FLUKE®
Calibration

742A Series

Resistance Standards

Instruction Manual

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Introduction

The 742A Series are small, light, rugged resistance standards. The standards require no temperature-controlled air or oil bath. The 742A Series are well suited for use as the following:

- Working standards
- Portable transfer standards
- Calibration support for the Fluke 5700A Calibrator

Stability and temperature coefficients of the 742A Series make them ideal for easy transport to and operation in any working environment within the range of 18 to 28 °C. The standards come with six-month and one-year uncertainty specifications. Depending on the accuracy required, a 742A can be recertified at intervals based on either specification.

Each 742A comes with a Report of Calibration and a rear panel label showing the measured value. The rear panel also has a Fluke Primary Standards Lab calibration label, labels that show temperature coefficient alpha and beta centered on 23 °C, and the standard's serial number.

Note

Refer to "How Temperature Correction Factors are Calculated," further on in this manual for definitions of alpha and beta.

Specifications

Table 1 lists specification for the available 742A Series Resistance Standards.

Table 1. 742A Series Resistance Standard Specifications

Model	Nominal Resistance at 23 °C	Time Stability		Calibration Uncertainty	Maximum Deviation from the 23 °C Value (18 to 28 °C)	Maximum Current (Voltage)	+1 PPM Error Adder When Current Exceeds the Following
		180 Day	1 Year				
742A-1	1 Ω	±5.0 ppm	±8.0 ppm	±1.0 ppm	3.0 ppm	500 mA (500 mV)	200 mA
742A-1.9	1.9 Ω	±5.0 ppm	±8.0 ppm	±1.0 ppm	3.0 ppm	200 mA (380 mV)	100 mA
742A-10	10 Ω	±5.0 ppm	±8.0 ppm	±1.0 ppm	3.0 ppm	100 mA (1 V)	20 mA
742A-100	100 Ω	±4.0 ppm	±6.0 ppm	±1.0 ppm	3.0 ppm	20 mA (2 V)	5 mA
742A-1 k	1 kΩ	±4.0 ppm	±6.0 ppm	±1.5 ppm	2.0 ppm	10 mA (10 V)	2 mA
742A-10 k	10 Ω	±2.5 ppm	±4.0 ppm	±1.0 ppm	1.5 ppm	3 mA (30 V)	600 µA
742A-19 k	19 Ω	±2.5 ppm	±4.0 ppm	±1.5 ppm	2.0 ppm	1.5 mA (28.5 V)	600 µA
742A-100 k	100 kΩ	±4.0 ppm	±6.0 ppm	±2.5 ppm	2.0 ppm	1 mA (100 V)	400 µA
742A-1 M	1 MΩ	±6.0 ppm	±8.0 ppm	±5.0 ppm	2.0 ppm	100 µA (100 V)	100 µA
742A-10 M	10 MΩ	±6.0 ppm	±9.0 ppm	±10.0 ppm	3.0 ppm	20 µA (200 V)	20 µA
742A-19 M	19 MΩ	±8.0 ppm	±10.0 ppm	±20.0 ppm	4.0 ppm	10 µA (190 V)	10 µA

General Specifications:

Accuracy: The initial resistance is trimmed to ±2 ppm of nominal. The measured value is printed on the rear panel.

Retrace Error (Hysteresis): 23 °C-18 °C-23 °C cycle: Negligible resistance shift
23 °C-28 °C-23 °C cycle: Negligible resistance shift
23 °C-0 °C-23 °C cycle: <2 ppm resistance shift
23 °C-40 °C-23 °C cycle: <2 ppm resistance shift

Operating Temperature Range: 23 ±5 °C

Storage Temperature Range: 0 to 40 °C

Report of Calibration: The report of calibration includes a table of resistance values in 0.5° increments from 18 to 28 °C.

Size: 8.6 cm H x 10.5 cm W x 12.7 cm L (including binding posts)
(3.4 in H x 4.15 in W x 5 in L (including binding posts))
Binding posts; 2.5 cm (1.0 in)

Weight: 0.68 to 0.91 kg (1.5 to 2.0 lbs), depending on model

Design and Construction Notes

The 742A Series are constructed of arrays of Fluke wirewound precision hermetically-sealed resistors. No adjustable resistors of any kind are used.

