUAL          | TOLERANCE  | P / <del>F</del> | READING       |
|--------|---------|-----------------|------------|------------------|---------------|
| 2 uA   | 1.9 uA  | <u>1.900 uA</u> | ±.15% +4C  | P / <del>F</del> | <u>1.8998</u> |
| 200 nA | 190 nA  | <u>190.0 nA</u> | ±.25% +1C  | P / <del>F</del> | <u>190.02</u> |
| 20 nA  | 19 nA   | <u>19.00 nA</u> | ±.25% +1C  | P / <del>F</del> | <u>19.002</u> |
| 2 nA   | 1.9 nA  | <u>1.900 nA</u> | ±.25% +5C  | P / <del>F</del> | <u>1.9001</u> |
| 200 pA | 190 pA  | <u>190.0 pA</u> | ±1.6% +1C  | P / <del>F</del> | <u>190.15</u> |
| 20 pA  | 19 pA   | <u>19.00 pA</u> | ±1.6% +7C  | P / <del>F</del> | <u>19.043</u> |
| 2 pA   | 1.9 pA  | <u>1.900 pA</u> | ±1.6% +66C | P / <del>F</del> | <u>1.9086</u> |

COULOMB ACCURACY

| RANGE | INPUT       | MIN   | READING     | MAX   |
|-------|-------------|-------|-------------|-------|
| 2nC   | 1V / 1000pF | 0.995 | <u>.999</u> | 1.005 |

DC VOLTAGE ACCURACY

| RANGE  | INPUT   | MIN    | READING       | MAX    |
|--------|---------|--------|---------------|--------|
| 200 mV | +190 mV | 189.87 | <u>190.01</u> | 190.13 |
|        | -190 mV | 189.87 | <u>189.99</u> | 190.13 |
| 2 V    | +1.9 V  | 1.8990 | <u>1.9001</u> | 1.9010 |
|        | -1.9 V  | 1.8990 | <u>1.9001</u> | 1.9010 |
| 20 V   | +19 V   | 18.990 | <u>19.001</u> | 19.010 |
|        | -19 V   | 18.990 | <u>19.001</u> | 19.010 |
| 200 V  | +190 V  | 189.86 | <u>190.01</u> | 190.14 |
|        | -190 V  | 189.86 | <u>190.01</u> | 190.14 |

RESISTANCE ACCURACY

| RANGE              | ACUTAL INPUT    | TOLERANCE        | READING                        |
|--------------------|-----------------|------------------|--------------------------------|
| 2 K $\Omega$ (19)  | <u>1.9000 K</u> | $\pm 0.2\%$ +4C  | P / <del>#</del> <u>1.8999</u> |
| 20 K $\Omega$      | <u>18.999 K</u> | $\pm 0.15\%$ +1C | P / <del>#</del> <u>18.999</u> |
| 200 K $\Omega$     | <u>189.99 K</u> | $\pm 0.25\%$ +1C | P / <del>#</del> <u>189.98</u> |
| 2 M $\Omega$       | <u>1.9000 M</u> | $\pm 0.25\%$ +1C | P / <del>#</del> <u>1.8999</u> |
| 20 M $\Omega$      | <u>18.997 M</u> | $\pm 0.25\%$ +1C | P / <del>#</del> <u>18.996</u> |
| 200 M $\Omega$ (1) | <u>99.99 M</u>  | $\pm 0.3\%$ +1C  | P / <del>#</del> <u>99.99</u>  |
| 2 G $\Omega$       | <u>1.0021 G</u> | $\pm 1.5\%$ +1C  | P / <del>#</del> <u>1.0025</u> |
| 20 G $\Omega$      | <u>9.980 G</u>  | $\pm 1.5\%$ + 1C | P / <del>#</del> <u>9.975</u>  |
| 200 G $\Omega$     | <u>98.823 G</u> | $\pm 1.5\%$ + 1C | P / <del>#</del> <u>98.37</u>  |

OUTPUT VOLTAGE SOURCE ACCURACY

| OUTPUT SETTING | MIN    | READING       | MAX     |
|----------------|--------|---------------|---------|
| 00.00V         | -0.050 | <u>+0.032</u> | +0.050  |
| +01.00 V       | +0.948 | <u>1.015</u>  | +1.052  |
| -01.00 V       | -0.948 | <u>.970</u>   | -1.052  |
| +10.00 V       | +9.930 | <u>10.01</u>  | +10.07  |
| -10.00 V       | -9.930 | <u>9.97</u>   | -10.07  |
| +25.00 V       | +24.90 | <u>25.02</u>  | +25.10  |
| -25.00 V       | -24.90 | <u>24.97</u>  | -25.10  |
| +50.00 V       | +49.85 | <u>50.02</u>  | +50.15  |
| -50.00 V       | -49.85 | <u>49.98</u>  | -50.15  |
| +100.00 V      | +99.75 | <u>100.04</u> | +100.25 |
| -100.00 V      | -99.75 | <u>100.01</u> | -100.25 |



# Rothe Development, Inc.

4614 SINCLAIR RD. SAN ANTONIO, TEXAS 78222-2099

210-648-3131 FAX: 210-648-4091

METROLOGY SERVICES DIVISION  
PRECISION MEASUREMENT EQUIPMENT LABORATORY  
TRACEABLE TO NIST

CHARGE # 107

CONTROL # 114 - 15981

WORK ORDER # 50278

|   |                                |
|---|--------------------------------|
| RECEIVED FROM Southwest Research Institute (30) DATE 10/02/95     | MFG Keithley                   |
| ADDRESS 6220 Culebra, Bldg. 64/Division 30 PHONE# 684-5111 * 2702 | MODEL 617                      |
| San Antonio, Tx 78284   | SERIAL # 537418                |
| CONTACT (NAME) Mr. Jim Patterson FAX# 522-3692                    | TYPE Programmable Electrometer |
| PURCHASE ORDER # 03602/ST271409/20-5704-042                       | ACCES. RCVD. Leads             |
| CUSTOMER COMMENTS N/T BEFORE & AFTER DATA OUT OF SPEC ITEM        |                                |

RUSH

- REPAIR
- OPERATIONAL CHECK
- CALIBRATION

CALIBRATION DATE 5 Oct 95 CALIBRATION INTERVAL 12 MO.

