

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN
CALIBRATION PROCEDURE FOR
STRAIN GAGE SIMULATOR
ARREL ENTERPRISES, MODEL SGS-300

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*This bulletin supersedes TB 9-6695-299-50, dated 4 February 1993.

SECTION I IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Strain Gage Simulator, Arrel Enterprises, Model SGS-300. The manufacturer's manual and MIS-38934 were used as the prime data sources in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. None.

b. Time and Technique. The time required for this calibration is approximately 2 hours, using the dc and low frequency technique.

2. Forms, Records, and Reports. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25. Appendix A contains a duplicate copy of table 3 and appendix B a sample calibration test report.

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Linearity	Range: Variable from 100% to 0% of 3 mV per volt (of input) in increments of 10% per step Accuracy: ± 25 ppm of FS (100%)

SECTION II EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Reference Calibration Standards Set NSN 4931-00-621-7878. Alternate items may be used by the calibrating activity. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. The accuracies listed in table 2 provide a two-to-one ratio between the standard and TI. Where the two-to-one ratio cannot be met, the two-to-one accuracy will be listed and the actual accuracy of the equipment selected is shown in parenthesis.

5. Accessories Required. The accessories required for this calibration are common usage accessories issued as indicated in paragraph 4 above and are not listed in this calibration procedure.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)																																																
CALIBRATOR	Dc volts: Range: 15.0 V (nominal) Accuracy: ±25 ppm	John Fluke, Model 5700A/CT (p/o MIS-35947)																																																
DC REFERENCE STANDARD	Range: 10 V Accuracy: Test report	John Fluke, Model 732A (732A)																																																
MULTIMETER	Range: 0 to 45 mV dc Resolution: 10 nV Accuracy: +(ppm) <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Nominal voltage input (mV)</th> <th colspan="2">Accuracy</th> </tr> </thead> <tbody> <tr> <td>0</td> <td></td> <td>N/A</td> <td></td> </tr> <tr> <td>4.5</td> <td></td> <td>124</td> <td></td> </tr> <tr> <td>9.0</td> <td></td> <td>62</td> <td></td> </tr> <tr> <td>13.5</td> <td></td> <td>46</td> <td></td> </tr> <tr> <td>18.0</td> <td></td> <td>31</td> <td></td> </tr> <tr> <td>22.5</td> <td></td> <td>25</td> <td>(26)</td> </tr> <tr> <td>27.0</td> <td></td> <td>21</td> <td>(22)</td> </tr> <tr> <td>31.5</td> <td></td> <td>18</td> <td>(19)</td> </tr> <tr> <td>36.0</td> <td></td> <td>16</td> <td>(17)</td> </tr> <tr> <td>40.5</td> <td></td> <td>14</td> <td>(16)</td> </tr> <tr> <td>45.0</td> <td></td> <td>N/A</td> <td></td> </tr> </tbody> </table>	Nominal voltage input (mV)		Accuracy		0		N/A		4.5		124		9.0		62		13.5		46		18.0		31		22.5		25	(26)	27.0		21	(22)	31.5		18	(19)	36.0		16	(17)	40.5		14	(16)	45.0		N/A		Hewlett Packard 3458A/E02 (MIS-35947/1 Type 2)
Nominal voltage input (mV)		Accuracy																																																
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4.5		124																																																
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36.0		16	(17)																																															
40.5		14	(16)																																															
45.0		N/A																																																
RESISTANCE STANDARD	Range: 10 kΩ Accuracy: Test report	General Radio, Type 1444A (MIS- 10400)																																																

'Utilizes manufacturer's 24-hour specifications.

SECTION III CALIBRATION PROCESS

6. Preliminary Instructions

- a. The instructions outlined in paragraphs 6 and 7 are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.
- b. Items of equipment used in this procedure are referenced within the text by common name as listed in table 2.
- c. Unless otherwise specified, verify the results of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Additional maintenance information is contained in the manufacturer's manual for this TI.
- d. Unless otherwise specified, all controls and control settings refer to the TI.