Each 742A is built with a temperature coefficient near zero at 23 °C. To further reduce errors caused by temperature changes, the binding posts are constructed of low-thermal emf material.

Features

Figure 1 shows a front panel view. Figure 2 shows a rear panel view. Table 2 describes binding post functions. Table 3 describes the rear panel labels.

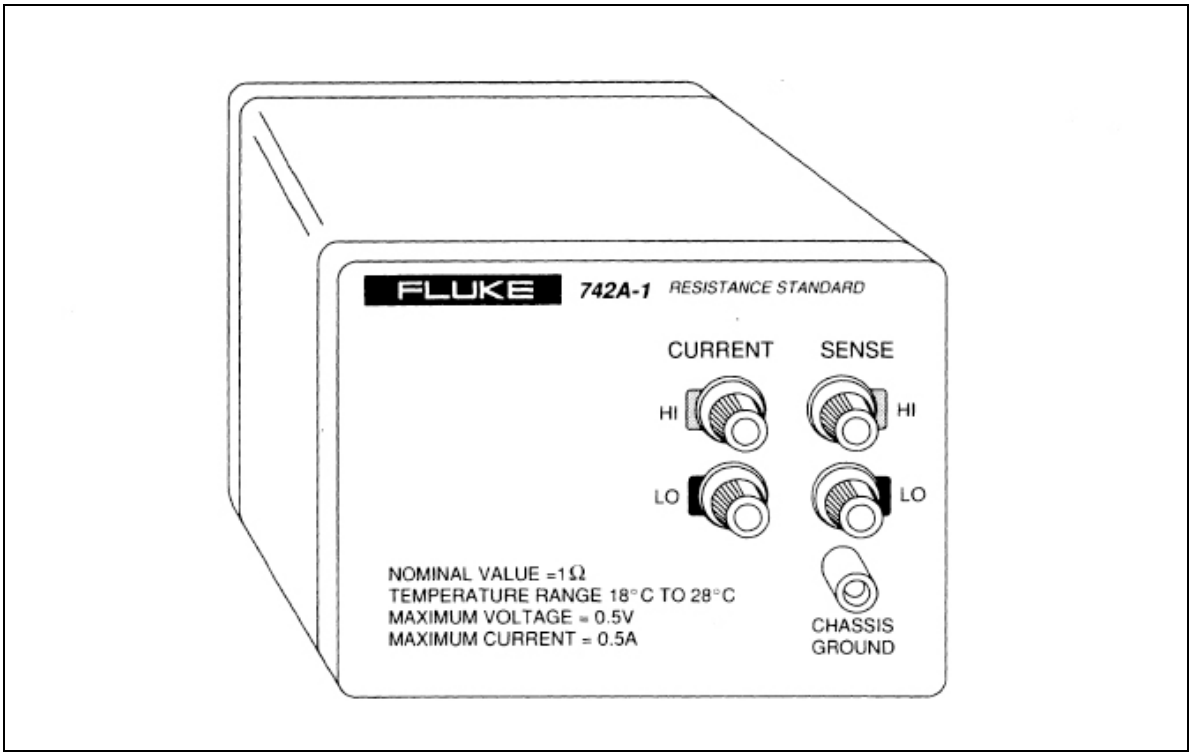

Figure 1. Typical Front Panel View

Table 2. Functions of the Binding Posts

742A Binding Post	Function
CURRENT HI	Input for the current source from an ohmmeter
CURRENT LO	Input for the current source from an ohmmeter
SENSE HI	Measurement point for a four-wire ohmmeter
SENSE LO	Measurement point for a four-wire ohmmeter
CHASSIS GROUND	Connected to the case for shielding