DATE DUE 5 Oct 96

- RECEIVED IN SPECS.
- RECEIVED INOPERATIVE
- RECEIVED OUT OF SPECS.

| CKT REF # | QTY. | MFG PART # | DESCRIPTION | COST | ROTHE TECH.       | OUR P.O. #   |
|-----------|------|------------|-------------|------|-------------------|--------------|
|           |      |            |             |      | PIS               |              |
|           |      |            |             |      | REPAIR LABOR HRS. | SERVICE CODE |
|           |      |            |             |      |                   | J            |
|           |      |            |             |      | PARTS TOTAL       |              |
|           |      |            |             |      | REPAIR LABOR      |              |
|           |      |            |             |      | SHIPPING          |              |
|           |      |            |             |      | TEAR DOWN CHARGE  |              |
|           |      |            |             |      | CALIBRATION       | 97.50        |
|           |      |            |             |      | TAX               |              |
|           |      |            |             |      | TOTAL             | 97.50        |

TR #'s 75, 20, 205

### COMMENTS

WORK PERFORMED: Cal Data Taken

CAL

TEMP. 73 °F

SPECS:  MFG  RDI

R.H. 34 %

PROCEDURE:  MFG  RDI  OTHER

RDI 2002

SHIP VIA: \_\_\_\_\_ DATE: \_\_\_\_\_ RECEIVED BY: \_\_\_\_\_

SOUTHWEST RESEARCH INSTITUTE  
Department of Quality Assurance  
Calibration Laboratory

CERTIFICATE OF CALIBRATION  
10/06/95

Issued to: DARRELL DUNN      DIV20      ,B57  
Manufacturer: KEITH  
Nomenclature: PROGRAMMABLE ELECTROMETER  
Serial Number: 537418  
Notes:

Asset Number: 001044  
Model Number: 617  
SwRI/Div. I.D. #:

ENVIRONMENTAL CONDITIONS

Temperature: 73.0F

Relative Humidity: 36%

CALIBRATION INFORMATION

Procedure Number: MFG  
Remarks: CALIBRATED BY ROTHE DEV.,  
CERT# 40528

Accuracy: MFGR SPECS  
Received IN Tolerance

Calibration was in accordance with requirements of MIL-STD-45662A.  
Measurements are traceable to the National Institute of Standards and Technology. Inspection and test data are on file and available for inspection.

STANDARDS USED FOR CERTIFICATION

| Asset # | Serial # | Mfg | Model # | Nomenclature | Cal Date | Int. | Cal Due |
|---------|----------|-----|---------|--------------|----------|------|---------|
|---------|----------|-----|---------|--------------|----------|------|---------|

VENDOR

Certified by : \_\_\_\_\_

Calibration Date: 10/05/95  
Interval: 12 months  
Next Calibration Due: 10/05/96

Certificate#: 18890



Southwest Research Institute  
6220 Culebra Road  
San Antonio, TX 78238  
Department of Quality Assurance  
Calibration Laboratory

# Certificate of Calibration

7 October 1996

Issued to: DARRELL DUNN                      DIV20                      B57  
Manufacturer/Model: KEITHLEY 617  
Description: PROGRAMMABLE ELECTROMETER  
Serial Number: 537418  
Asset Number: 001044

## Environmental Conditions

Temperature: 73.0 Deg. F

Humidity: 34%

## Calibration Information

Calibration was in accordance with requirements of MIL-STD-45662A and ANSI/NC SL Z540-1-1994. Measurements are traceable to the National Institute of Standards and Technology (NIST). This report may not be reproduced except in full without written approval of the originator. Inspection and test data are on file and available for inspection.

Calibration Date: 4 Oct 96

Calibration Procedure: MFG

Interval: 12 months

Accuracy: MFGR SPECS

Next Calibration Due: 4 Oct 97

Received: In Tolerance

Remarks: CAL BY ROTHE DEVELOPMENT, SAN ANTONIO, TX  
CERT. #45244

Certificate # 22862

Signed: 

LAST PAGE OF REPORT  
Total Pages Printed: 1



Southwest Research Institute  
6220 Culebra Road  
San Antonio, TX 78238  
Department of Quality Assurance  
Calibration Laboratory

# Certificate of Calibration

24 October 1997

Issued to: DARRELL DUNN                      DIV20                      B57  
Manufacturer/Model: KEITHLEY 617  
Description: PROGRAMMABLE ELECTROMETER  
Serial Number: 537418  
Asset Number: 001044

## Environmental Conditions

Temperature: 73.00      Deg. F                      Humidity: 34      % RH

## Calibration Information

Calibration was in accordance with requirements of MIL-STD-45662A and ANSI/NC SL Z540-1-1994. Measurements are traceable to the National Institute of Standards and Technology (NIST). This report may not be reproduced except in full without written approval of the originator. Inspection and test data are on file and available for inspection.

The uncertainty of the calibration was sufficient to determine that the instrument met the manufacturer's specifications.

Calibration Date: 23 Oct 97                      Calibration Procedure: MFG  
Interval: 12 months                      Uncertainty: MFG SPECS  
Next Calibration Due: 23 Oct 98                      Received: In Tolerance  
Remarks: CALIBRATED BY ROTHE DEV., SAN ANTONIO, TX.  
ROTHE CERT. #50032.

## Standards Used

| Asset  | MFR | Model | Description | Serial No. | Due Cal |
|--------|-----|-------|-------------|------------|---------|
| VENDOR |     |       |             |            |         |

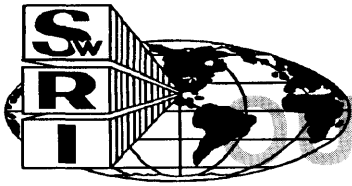
Signed: \_\_\_\_\_

Title: \_\_\_\_\_

LAST PAGE OF REPORT  
Total Pages Printed: 1

Certificate # 27163





Southwest Research Institute  
6220 Culebra Road  
San Antonio, TX 78238  
Department of Quality Assurance  
Calibration Laboratory

## Out of Tolerance Notice

2 November 1998

The following asset was found to be out of tolerance when submitted for calibration. Please be aware measurements made with this instrument may be inaccurate.

### Instrument Information

Issued to: DARRELL DUNN DIV20 B57

Manufacturer/Model: KEITHLEY 617

Description: PROGRAMMABLE ELECTROMETER

Serial Number: 537418

Asset Number: 001044

SwRI Cap No.: 26000

Accuracy: MFG SPECS

Calibration Interval: 12 months

Calibration Procedure: MFG

Remarks: CALIBRATED BY ROTHE DEV., SAN ANTONIO, TX.  
ROTHE CERT. #55080.

### Calibration Results

Out of Tolerance Date: 30 Oct 98

Last Valid Calibration Date: 23 Oct 97

#### INPUT CURRENT VERIFICATION

SET-UP: 2PA RANGE, INPUT CAPPED, TOLERANCE <66 C

READING

\* .0103

#### CURRENT ACCURACY

| RANGE | INPUT  | MIN    | READING  | MAX    |
|-------|--------|--------|----------|--------|
| 20 PA | 19 PA  | 18.689 | * 19.770 | 19.311 |
| 2 PA  | 1.9 PA | 1.8630 | * 2.295  | 1.9370 |

\*INDICATES OUT OF TOLERANCE CONDITION.

Certificate # 31711

Signed: 

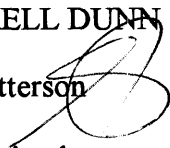
Checked by: \_\_\_\_\_

## Out of Tolerance Notice



**SOUTHWEST RESEARCH INSTITUTE  
CALIBRATION LABORATORY  
MEMORANDUM**

**December 27, 1999**

**To:** DARRELL DUNN DIV20 B57  
**From:** Jim Patterson   
**Subject:** Calibration by an approved supplier

**Manufacturer/Model:** KEITHLEY 617  
**Description:** ELECTROMETER  
**Serial Number:** 537418  
**Asset Number:** 001044  
**Calibration Due:** December 26, 2000  
**Remarks:** ROTHE CERTIFICATE NO.: 15981:946195283.