7. Equipment Setup

WARNING

HIGH VOLTAGE is used or exposed during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions. REDUCE OUTPUT(S) to minimum after each step within the performance check where applicable.

a. Utilizing the dc reference standard and resistance standard, characterize multimeter to obtain 24-hour manufacturer specifications.

NOTE

If ambient temperature drifts more than 1 degree Celsius prior to completing paragraph 8 below, the characterization and paragraph 8 below must be repeated.

b. Configure multimeter as listed in (1) through (6) below:

(1) **DCV.**

(2) **RANGE AUTO.**

(3) **NDIG 8.**

(4) **NLPC 200.**

(5) **Trig SGL.**

(6) **Guard** pushbutton to **Open** (released).

c. Connect high quality test leads to TI as illustrated in figure 1.

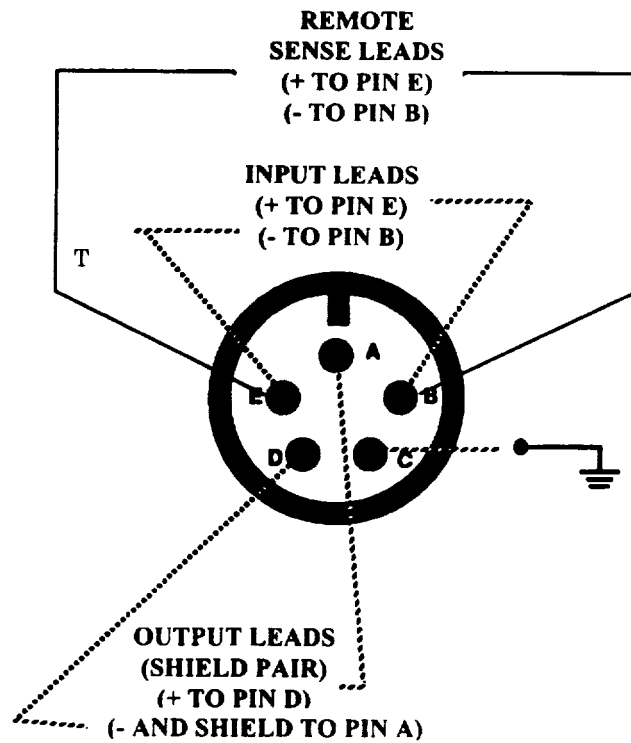


Figure 1. Test instrument rear connector - pin connections.

8. Linearity

a. Performance Check

- (1) Connect equipment as shown in figure 2, except do not connect TI input leads to calibrator OUTPUT.

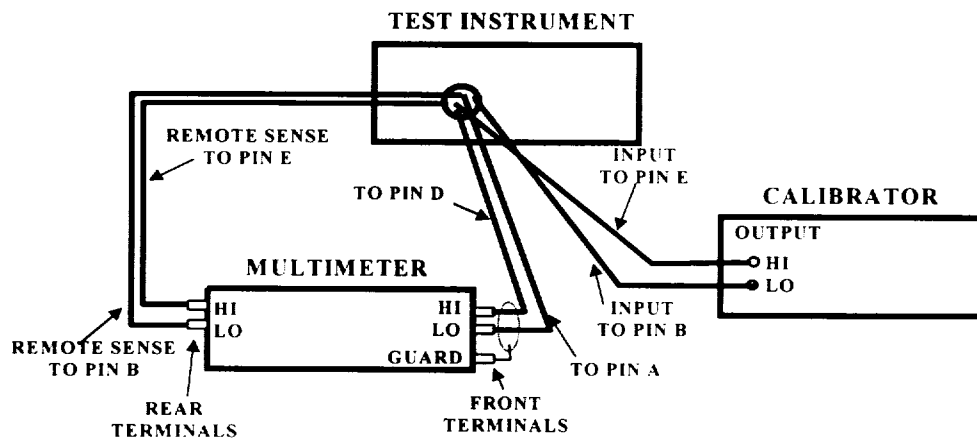


Figure 2. Equipment connections.