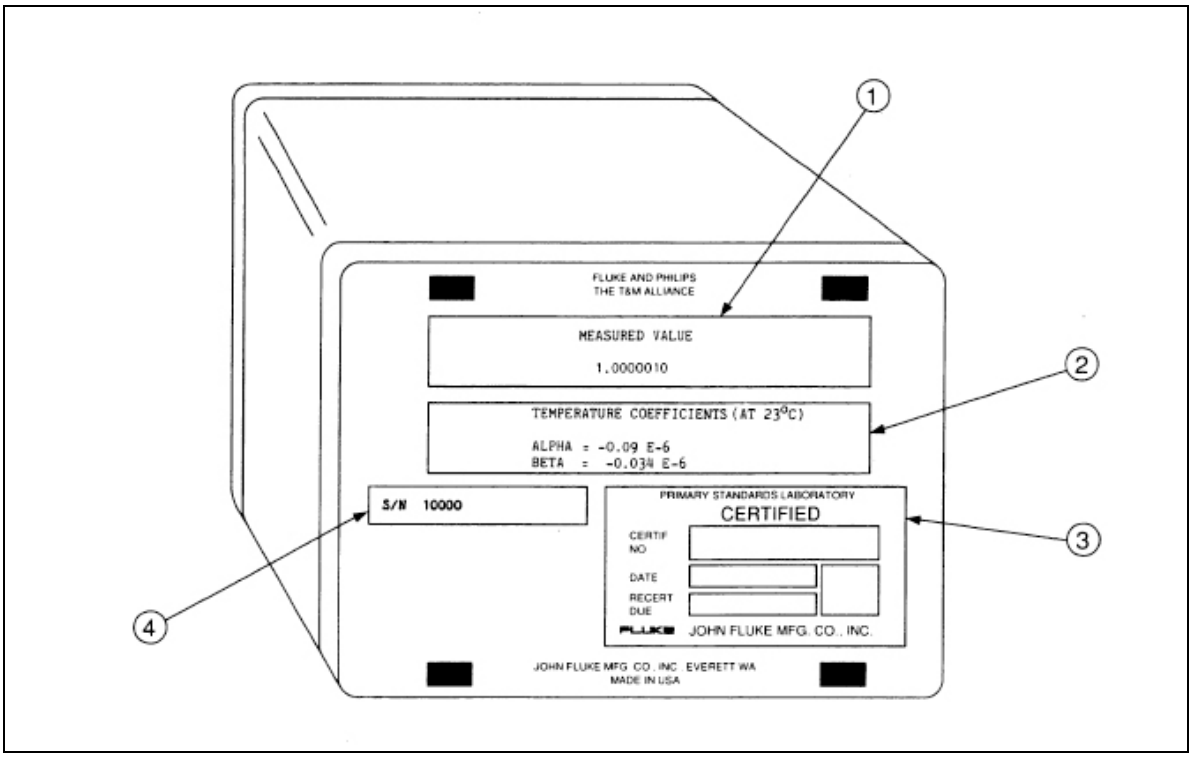

Figure 2. Typical Rear Panel View

Table 3. Contents of the Rear Panel Labels

Ref No.	Label Information
(1)	Measured value label. Shows the measured value at 23±0.6°; the same as on the Report of Calibration.
(2)	Temperature coefficient label. Shows alpha and beta centered on 23 °C. Refer to “How Temperature Correction Factors are Calculated,“ further on in this manual for definitions of alpha and beta, and the formula to predict exact resistance at different temperatures.
(3)	Fluke Primary Standards Lab Calibration Label documents traceability to the U.S. National Bureau of Standards.
(4)	Serial number label. Shows the standard’s serial number. This number and the full model number (i.e., 742A-1) positively identify a particular unit.

Operating Notes

This part of the manual explains operational and environmental considerations for the 742A Series. Follow these guidelines when operating or storing the resistance standard. Precautions for handling are under “Care and Maintenance.”

Connecting to the 742A Series

⚠ Caution

Do not apply voltages above the maximum voltage printed on the front panel. Excessive voltage can cause a permanent shift in resistance values or damage.

The specifications for models with CURRENT and SENSE binding posts require four-wire connections to the standard. Use these binding posts as described in Table 2.

For the case to act as a shield, the CHASSIS GROUND binding post must be connected to earth ground or instrumental guard at some point in a calibration system. Normally when two or more instruments with guards are connected together, the use of a single common grounding point avoids ground loops. If applicable, ground the 742A CHASSIS GROUND binding post to that common grounding point.

Figure 3 shows a typical connection to a four-wire ohmmeter. Figure 4 shows the connection used to calibrate the 1 Ω internal resistance standard in the 5700A.

Cable Recommendations

For optimum results, use two sets of the Fluke 5440A-7004 Low Thermal Test Leads, which are designed to reduce errors caused by thermal emfs.