**Supplier:** ROTHE DEVELOPMENT, INC., SAN ANTONIO, TX


The above item was sent to an approved supplier who is listed on the SwRI Approved Suppliers List (ASL). This supplier is qualified to supply a product or service in support of project activities that require the use of approved suppliers. Please notify Mark Romero, extension 5215, of any discrepancies with the item or calibration documentation.

Attachment(s)   1

**SOUTHWEST RESEARCH INSTITUTE  
CALIBRATION LABORATORY  
MEMORANDUM**

**April 4, 2003**

**To:** DARRELL DUNN DIV20 B57

**From:** Walt Hill, Metrology Group Leader,   
Institute Calibration Laboratory

**Subject:** Status of Calibration Supplier

**Manufacturer/Model:** KEITHLEY 617

**Description:** ELECTROMETER

**Serial Number:** 537418

**Asset Number:** 001044

**Work Order Number:** 444053038

**Date Calibrated:** April 2, 2003

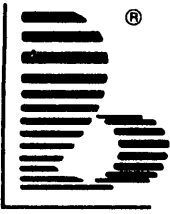
**Supplier:** ROTHE DEVELOPMENT, SAN ANTONIO TX - AUDIT - 648-3131

**Remarks:** ROTHE CERT# 15981:1049290409

- Supplier is on the Approved Suppliers List (ASL).
- Supplier is not on the Approved Suppliers List.
- Calibration is ISO 17025 accredited.
- Calibration is not ISO 17025 accredited.
- There is no known supplier to meet ISO 17025 accreditation at this time.

Please notify the Institute Calibration Laboratory, extension 5215, of any discrepancies with the item or calibration documentation.

Attachment(s) 5



CERT. NUMBER:  
15981:1049290409

**ROTHE DEVELOPMENT, INC.**  
**METROLOGY SERVICES DIVISION**

4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 PH:210-648-3131

# CERTIFICATE OF CALIBRATION

ISSUED TO: Southwest Research Institute MFG: Keithley  
(30) MODEL: 617 CAL DATE: 4/2/2003  
6220 Culebra NOMEN: PROG ELECTROMETER DUE DATE: 4/2/2004  
San Antonio, TX 78294 S/N: 537418  
CUST. ID:

CONTROL NO.: 103 - 15981  
TECHNICIAN: 4  
SPECIFICATIONS: MFG  
PROCEDURE: MFG  
WORK ORDER: 002027769  
CUSTOMER P.O.: 01571R/ST408333/1.15.02.  
RECEIVED CONDITION: IN TOLERANCE  
RETURNED CONDITION: IN TOLERANCE

CALIBRATION PERFORMED AT: RDMSD  
CALIBRATION INTERVAL: 12Mo.  
TEMPERATURE: 72.0 °F  
RELATIVE HUMIDITY: 36 %  
DATE RECEIVED: 3/31/2003

COMMENTS:

ATTACHMENTS: CALIBRATION DATA 4 SHEETS

All Calibrations performed at Rothe Development, Inc. Metrology Services Division meet the requirements of ANSI/NC SL Z540-1-1994, ISO/IEC GUIDE 25, and ISO 10012-1, and are traceable to the National Institute of Standards and Technology. The collective uncertainty of the measurement(s) does not exceed 25% (TUR $\geq$ 4:1) of the instrument specification(s) unless noted in the COMMENTS section.

| TR# | MFG       | MODEL    | SERIAL NO. | DUE DATE   |
|-----|-----------|----------|------------|------------|
| 20  | FLUKE     | 5700A/EP | 4605002    | 6/25/2003  |
| 259 | FLUKE     | 5725A    | 6585002    | 6/25/2003  |
| 231 | HP        | 34401A   | 3146A45255 | 7/5/2003   |
| 75  | JRL       | NMN      | 75         | 1/8/2004   |
| 235 | GUILDLINE | 6500A    | 59660      | 12/19/2003 |

APPROVED BY:

CMS

QCO

DATE

4/3/2003

ROTHE DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: KEITHLEY 617 ELECTROMETER

CUSTOMER: SWRT DATE: 2 Apr 03  
 WO NUMBER: 002027769 TECH: PJS  
 SERIAL: 537418 INST NO: 15981  
 CUST ID: \_\_\_\_\_

CALIBRATION DATA TAKEN INCOMING \_\_\_\_\_  
 OUTGOING ✓

CONDITION OF EQUIPMENT IN TOLERANCE ✓  
 OUT OF TOLERANCE \_\_\_\_\_

INPUT CURRENT VERIFICATION

SET-UP: 2PA RANGE, INPUT CAPPED, TOLERANCE <66 C READING -0.0006

CURRENT ACCURACY

| RANGE  | INPUT      | MIN    | READING       | MAX    |
|--------|------------|--------|---------------|--------|
| 20 mA  | ZERO CHECK | -0.001 | <u>0.000</u>  | +0.001 |
|        | 19 mA      | 18.970 | <u>19.000</u> | 19.030 |
| 2 mA   | 1.9 mA     | 1.8967 | <u>1.9001</u> | 1.9033 |
| 200 uA | 190 uA     | 189.70 | <u>190.00</u> | 190.30 |
| 20 uA  | 19 uA      | 18.970 | <u>19.001</u> | 19.030 |
| 2 uA   | 1.9 uA     | 1.8967 | <u>1.8999</u> | 1.9033 |
| 200 nA | 190 nA     | 189.51 | <u>189.96</u> | 190.49 |
| 20 nA  | 19 nA      | 18.951 | <u>19.000</u> | 19.049 |
| 2 nA   | 1.9 nA     | 1.8947 | <u>1.9001</u> | 1.9053 |
| 200 pA | 190 pA     | 186.95 | <u>190.05</u> | 193.05 |
| 20 pA  | 19 pA      | 18.689 | <u>19.016</u> | 19.311 |
| 2 pA   | 1.9 pA     | 1.8630 | <u>1.9011</u> | 1.9370 |

COULOMB ACCURACY

| RANGE | INPUT       | MIN    | READING       | MAX    |
|-------|-------------|--------|---------------|--------|
| 2nC   | 1V / 1000pF | 0.9949 | <u>1.0002</u> | 1.0051 |

DC VOLTAGE ACCURACY

| RANGE  | INPUT   | MIN    | READING       | MAX    |
|--------|---------|--------|---------------|--------|
| 200 mV | +190 mV | 189.87 | <u>190.00</u> | 190.13 |
|        | -190 mV | 189.87 | <u>189.99</u> | 190.13 |
| 2 V    | +1.9 V  | 1.8990 | <u>1.8999</u> | 1.9010 |
|        | -1.9 V  | 1.8990 | <u>1.9000</u> | 1.9010 |
| 20 V   | +19 V   | 18.990 | <u>18.999</u> | 19.010 |
|        | -19 V   | 18.990 | <u>19.000</u> | 19.010 |
| 200 V  | +190 V  | 189.86 | <u>190.00</u> | 190.14 |
|        | -190 V  | 189.86 | <u>190.01</u> | 190.14 |