(2) Set TI **POLARITY** switch to + and **OUTPUT SIGNAL** dial to **100** then short input leads together (using alligator clip). Allow 1 to 3 minutes for thermal stabilization, then execute multimeter **MATH NULL** and **TRIG** functions, to store multimeter indication in the offset register.

(3) Connect TI input leads to calibrator **OUTPUT** as shown in figure 2.

(4) Set calibrator for an initial 15 V dc output then adjust calibrator for a 0.04500000 V (± 10 digits) indication on multimeter for the front panel terminals. Allow approximately 30 minutes for stabilization. (Multimeter may be set to **TRIG AUTO** and **NPLC 20** for this step).

NOTE

Stabilization time may vary. Prior to performing steps (6) through (8) below, ensure that multimeter will maintain the 0.04500000 V (± 10 digits) indication for approximately 5 minutes. This should be sufficient time to take and record required measurements.

(5) Readjust calibrator to maintain the 0.04500000 (± 10 digits) multimeter indication. (Ensure multimeter is returned to settings in **7b** above before proceeding with (6) below.)

(6) Press calibrator **NEW REF** pushbutton. Press the terminal pushbutton on the multimeter to rear and execute the **TRIG** function to determine the input voltage at the test instrument using the remote sense leads. Record the multimeters displayed value in table 3, section A, as V_{IN} (+100 percent).

(7) Set **OUTPUT SIGNAL** dial to settings specified in table 3, section A. At each dial position, take a measurement with multimeter with the terminal switch set to the front. Record multimeter indications in table 3, section A. Multimeter indications will be within the limits specified.

(8) Set TI **OUTPUT SIGNAL** dial back to 100 and measure output. If multimeter indication is not 0.04500000 (± 10 digits), repeat (5) through (7) above.

(9) Repeat (1) through (8) above with the **POLARITY** switch set to the position.

Record measurement results in table 3, section B.

b. Adjustments. No adjustments can be made.

Table 3. Linearity

SECTION A			
$V_{IN} =$ _____	V (+100%)	VOLT = 0.045 V	
	Multimeter		
Test instrument OUTPUT SIGNAL	Indications	Limits (in V)	
dial settings	(in V)	Min	Max
100	+0.04500000		
90	_____	+0.04049888	+0.04050112
80	_____	+0.03599888	+0.03600112
70	_____	+0.03149888	+0.03150112
60	_____	+0.02699888	+0.02700112
50	_____	+0.02249888	-0.02250112
40	_____	+0.01799888	+0.01800112
30	_____	+0.01349888	+0.01350112
20	_____	+0.00899888	+0.00900112
10	_____	+0.00449888	+0.00450112
0	_____	-0.00000112	+0.00000112
SECTION B			
$V_{IN} =$ _____	V (-100%)	$V_{OUT} = 0.045V$	
	Multimeter		
Test instrument OUTPUT SIGNAL dial settings	Indications (in V)	Limits (in V)	
		Min	Max
100	-0.04500000		
90	_____	-0.04049888	-0.04050112
80	_____	-0.03599888	-0.03600112
70	_____	-0.03149888	-0.03150112
60	_____	-0.02699888	-0.02700112
50	_____	-0.02249888	-0.02250112
40	_____	-0.01799888	-0.01800112
30	_____	-0.01349888	-0.01350112
20	_____	-0.00899888	-0.00900112
10	_____	-0.00449888	-0.00450112
0	_____	-0.00000112	+0.00000112

9. Calibration Test Report

- a. A calibration test report is required for this TI.
- b. Calibration activities will maintain a case history file of test reports for the TI. The file will contain an accumulation of at least six of the most recent test reports.
- c. An example of calibration data to be annotated on the test report is in appendix B.
- d. Transcribe V_{IN} and multimeter indication data from table 3, sections A and B, to calibration test report.
- e. Calculate, and record, the mV/V value for the calibration test report, using the formula:

$$(V_{OUT} / V_{IN}) \times 1000 = \text{mV/V output}$$

Where: V_{OUT} = recorded multimeter indication from front terminals in volts
 V_{IN} = recorded multimeter indication from rear terminals in volts

10. Final Procedure

- a. Deenergize and disconnect all equipment.
- b. Annotate and affix DA label/form in accordance with TB 750-25.