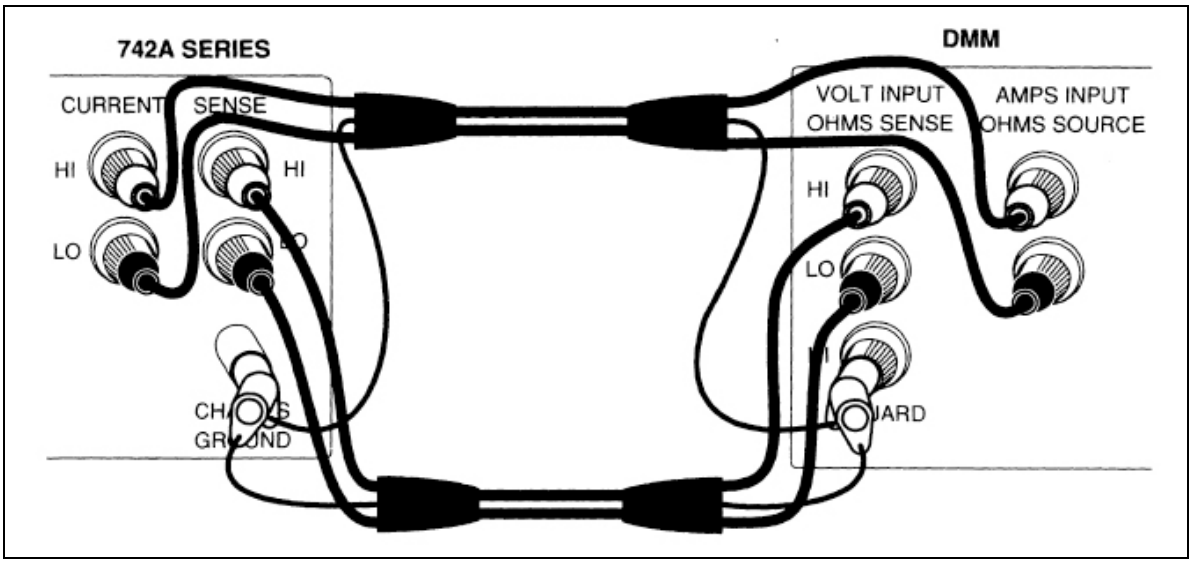

Figure 3. Connection to a Four-Wire Ohmmeter

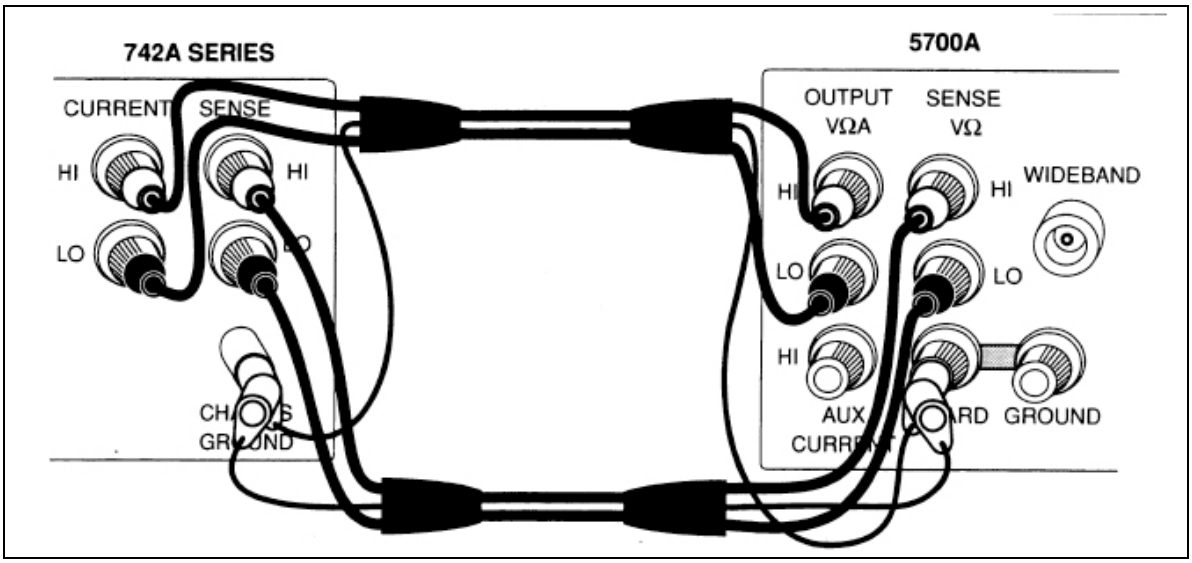

Figure 4. Connection to Calibrate the 5700A

Operating Temperature Range

You can use the 742A Series in ambient temperatures between 18 and 28 °C. To predict the deviation from the nominal at temperatures other than 23 °C, use the temperature characterization table provided with each unit. The table shows the calculated value and the deviation from nominal at temperatures between 18 and 28 °C in half-degree increments. An example of this table is included as Table 4.

How Temperature Correction Factors are Calculated

A label on the rear panel shows temperature coefficient factors alpha and beta centered on 23 °C. (See Figure 2 for the label location.) The values of alpha and beta are individualized for each 742A. Alpha and beta are established by measurement in the Fluke Primary Standards Lab at 18 °C, 23 °C, and 28 °C. The temperature characterization table is generated from these three measurements and the following formula:

$$R_t = R_{23}\,[1+\alpha\,(t-23)+\beta\,(t-23)^2]$$

Where, R_t = Resistance at t°C
R_{23} = Resistance at 23°C
α = Slope of the curve (ppm/°C) at 23°C
β = Rate of change of slope of the curve (ppm/°C^2)

α and β are constants which do not change appreciably over time and hence need to be determined only once.