RESISTANCE ACCURACY

| RANGE              | ACUTAL INPUT    | TOLERANCE        | P / F | READING       |
|--------------------|-----------------|------------------|-------|---------------|
| 2 K $\Omega$ (19)  | <u>1.8999 K</u> | $\pm 0.2\%$ +4C  | P / F | <u>1.8999</u> |
| 20 K $\Omega$      | <u>18.999 K</u> | $\pm 0.15\%$ +1C | P / F | <u>18.999</u> |
| 200 K $\Omega$     | <u>189.99 K</u> | $\pm 0.25\%$ +1C | P / F | <u>189.99</u> |
| 2 M $\Omega$       | <u>1.9000 M</u> | $\pm 0.25\%$ +1C | P / F | <u>1.8999</u> |
| 20 M $\Omega$      | <u>18.997 M</u> | $\pm 0.25\%$ +1C | P / F | <u>18.997</u> |
| 200 M $\Omega$ (1) | <u>100.00 M</u> | $\pm 0.3\%$ +1C  | P / F | <u>100.00</u> |
| 2 G $\Omega$       | <u>.9961 G</u>  | $\pm 1.5\%$ +1C  | P / F | <u>.9961</u>  |
| 20 G $\Omega$      | <u>9.9756</u>   | $\pm 1.5\%$ + 1C | P / F | <u>9.975</u>  |
| 200 G $\Omega$     | <u>98.916</u>   | $\pm 1.5\%$ + 1C | P / F | <u>98.50</u>  |

OUTPUT VOLTAGE SOURCE ACCURACY

| OUTPUT SETTING | MIN    | READING        | MAX    |
|----------------|--------|----------------|--------|
| 00.00V         | -0.050 | <u>0.032</u>   | +0.050 |
| +01.00 V       | 0.948  | <u>1.015</u>   | 1.052  |
| -01.00 V       | 0.948  | <u>.971</u>    | 1.052  |
| +10.00 V       | 9.930  | <u>10.013</u>  | 10.07  |
| -10.00 V       | 9.930  | <u>9.972</u>   | 10.07  |
| +25.00 V       | 24.90  | <u>25.018</u>  | 25.10  |
| -25.00 V       | 24.90  | <u>24.974</u>  | 25.10  |
| +50.00 V       | 49.85  | <u>50.023</u>  | 50.15  |
| -50.00 V       | 49.85  | <u>49.981</u>  | 50.15  |
| +100.00 V      | 99.75  | <u>100.038</u> | 100.25 |
| -100.00 V      | 99.75  | <u>100.008</u> | 100.25 |

INST NO: 15981

DOC. DATE: 2/22/2001

INCOMING  
 OUTGOING

ROTHE DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: KEITHLEY 617 ELECTROMETER

CUSTOMER: SWRI  
 WO NUMBER: 002027769  
 SERIAL: 537418  
 CUST ID: \_\_\_\_\_

DATE: 2 Apr 03  
 TECH: PJS  
 INST NO: 15981

CALIBRATION DATA TAKEN

INCOMING ✓  
 OUTGOING \_\_\_\_\_

CONDITION OF EQUIPMENT

IN TOLERANCE ✓  
 OUT OF TOLERANCE \_\_\_\_\_

INPUT CURRENT VERIFICATION

SET-UP: 2PA RANGE, INPUT CAPPED, TOLERANCE <66 C READING -0021

CURRENT ACCURACY

| RANGE  | INPUT      | MIN    | READING       | MAX    |
|--------|------------|--------|---------------|--------|
| 20 mA  | ZERO CHECK | -0.001 | <u>0.000</u>  | +0.001 |
|        | 19 mA      | 18.970 | <u>18.982</u> | 19.030 |
| 2 mA   | 1.9 mA     | 1.8967 | <u>1.8978</u> | 1.9033 |
| 200 uA | 190 uA     | 189.70 | <u>190.02</u> | 190.30 |
| 20 uA  | 19 uA      | 18.970 | <u>19.004</u> | 19.030 |
| 2 uA   | 1.9 uA     | 1.8967 | <u>1.8988</u> | 1.9033 |
| 200 nA | 190 nA     | 189.51 | <u>189.97</u> | 190.49 |
| 20 nA  | 19 nA      | 18.951 | <u>19.002</u> | 19.049 |
| 2 nA   | 1.9 nA     | 1.8947 | <u>1.8985</u> | 1.9053 |
| 200 pA | 190 pA     | 186.95 | <u>190.04</u> | 193.05 |
| 20 pA  | 19 pA      | 18.689 | <u>19.018</u> | 19.311 |
| 2 pA   | 1.9 pA     | 1.8630 | <u>1.9023</u> | 1.9370 |

COULOMB ACCURACY

| RANGE | INPUT       | MIN    | READING      | MAX    |
|-------|-------------|--------|--------------|--------|
| 2nC   | 1V / 1000pF | 0.9949 | <u>.9990</u> | 1.0051 |



DC VOLTAGE ACCURACY

| RANGE  | INPUT   | MIN    | READING       | MAX    |
|--------|---------|--------|---------------|--------|
| 200 mV | +190 mV | 189.87 | <u>190.01</u> | 190.13 |
|        | -190 mV | 189.87 | <u>189.99</u> | 190.13 |
| 2 V    | +1.9 V  | 1.8990 | <u>1.9003</u> | 1.9010 |
|        | -1.9 V  | 1.8990 | <u>1.9003</u> | 1.9010 |
| 20 V   | +19 V   | 18.990 | <u>19.000</u> | 19.010 |
|        | -19 V   | 18.990 | <u>19.001</u> | 19.010 |
| 200 V  | +190 V  | 189.86 | <u>190.02</u> | 190.14 |
|        | -190 V  | 189.86 | <u>190.03</u> | 190.14 |

RESISTANCE ACCURACY

| RANGE      | ACUTAL INPUT    | TOLERANCE  | P / F | READING       |
|------------|-----------------|------------|-------|---------------|
| 2 KΩ (19)  | <u>1.8999 K</u> | ±0.2% +4C  | P / F | <u>1.8999</u> |
| 20 KΩ      | <u>18.999 K</u> | ±0.15% +1C | P / F | <u>18.999</u> |
| 200 KΩ     | <u>189.99 K</u> | ±0.25% +1C | P / F | <u>189.97</u> |
| 2 MΩ       | <u>1.9000 M</u> | ±0.25% +1C | P / F | <u>1.8995</u> |
| 20 MΩ      | <u>18.997 M</u> | ±0.25% +1C | P / F | <u>18.999</u> |
| 200 MΩ (1) | <u>100.00 M</u> | ±0.3% +1C  | P / F | <u>100.01</u> |
| 2 GΩ       | <u>.9961 G</u>  | ±1.5% +1C  | P / F | <u>.9962</u>  |
| 20 GΩ      | <u>9.975 G</u>  | ±1.5% + 1C | P / F | <u>9.971</u>  |
| 200 GΩ     | <u>98.91 G</u>  | ±1.5% + 1C | P / F | <u>98.48</u>  |