**APPENDIX A
DUPLICATE TABLE 3**

SECTION A			
$V_{IN} =$ _____		$V (+100\%)$	
		$V_{OUT} = 0.045 V$	
		Multimeter	
Test instrument OUTPUT SIGNAL dial settings	Indications (in V)	Limits (in V)	
		Min	Max
100	+0.04500000		
90	_____	+0.04049888	+0.04050112
80	_____	+0.03599888	+0.03600112
70	_____	+0.03149888	+0.03150112
60	_____	+0.02699888	+0.02700112
50	_____	+0.02249888	-0.02250112
40	_____	+0.01799888	+0.01800112
30	_____	+0.01349888	+0.01350112
20	_____	+0.00899888	+0.00900112
10	_____	+0.00449888	+0.00450112
0	_____	-0.00000112	+0.00000112
SECTION B			
$V_{IN} =$ _____		$V (-100\%)$	
		$V_{OUT} = 0.045V$	
		Multimeter	
Test instrument OUTPUT SIGNAL dial settings	Indications (in V)	Limits (in V)	
		Min	Max
100	-0.04500000		
90	_____	-0.04049888	-0.04050112
80	_____	-0.03599888	-0.03600112
70	_____	-0.03149888	-0.03150112
60	_____	-0.02699888	-0.02700112
50	_____	-0.02249888	-0.02250112
40	_____	-0.01799888	-0.01800112
30	_____	-0.01349888	-0.01350112
20	_____	-0.00899888	-0.00900112
10	_____	-0.00449888	-0.00450112
0	_____	-0.00000112	+0.00000112

APPENDIX B

SAMPLE CALIBRATION TEST REPORT

SAMPLE CALIBRATION TEST REPORT		
Performing UIC: _____	Owner UIC: _____	
REPORT OF CALIBRATION FOR: Strain Gage Simulator, Arrel Enterprises, Model SGS-300, Serial No. _____		
CALIBRATION MEASUREMENT VALUES		
(positive) POLARITY switch positions		
Input voltage (V_{IN}) = _____ V		
OUTPUT SIGNAL dial positions	Measured output (V_{OUT}) (in V)	Calculated mV/V output'
100	+0.04500000	_____ mV/V
90	+ _____	_____ mV/V
80	+ _____	_____ mV/V
70	+ _____	_____ mV/V
60	+ _____	_____ mV/V
50	+ _____	_____ mV/V
40	+ _____	_____ mV/V
30	+ _____	_____ mV/V
20	+ _____	_____ mV/V
10	+ _____	_____ mV/V
0	+ _____	_____ mV/V

APPENDIX B - Continued

SAMPLE CALIBRATION TEST REPORT - CONTINUED

SAMPLE CALIBRATION TEST REPORT - CONTINUED		
(negative) POLARITY switch positions		
Input voltage (V _{IN}) = _____ V		
OUTPUT SIGNAL dial positions	Measured output (V _{OUT}) (in V)	Calculated mV/V output ¹
100	-0.04500000	_____ mV/V
90	-	_____ mV/V
80	-	_____ mV/V
70	-	_____ mV/V
60	-	_____ mV/V
50	-	_____ mV/V
40	-	_____ mV/V
30	-	_____ mV/V
20	-	_____ mV/V
10	-	_____ mV/V
0	-/+ _____	_____ mV/V

¹mV/V output = (V_{OUT} / V_{IN}) x 1000. Where V_{OUT} = measured output, V_{IN} = input voltage, percent = **OUTPUT SIGNAL** dial position (100 = 1.0, 90 = 0.9, etc.)

Under the conditions stated, the above measured and computed values are in error by no more than 25 ppm of full scale (dial setting of 100).

This calibration is traceable to and compatible with NIST measurements.

Calibration Report No: _____

Temperature: _____

Relative Humidity: _____

Date: _____

Calibrating Technician

Facility Chief

By Order of the Secretary of the Army:

Official:

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Secretary of the Army*
05261

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