In the case of the example 742A-1 used in this manual, α and β are calculated as follows:

$$\alpha = \frac{(R_{28}-R_{18})}{\Delta t} = \frac{-0.9\,E-6}{10} = -0.09\,E-6$$

$$\beta = \frac{\frac{(R_{28}+R_{18})}{2}-R_{23}}{\left(\frac{\Delta t}{2}\right)^2} = \frac{-0.85\,E-6}{25} = -0.034\,E-6$$

Where, R_{28} = Resistance at 28 °C
R_{18}= Resistance at 18 °C
R_{23}= Resistance at 23 °C
Δt= (28 – 18) = 10

Table 4. Example 742A-1 Temperature Characterization Chart

Test Number: XXXX — Serial No.: XXXXXX
Date: 04-Aug-88 — Alpha = -0.090 E-6
Page 2 of 2 — Beta = -0.034 E-6

Temp (Celsius)	Resistance (Ohms)	Dev from nominal (in ppm)
18.0	1.0000006	0.6
18.5	1.0000007	0.7
19.0	1.0000008	0.8
19.5	1.0000009	0.9
20.0	1.0000010	1.0
20.5	1.0000010	1.0
21.0	1.0000010	1.0
21.5	1.0000011	1.1
22.0	1.0000011	1.1
22.5	1.0000010	1.0
23.0	1.0000010	1.0
23.5	1.0000009	0.9
24.0	1.0000009	0.9
24.5	1.0000008	0.8
25.0	1.0000007	0.7
25.5	1.0000006	0.6
26.0	1.0000004	0.4
26.5	1.0000003	0.3
27.0	1.0000001	0.1
27.5	0.9999999	-0.1
28.0	0.9999997	-0.3

Figure 5 shows a graph of the value of the 742A-1 represented by the sample temperature characterization chart (Table 4). To illustrate use of the formula, calculations for resistance at 20 °C and 26 °C are shown. You can see that using the formula shown with alpha and beta you get the same value as in the characterization table.