OUTPUT VOLTAGE SOURCE ACCURACY

| OUTPUT SETTING | MIN    | READING        | MAX    |
|----------------|--------|----------------|--------|
| 00.00V         | -0.050 | <u>0.032</u>   | +0.050 |
| +01.00 V       | 0.948  | <u>1.015</u>   | 1.052  |
| -01.00 V       | 0.948  | <u>.971</u>    | 1.052  |
| +10.00 V       | 9.930  | <u>10.013</u>  | 10.07  |
| -10.00 V       | 9.930  | <u>9.972</u>   | 10.07  |
| +25.00 V       | 24.90  | <u>25.018</u>  | 25.10  |
| -25.00 V       | 24.90  | <u>24.974</u>  | 25.10  |
| +50.00 V       | 49.85  | <u>50.023</u>  | 50.15  |
| -50.00 V       | 49.85  | <u>49.981</u>  | 50.15  |
| +100.00 V      | 99.75  | <u>100.038</u> | 100.25 |
| -100.00 V      | 99.75  | <u>100.008</u> | 100.25 |

INST NO: 15981

DOC. DATE: 2/22/2001

INCOMING  
 OUTGOING

**SOUTHWEST RESEARCH INSTITUTE  
CALIBRATION LABORATORY  
MEMORANDUM**

**October 14, 2003**

**To:** DARRELL DUNN DIV20 B57

**From:** Walt Hill, Metrology Group Leader  
Institute Calibration Laboratory



**Subject:** Status of Calibration Supplier

**Manufacturer/Model:** KEITHLEY 617

**Description:** ELECTROMETER

**Serial Number:** 537418

**Asset Number:** 001044

**Work Order Number:** 444055692

**Date Calibrated:** October 7, 2003

**Supplier:** ROTHE DEVELOPMENT, SAN ANTONIO TX - AUDIT - 648-3131

**Remarks:** Rothe Cert # 15981:1065540017

Supplier is on the Approved Suppliers List (ASL).

Supplier is not on the Approved Suppliers List.

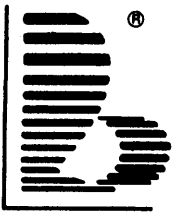
Calibration is ISO 17025 accredited.

Calibration is not ISO 17025 accredited.

There is no known supplier to meet ISO 17025 accreditation at this time.

Please notify the Institute Calibration Laboratory, extension 5215, of any discrepancies with the item or calibration documentation.

Attachment(s) 3



CERT. NUMBER:  
15981:1065540017

**ROTHE DEVELOPMENT, INC.**  
**METROLOGY SERVICES DIVISION**

4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 PH:210-648-3131

# CERTIFICATE OF CALIBRATION

ISSUED TO: Southwest Research Institute MFG: Keithley  
(30) MODEL: 617 CAL DATE: 10/7/2003  
6220 Culebra NOMEN: PROG ELECTROMETER DUE DATE:  
San Antonio, TX 78284 S/N: 537419  
CUST. ID:

CONTROL NO.: 103 - 15981  
TECHNICIAN: 9  
SPECIFICATIONS: MFG  
PROCEDURE: MFG  
WORK ORDER: 002032492  
CUSTOMER P.O.: 01566R/ST418022/1.20.007  
RECEIVED CONDITION: IN TOLERANCE  
RETURNED CONDITION: IN TOLERANCE

CALIBRATION PERFORMED AT: RDMSD  
CALIBRATION INTERVAL: 0  
TEMPERATURE: 72.0 °F  
RELATIVE HUMIDITY: 37 %

DATE RECEIVED: 10/6/2003

COMMENTS:

ATTACHMENTS: CALIBRATION DATA 2 SHEETS

All Calibrations performed at Rothe Development, Inc. Metrology Services Division meet the requirements of ANSI/NCSL Z540-1-1994, ISO/IEC GUIDE 25, and ISO 10012-1, and are traceable to the National Institute of Standards and Technology. The collective uncertainty of the measurement(s) does not exceed 25% (TUR $\geq$ 4:1) of the instrument specification(s) unless noted in the COMMENTS section.

| TR# | MFG       | MODEL    | SERIAL NO. | DUE DATE   |
|-----|-----------|----------|------------|------------|
| 235 | GUILDLINE | 6500A    | 59660      | 12/19/2003 |
| 20  | FLUKE     | 5700A/EP | 4605002    | 12/19/2003 |
| 258 | FLUKE     | 5725A    | 6585002    | 12/19/2003 |
| 231 | HP        | 34401A   | 3146A45255 | 1/7/2004   |
| 182 | GEN RAD   | 1433-H   | 32941      | 7/24/2004  |



REGISTERED TO ISO 9001  
CERTIFICATE NO. A8423

APPROVED BY: Will R. Wright

CMS

QCO

DATE

10/7/2003

ROTHE DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: KEITHLEY 617 ELECTROMETER

CUSTOMER: Southwest Research  
 WO NUMBER: 002032492  
 SERIAL: 537418  
 CUST ID: \_\_\_\_\_

DATE: 07 Oct 03  
 TECH: W. Manney  
 INST NO: 15981

CALIBRATION DATA TAKEN

INCOMING ✓  
 OUTGOING ✓

CONDITION OF EQUIPMENT

IN TOLERANCE ✓  
 OUT OF TOLERANCE \_\_\_\_\_

INPUT CURRENT VERIFICATION

SET-UP: 2PA RANGE, INPUT CAPPED, TOLERANCE <66 C      READING 0050

CURRENT ACCURACY

| RANGE  | INPUT      | MIN    | READING       | MAX    |
|--------|------------|--------|---------------|--------|
| 20 mA  | ZERO CHECK | -0.001 | <u>-0.000</u> | +0.001 |
|        | 19 mA      | 18.970 | <u>19.013</u> | 19.030 |
| 2 mA   | 1.9 mA     | 1.8967 | <u>1.9020</u> | 1.9033 |
| 200 uA | 190 uA     | 189.70 | <u>190.01</u> | 190.30 |
| 20 uA  | 19 uA      | 18.970 | <u>19.001</u> | 19.030 |
| 2 uA   | 1.9 uA     | 1.8967 | <u>1.8997</u> | 1.9033 |
| 200 nA | 190 nA     | 189.51 | <u>189.96</u> | 190.49 |
| 20 nA  | 19 nA      | 18.951 | <u>18.999</u> | 19.049 |
| 2 nA   | 1.9 nA     | 1.8947 | <u>1.8993</u> | 1.9053 |
| 200 pA | 190 pA     | 186.95 | <u>190.11</u> | 193.05 |
| 20 pA  | 19 pA      | 18.689 | <u>19.012</u> | 19.311 |
| 2 pA   | 1.9 pA     | 1.8630 | <u>1.8856</u> | 1.9370 |

COULOMB ACCURACY

| RANGE | INPUT       | MIN    | READING      | MAX    |
|-------|-------------|--------|--------------|--------|
| 2nC   | 1V / 1000pF | 0.9949 | <u>.9975</u> | 1.0051 |

DC VOLTAGE ACCURACY

| RANGE  | INPUT   | MIN    | READING       | MAX    |
|--------|---------|--------|---------------|--------|
| 200 mV | +190 mV | 189.87 | <u>190.00</u> | 190.13 |
|        | -190 mV | 189.87 | <u>189.99</u> | 190.13 |
| 2 V    | +1.9 V  | 1.8990 | <u>1.8999</u> | 1.9010 |
|        | -1.9 V  | 1.8990 | <u>1.9000</u> | 1.9010 |
| 20 V   | +19 V   | 18.990 | <u>18.999</u> | 19.010 |
|        | -19 V   | 18.990 | <u>19.000</u> | 19.010 |
| 200 V  | +190 V  | 189.86 | <u>190.00</u> | 190.14 |
|        | -190 V  | 189.86 | <u>190.00</u> | 190.14 |

RESISTANCE ACCURACY

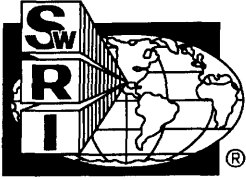
| RANGE              | ACUTAL INPUT  | TOLERANCE        |       | READING       |
|--------------------|---------------|------------------|-------|---------------|
| 2 K $\Omega$ (19)  | <u>1.8999</u> | $\pm 0.2\%$ +4C  | P / F | <u>1.9001</u> |
| 20 K $\Omega$      | <u>18.999</u> | $\pm 0.15\%$ +1C | P / F | <u>18.999</u> |
| 200 K $\Omega$     | <u>189.99</u> | $\pm 0.25\%$ +1C | P / F | <u>189.98</u> |
| 2 M $\Omega$       | <u>1.8999</u> | $\pm 0.25\%$ +1C | P / F | <u>1.8999</u> |
| 20 M $\Omega$      | <u>18.997</u> | $\pm 0.25\%$ +1C | P / F | <u>18.997</u> |
| 200 M $\Omega$ (1) | <u>100.23</u> | $\pm 0.3\%$ +1C  | P / F | <u>100.21</u> |
| 2 G $\Omega$       | <u>.9959</u>  | $\pm 1.5\%$ +1C  | P / F | <u>.9962</u>  |
| 20 G $\Omega$      | <u>9.978</u>  | $\pm 1.5\%$ + 1C | P / F | <u>9.975</u>  |
| 200 G $\Omega$     | <u>98.85</u>  | $\pm 1.5\%$ + 1C | P / F | <u>98.11</u>  |

OUTPUT VOLTAGE SOURCE ACCURACY

| OUTPUT SETTING | MIN    | READING       | MAX    |
|----------------|--------|---------------|--------|
| 00.00V         | -0.050 | <u>.032</u>   | +0.050 |
| +01.00 V       | 0.948  | <u>1.016</u>  | 1.052  |
| -01.00 V       | 0.948  | <u>.971</u>   | 1.052  |
| +10.00 V       | 9.930  | <u>10.01</u>  | 10.07  |
| -10.00 V       | 9.930  | <u>9.973</u>  | 10.07  |
| +25.00 V       | 24.90  | <u>25.02</u>  | 25.10  |
| -25.00 V       | 24.90  | <u>24.98</u>  | 25.10  |
| +50.00 V       | 49.85  | <u>50.03</u>  | 50.15  |
| -50.00 V       | 49.85  | <u>49.98</u>  | 50.15  |
| +100.00 V      | 99.75  | <u>100.04</u> | 100.25 |
| -100.00 V      | 99.75  | <u>100.01</u> | 100.25 |

INST NO: 15981

DOC. DATE: 2/22/2001



# SOUTHWEST RESEARCH INSTITUTE™

6220 Culebra Road, P.O. Drawer 28510  
Institute Quality Systems  
Institute Calibration Laboratory  
Phone: 210-522-5215 Fax 210-522-3692



## Certificate of Calibration

**Submitted By:** DIV20

**Address:** B57

**Contact:** DARRELL DUNN

**Manufacturer Model:** KEITHLEY 617

**Description:** ELECTROMETER

**Serial No:** 537418

**Asset No:** 001044

**Procedure:** CL-658, 03/02

**Work Order:** 444058433

**Date Issued:** Apr 27, 2004

**Calibration Date:** Apr 27, 2004

**\*\*Calibration Due:** Oct 27, 2004

**Calibration Location:** Bldg. 64

**Environment:** Temp. 73.0°F Hum. 33 %RH

**\*As Found:** IN TOLERANCE

**\*As Left:** IN TOLERANCE

This certificate documents traceability to the National Institute of Standards and Technology (NIST) and the International System of Units (SI). The Laboratory quality system conforms to ISO/IEC 17025, 1999 and ANSI/NCCL Z540-1-1994 which are equivalent to relevant requirements of the ISO 9000-1994 series of standards. This certificate may not be reproduced, except in full, without the written approval of the Southwest Research Institute Calibration Laboratory. The results of this calibration relate only to the individual instrument described above. This certificate shall not be used to claim product endorsement by the American Association for Laboratory Accreditation (A2LA) or any agency of the U. S. Government.

Uncertainty evaluation includes the item under test and is calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM). The uncertainty represents an expanded uncertainty using a coverage factor of  $k=2$  to approximate a 95% confidence level. The calibration process provides a Test Uncertainty Ratio (TUR) of less than or equal to 25% (4:1) of the test limit unless otherwise stated in remarks or an attachment.

\*The client has sole responsibility for determination of in/out of tolerance or compliance/noncompliance. An in/out of tolerance opinion is provided for your convenience based only on the Test Instrument (TI) reading(s) and limits as reported. The reported uncertainty relates only to the results at the time of calibration and does not imply any short or long term stability of the TI.

\*\*Calibration interval is determined by the client and does not assure the instrument will remain within tolerance until this date. Any number of factors may cause the instrument to be out of tolerance before the next calibration date.

**Remarks:** None

### Standards Used

| Asset  | Manufacturer    | Model         | Description        | Cal Due    |
|--------|-----------------|---------------|--------------------|------------|
| 001505 | HEWLETT-PACKARD | 3458A/OPT-002 | MULTIMETER         | Mar 19, 05 |
| 000182 | FLUKE           | 5700A/EP      | CALIBRATOR         | Jun 04, 04 |
| 009829 | ESI             | SR1050-10M    | DECADE RESISTOR    | Nov 26, 04 |
| 000108 | GENERAL RADIO   | 1433G         | DECADE RESISTOR    | Mar 24, 05 |
| 009753 | GEN RAD         | 1422-CB       | CAPACITOR STANDARD | Oct 31, 04 |

Approved by: Walt Hill  
Metrology Group Leader  
m\A21a1.rpt Rev date 15, August 02