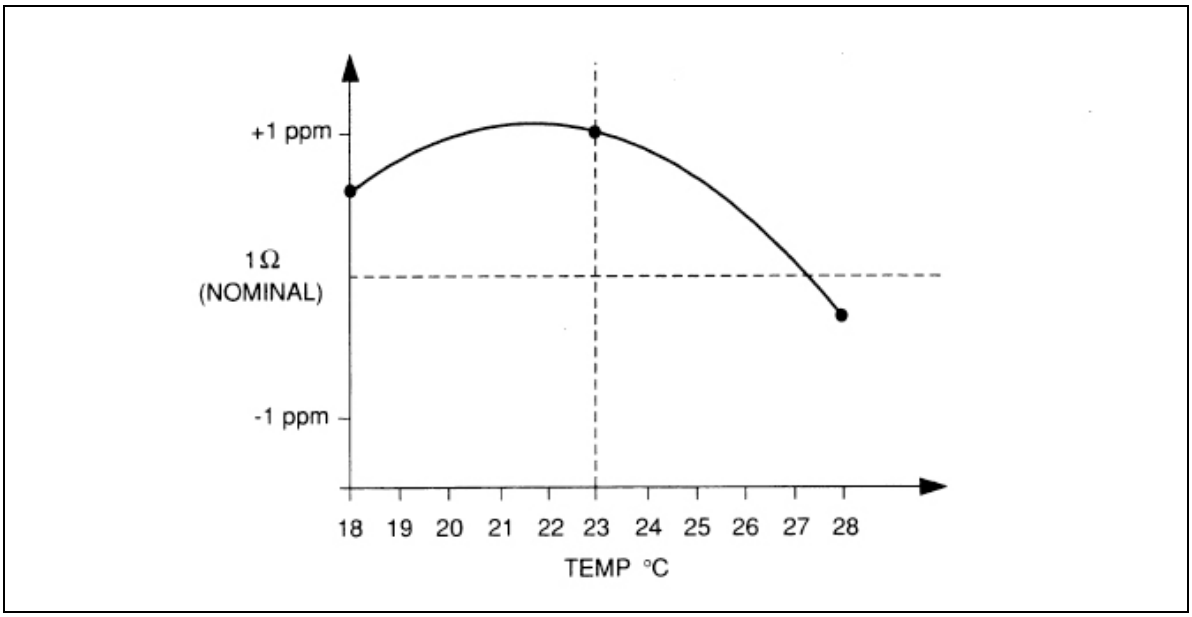

Figure 5. Graph of Resistance VS. Temperature for Sample 742A-1

R_t = R_{23} [1+ α (t - 23) + β $(t - 23)^2$]
At = 20 °C,
R_{20} = 1.00000010 [1 + (-0.09 E-6) (-3) + (-0.034 E-6) $(-3)^2$]
= 1.00000010 (1.0000003 – 0.0000003)
= 1.00000010 (1.0000000)
= 1.00000010 Ω

R_t = R_{23} [1+ α (t - 23) + β $(t - 23)^2$]
At = 26 °C,
R_{26} = 1.00000010 [1 + (-0.09 E-6) (3) + (-0.034 E-6) $(-3)^2$]
= 1.00000010 (1 - 0.0000003 – 0.0000003)
= 1.00000010 (1 - 0.0000006)
= 1.00000004 Ω

Storage Temperature Range

To maintain accuracy within the specified limits, do not subject the 742A Series to temperatures below 0 °C or above 40 °C. If exposure to temperatures outside this range is unavoidable, you can minimize the adverse effects by doing the following:

- Keep the standards in the optional transit case (Option 742A-7002). The transit case is insulated and helps protect the standards during short-term temperature extremes.
- Keep exposure to temperature extremes brief.

Care and Maintenance

The only maintenance procedure for the 742A Series is occasional cleaning. The following text gives cleaning instructions and precautions for handling.

Cleaning the 742A Series

To keep the 742A Series looking like new, clean the outer surfaces using a soft cloth slightly dampened with water or a non-abrasive mild cleaning solution that does not harm plastics.

⚠Caution

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They can damage the plastic materials used in the resistance standard.

Precautions for Handling

The 742A Series are designed for mechanical stability, but do not abuse the standard with excessive shock. Avoid temperature extremes as mentioned under “Storage Temperature Range”. When you transport the standard, it is recommended that you use the Option 742A-7002 Transit Case for shock and temperature protection. The case holds two 742A Series Resistance Standards.

Servicing Information

Because the 742A Series are certified and non-adjustable resistance standards, they are considered non-user repairable. If the unit is damaged, it must be returned to the factory for repair and calibration.

Recertification

For recertification, send the resistance standard to a Fluke technical center. For a nominal fee, Fluke will remeasure and recertify the value of our 742A based on comparison to standards traceable to the U.S. National Bureau of Standards. A new temperature characterization chart is provided on recertification. If you wish, you can record the changes at each recertification and use this data to more closely predict the performance of you 742A.