Measurements by: Scott Kester  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Calibration Report

|             |           |       |              |            |           |
|-------------|-----------|-------|--------------|------------|-----------|
| Work Order: | 444058433 | Mfr.  | KEITHLEY     | Technician | SRK       |
| Asset No.   | 001044    | Model | 617          | Cal Date.  | 27-Apr-04 |
| Serial No.  | 537418    | Type. | ELECTROMETER |            |           |
| Remarks:    |           |       |              |            |           |

| Function/Range | Test Point | TI Reading | Difference | +/-Test Limits | +/-Uncertainty | Found/Left |
|----------------|------------|------------|------------|----------------|----------------|------------|
| DC Amps        | pAmps      | pAmps      | pAmps      | pAmps          | pAmps          | Result     |
| 200 pA         | 190.00     | 189.41     | -0.59      | 3.05           | 0.03           | Pass       |
|                | nAmps      | nAmps      | nAmps      | nAmps          | nAmps          |            |
| 2 nA           | 1.9000     | 1.8993     | -0.0007    | 0.0053         | 0.0002         | Pass       |
| 20 nA          | 19.000     | 18.994     | -0.006     | 0.049          | 0.002          | Pass       |
| 200 nA         | 190.00     | 189.94     | -0.06      | 0.49           | 0.03           | Pass       |
|                | uAmps      | uAmps      | uAmps      | uAmps          | uAmps          |            |
| 2 uA           | 1.9000     | 1.8999     | -0.0001    | 0.0033         | 0.0002         | Pass       |
| 20 uA          | 19.000     | 19.000     | 0.000      | 0.030          | 0.002          | Pass       |
| 200 uA         | 190.00     | 190.00     | 0.00       | 0.30           | 0.02           | Pass       |
|                | mAmps      | mAmps      | mAmps      | mAmps          | mAmps          |            |
| 2 mA           | 1.9000     | 1.9030     | 0.0030     | 0.0033         | 0.0002         | Pass       |
| 20 mA          | 19.000     | 19.030     | 0.030      | 0.030          | 0.002          | Pass       |
|                | nC         | nC         | nC         | nC             | nC             |            |
| 20 nC          | 19.000     | 18.958     | -0.042     | 0.077          | 0.0012         | Pass       |
| DCV            | mVolts     | mVolts     | mVolts     | mVolts         | mVolts         |            |
| 200 mVolt      | 190.00     | 190.02     | 0.02       | 0.14           | 0.012          | Pass       |
|                | Volts      | Volts      | Volts      | Volts          | Volts          |            |
| 2 Volt         | 0.4000     | 0.4000     | 0.0000     | 0.0003         | 0.00012        | Pass       |
|                | 0.8000     | 0.8000     | 0.0000     | 0.0005         | 0.00012        | Pass       |
|                | 1.2000     | 1.2000     | 0.0000     | 0.0007         | 0.00012        | Pass       |
|                | 1.6000     | 1.5999     | -0.0001    | 0.0009         | 0.00012        | Pass       |
|                | 1.9000     | 1.8999     | -0.0001    | 0.0011         | 0.00012        | Pass       |
| 20 Volt        | 19.000     | 18.999     | -0.001     | 0.011          | 0.0012         | Pass       |
| 200 Volt       | 190.00     | 189.99     | -0.01      | 0.14           | 0.012          | Pass       |
| Resistance     | MOhm       | MOhm       | MOhm       | MOhm           | MOhm           |            |
| 20 GOhm        | 110        | 110        | 0          | 4              | 1.2            | Pass       |
| 2 GOhm         | 100.0      | 100.2      | 0.2        | 1.6            | 0.16           | Pass       |
| 200 MOhm       | 100.00     | 100.00     | 0.00       | 0.31           | 0.10           | Pass       |
| 20 MOhm        | 10.000     | 10.001     | 0.001      | 0.026          | 0.0012         | Pass       |
| 2 MOhm         | 1.0000     | 0.9997     | -0.0003    | 0.0026         | 0.00012        | Pass       |
|                | kOhm       | kOhm       | kOhm       | kOhm           | kOhm           |            |
| 200 kOhm       | 100.00     | 100.00     | 0.00       | 0.26           | 0.012          | Pass       |
| 20 kOhm        | 10.000     | 10.000     | 0.000      | 0.016          | 0.0017         | Pass       |
| 2 kOhm         | 1.0000     | 1.0005     | 0.0005     | 0.00211        | 0.00010        | Pass       |

Southwest Research Institute  
 Calibration Laboratory  
 Calibration Report

|             |           |       |              |            |           |
|-------------|-----------|-------|--------------|------------|-----------|
| Work Order: | 444058433 | Mfr.  | KEITHLEY     | Technician | SRK       |
| Asset No.   | 001044    | Model | 617          |            |           |
| Serial No.  | 537418    | Type. | ELECTROMETER | Cal Date.  | 27-Apr-04 |

| Voltage Source | Volts    | Volts    | Volts  | Volts | Volts  | Found/Left |
|----------------|----------|----------|--------|-------|--------|------------|
|                | 0.000    | 0.032    | 0.032  | 0.050 | 0.0012 | Pass       |
|                | 10.000   | 10.014   | 0.014  | 0.070 | 0.0012 | Pass       |
|                | 50.000   | 50.027   | 0.027  | 0.150 | 0.0012 | Pass       |
|                | 100.000  | 100.045  | 0.045  | 0.250 | 0.0015 | Pass       |
|                | -100.000 | -100.015 | -0.015 | 0.250 | 0.0015 | Pass       |
|                | -50.000  | -49.985  | 0.015  | 0.150 | 0.0012 | Pass       |
|                | -10.000  | -9.973   | 0.027  | 0.070 | 0.0012 | Pass       |

END OF REPORT





# SOUTHWEST RESEARCH INSTITUTE™

6220 Culebra Road, P.O. Drawer 28510  
Institute Quality Systems  
Institute Calibration Laboratory  
Phone: 210-522-5215 Fax 210-522-3692



Certificate #  
0972-01

## Certificate of Calibration

**Submitted By:** DIV20  
**Address:** B57  
**Contact:** DARRELL DUNN  
**Manufacturer Model:** KEITHLEY 617  
**Description:** ELECTROMETER  
**Serial No:** 537418  
**Asset No:** 001044  
**Procedure:** CL-658, 03/02

**Work Order:** 444061389  
**Date Issued:** Dec 2, 2004  
**Calibration Date:** Dec 2, 2004  
**\*\*Calibration Due:** Jun 2, 2005  
**Calibration Location:** Bldg. 64  
**Environment:** Temp. 74.0°F Hum. 39 %RH  
**\*As Found:** IN TOLERANCE  
**\*As Left:** IN TOLERANCE

This certificate documents traceability to the National Institute of Standards and Technology (NIST) and the International System of Units (SI). The Laboratory quality system conforms to ISO/IEC 17025, 1999 and ANSI/NCSL Z540-1-1994 which are equivalent to relevant requirements of the ISO 9000-1994 series of standards. This certificate may not be reproduced, except in full, without the written approval of the Southwest Research Institute Calibration Laboratory. The results of this calibration relate only to the individual instrument described above. This certificate shall not be used to claim product endorsement by the American Association for Laboratory Accreditation (A2LA) or any agency of the U. S. Government

Uncertainty evaluation includes the item under test and is calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM). The uncertainty represents an expanded uncertainty using a coverage factor of k=2 to approximate a 95% confidence level. See Remarks or attached Calibration Report with the same Work Order number for calibration data.

\*The client has sole responsibility for determination of in/out of tolerance or compliance/noncompliance. An in/out of tolerance opinion is provided for your convenience based only on the Test Instrument (TI) reading(s) and limits as reported. The reported uncertainty relates only to the results at the time of calibration and does not imply any short or long term stability of the TI.

\*\*Calibration interval is determined by the client and does not assure the instrument will remain within tolerance until this date. Any number of factors may cause the instrument to be out of tolerance before the next calibration date.

**Remarks:** None

### Standards Used

| Asset  | Manufacturer  | Model      | Description        | Cal Due    |
|--------|---------------|------------|--------------------|------------|
| 000182 | FLUKE         | 5700A/EP   | CALIBRATOR         | Dec 23, 04 |
| 010465 | FLUKE         | 8508A-01   | MULTIMETER         | Jun 10, 05 |
| 009753 | GEN RAD       | 1422-CB    | CAPACITOR STANDARD | Oct 26, 05 |
| 009829 | ESI           | SR1050-10M | DECADE RESISTOR    | Nov 09, 05 |
| 000185 | GENERAL RADIO | 1433G      | DECADE RESISTOR    | Mar 05, 05 |

Approved by: Walt Hill  
Metrology Group Leader  
m:\a2la1.rpt Rev date 11, May 04

Measurements by: Scott Kester  
Metrology Technician

Southwest Research Institute  
 Calibration Laboratory  
 Measurement Report

|             |           |       |              |            |           |
|-------------|-----------|-------|--------------|------------|-----------|
| Work Order: | 444061389 | Mfr.  | KEITHLEY     | Technician | SRK       |
| Asset No.   | 001044    | Model | 617          | Cal Date.  | 02-Dec-04 |
| Serial No.  | 537418    | Type. | ELECTROMETER |            |           |

| Voltage Source | Volts    | Volts    | Volts  | Volts | Volts  | Found/Left |
|----------------|----------|----------|--------|-------|--------|------------|
|                | 0.000    | 0.032    | 0.032  | 0.050 | 0.0012 | Pass       |
|                | 10.000   | 10.013   | 0.013  | 0.070 | 0.0012 | Pass       |
|                | 50.000   | 50.021   | 0.021  | 0.150 | 0.0012 | Pass       |
|                | 100.000  | 100.034  | 0.034  | 0.250 | 0.0015 | Pass       |
|                | -100.000 | -100.004 | -0.004 | 0.250 | 0.0015 | Pass       |
|                | -50.000  | -49.979  | 0.021  | 0.150 | 0.0012 | Pass       |
|                | -10.000  | -9.972   | 0.028  | 0.070 | 0.0012 | Pass       |

END OF REPORT

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

|             |           |       |              |            |           |
|-------------|-----------|-------|--------------|------------|-----------|
| Work Order: | 444061389 | Mfr.  | KEITHLEY     | Technician | SRK       |
| Asset No.   | 001044    | Model | 617          |            |           |
| Serial No.  | 537418    | Type. | ELECTROMETER | Cal Date.  | 02-Dec-04 |

Remarks:

| Function/Range | Test Point | TI Reading | Difference | +/-Test Limits | +/-Uncertainty | Found/Left |
|----------------|------------|------------|------------|----------------|----------------|------------|
| DC Amps        | pAmps      | pAmps      | pAmps      | pAmps          | pAmps          | Result     |
| 200 pA         | 190.00     | 188.48     | -1.52      | 3.05           | 0.031          | Pass       |
|                | nAmps      | nAmps      | nAmps      | nAmps          | nAmps          |            |
| 2 nA           | 1.9000     | 1.8989     | -0.0011    | 0.0053         | 0.00022        | Pass       |
| 20 nA          | 19.000     | 18.989     | -0.011     | 0.049          | 0.0022         | Pass       |
| 200 nA         | 190.00     | 189.87     | -0.13      | 0.49           | 0.031          | Pass       |
|                | uAmps      | uAmps      | uAmps      | uAmps          | uAmps          |            |
| 2 uA           | 1.9000     | 1.8997     | -0.0003    | 0.0033         | 0.00019        | Pass       |
| 20 uA          | 19.000     | 18.992     | -0.008     | 0.030          | 0.0019         | Pass       |
| 200 uA         | 190.00     | 189.98     | -0.02      | 0.30           | 0.019          | Pass       |
|                | mAmps      | mAmps      | mAmps      | mAmps          | mAmps          |            |
| 2 mA           | 1.9000     | 1.9030     | 0.0030     | 0.0033         | 0.00014        | Pass       |
| 20 mA          | 19.000     | 19.030     | 0.030      | 0.030          | 0.0014         | Pass       |
|                | nC         | nC         | nC         | nC             | nC             |            |
| 20 nC          | 19.000     | 19.060     | 0.060      | 0.077          | 0.0012         | Pass       |
| DCV            | mVolts     | mVolts     | mVolts     | mVolts         | mVolts         |            |
| 200 mVolt      | 190.00     | 190.01     | 0.01       | 0.14           | 0.012          | Pass       |
|                | Volts      | Volts      | Volts      | Volts          | Volts          |            |
| 2 Volt         | 0.4000     | 0.4000     | 0.0000     | 0.0003         | 0.00012        | Pass       |
|                | 0.8000     | 0.8000     | 0.0000     | 0.0005         | 0.00012        | Pass       |
|                | 1.2000     | 1.2000     | 0.0000     | 0.0007         | 0.00012        | Pass       |
|                | 1.6000     | 1.5999     | -0.0001    | 0.0009         | 0.00012        | Pass       |
|                | 1.9000     | 1.8999     | -0.0001    | 0.0011         | 0.00012        | Pass       |
| 20 Volt        | 19.000     | 18.999     | -0.001     | 0.011          | 0.0012         | Pass       |
| 200 Volt       | 190.00     | 189.99     | -0.01      | 0.14           | 0.012          | Pass       |
| Resistance     | MOhm       | MOhm       | MOhm       | MOhm           | MOhm           |            |
| 20 GOhm        | 110        | 110        | 0          | 4              | 1.2            | Pass       |
| 2 GOhm         | 100.0      | 100.1      | 0.1        | 1.6            | 0.16           | Pass       |
| 200 MOhm       | 100.00     | 100.01     | 0.01       | 0.31           | 0.10           | Pass       |
| 20 MOhm        | 10.000     | 10.002     | 0.002      | 0.026          | 0.0012         | Pass       |
| 2 MOhm         | 1.0000     | 0.9999     | -0.0001    | 0.0026         | 0.00012        | Pass       |
|                | kOhm       | kOhm       | kOhm       | kOhm           | kOhm           |            |
| 200 kOhm       | 100.00     | 100.00     | 0.00       | 0.26           | 0.012          | Pass       |
| 20 kOhm        | 10.000     | 10.001     | 0.001      | 0.016          | 0.0017         | Pass       |
| 2 kOhm         | 1.0000     | 1.0007     | 0.0007     | 0.00211        | 0.00010        | Pass       |