Standard Resistors Series
Databook
Standard Resistors
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New Stress-Free Ultra Stable Primary Standard Resistor

FEATURES

- Utilizing New Generation Stress Free Bulk Metal® Foil technology
- Long-term stability: 0.5 ppm/yr (0.2 ppm/yr typical)
- Temperature coefficient: less than ±0.05 ppm/°C at 23°C ±5°C
- Excellent humidity coefficient of resistance less than 0.1 ppm/% RH
- Excellent pressure coefficient of resistance less than 0.001 ppm/hPa
- Available wide range of resistance values at 1Ω, 10Ω, 25Ω, 100Ω, 1kΩ, 10kΩ

MASS

Approx. 2.5 kg (5.5 lbs)

DESCRIPTION

The USR-SF series is an ultra stable primary standard resistor which is an enhanced version of the USR/ASR series through the use of Bulk Metal® Foil technology.

The ultra stable resistive element utilizes new generation stress-free Bulk Metal Foil technology developed by Alpha Electronics with 37 years experience and is based on using proprietary Nickel Chrome alloy. This results in extremely low temperature coefficients as ±0.05 ppm/°C at 23°C ±5°C. This performance is unique to Alpha Electronics throughout the world.

The stress-free resistance element eliminates stress factors using a special treatment process and is encapsulated in a specially-designed ceramic case to protect against humidity and oxidation. Thus, less than 0.5 ppm/year (0.2 ppm/year typical) is realized.

Alpha's Bulk Metal Foil construction provides excellent AC characteristics—superior to performance of conventional wirewound standard resistors.

The USR-SF, with its extreme long-term stability and low TCR, can be used in air which reduces cost and operation for maintenance of oil bath.

SPECIFICATIONS

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<td>±2 ppm</td>
<td>±2.5 ppm</td>
<td>±0.05 ppm/°C</td>
<td>±0.5 ppm/°C</td>
<td>±0.5 ppm/yr</td>
<td>1.0 W</td>
<td>±1 ppm/°C</td>
<td>18–28 °C</td>
<td>0–50 °C</td>
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* Rated power will be different per future additional low values.

For any questions, contact sales-alpha@alpha-elec.co.jp
Primary Standard Resistor

FEATURES
• Excellent long-term stability of resistance, less than 3 ppm/year
• Low temperature coefficient, less than 0.2 ppm/°C
• The resistance value may be specified from 1Ω to 10 MΩ
• Excellent AC characteristics due to non-wirewound technology
• Compact and sturdy construction designed for easy operation and storage
• Certificate of Calibration and Inspection sheets traceable to NMIJ* are provided at shipment.
  *NMIJ: National Metrology Institute of Japan

MASS
Approx. 2.5 kg (5.5 lbs)

DESCRIPTION
The ASR series is an extremely stable standard resistor. Alpha’s Ni/Cr alloy Bulk Metal® Foil technology is used as the resistive element, providing high stability and low temperature coefficient. The process of building a standard resistor requires significant experience and a great degree of skill. Due to our long-term experience in developing and enhancing ultra stable Bulk Metal® Foil technology, we are able to provide products with consistency of performance under strict quality control.

With the extreme stability of this resistor relative to temperature change, the ASR can be used in air without oil bath or critical environmental temperature control eliminating added expense and maintenance problems.

The ASR is designed to be used in a broad range of environments—from a production floor for making precise measurements, to a corporate traceability system as a calibration and reference standard.

The resistors are mounted in a compact sturdy box with cover whose construction is designed to protect the resistor and terminals from any damages.

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<tbody>
<tr>
<td>ASR-1R0</td>
<td>1Ω</td>
<td>±5</td>
<td>±2.5 Ω at 23°C</td>
<td>±0.2 Ω at 0–23°C</td>
<td>±2 @ 23–50°C</td>
<td>±3</td>
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<td>±5</td>
<td>707</td>
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<td>±0.2 Ω at 0–23°C</td>
<td>±2 @ 23–50°C</td>
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<td>±1</td>
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<td>0–50</td>
<td>–10–60</td>
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<td>±2.5 Ω at 23°C</td>
<td>±0.2 Ω at 0–23°C</td>
<td>±2 @ 23–50°C</td>
<td>±3</td>
<td>0.1</td>
<td>±1</td>
<td>10.0</td>
<td>1.00</td>
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<td>0–50</td>
<td>–10–60</td>
<td>3</td>
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<tr>
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<td>1 kΩ</td>
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<td>±2.5 Ω at 23°C</td>
<td>±0.2 Ω at 0–23°C</td>
<td>±2 @ 23–50°C</td>
<td>±3</td>
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<td>±2 @ 23–50°C</td>
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<td>±0.2 Ω at 0–23°C</td>
<td>±2 @ 23–50°C</td>
<td>±3</td>
<td>0.1</td>
<td>±1</td>
<td>0.31</td>
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<td></td>
<td>0–50</td>
<td>–10–60</td>
<td>3</td>
</tr>
<tr>
<td>ASR-105</td>
<td>1 MΩ</td>
<td>±5</td>
<td>±2.5 Ω at 23°C</td>
<td>±0.2 Ω at 0–23°C</td>
<td>±2 @ 23–50°C</td>
<td>±3</td>
<td>0.1</td>
<td>±1</td>
<td>0.10</td>
<td>1000</td>
<td></td>
<td>0–50</td>
<td>–10–60</td>
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* Power=Power rating
CSR Series

Working Standard Resistor

FEATURES
- Usable in air without oil bath
- Wide resistance range available from 1 mΩ to 100 MΩ
- Excellent performance versus cost
- Terminals aligned in a single row for easier wiring and placement
- Certificate of Calibration and Inspection sheets traceable to NMIJ* are provided at shipment.
  *NMIJ: National Metrology Institute of Japan

MASS
Approx. 300g (0.66 lbs)

DESCRIPTION
The CSR series has Bulk Metal® Foil resistance elements, which have the same excellent stability and low temperature coefficient of resistance as the ASR series—a precision level that cannot be provided by any other resistance material. In addition, the CSR is designed for equal ease of use in the laboratory or on the production floor. Its construction is designed to give priority for portability and workability, being used in air without an oil bath.

CUSTOMIZED SPECIFICATIONS
Available for any customized resistance value. Contact to our sales department for more details.

SPECIFICATIONS

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<tr>
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<tr>
<td>CSR-1N0</td>
<td>1 mΩ</td>
<td>±100</td>
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<td>2.23</td>
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<td>0.31</td>
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<td>1.00</td>
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<td>5</td>
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<td>±1</td>
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<td>0.1</td>
<td>±0.01</td>
<td>0–50</td>
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<td>0.003</td>
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<td>0.001</td>
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<td>0.00001</td>
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www.alpha-elec.co.jp

For any questions, contact
sales-alpha@alpha-elec.co.jp

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Revision: 30-Mar-2015
High Power Standard Resistor

FEATURES
- For high power measurement
- Excellent long-term stability
- Compact size. Usable in air. Low temperature coefficient for small resistance values
- Temperature efficient design to control self-heating
- Certificate of Calibration and Inspection sheets traceable to NMIJ* are provided at shipment.
  *NMIJ: National Metrology Institute of Japan

MASS
Approx. 600g (1.3 lbs)

DESCRIPTION
The LSR series is developed to meet the requirements of high current / low resistance applications. Bulk Metal® Foil resistive elements are used to ensure the best long-term stability and lowest temperature coefficient is achieved.

The enclosure is made of perforated aluminum to allow effective temperature dissipation, especially under conditions of high electrical power.

The LSR can be used in air without oil bath or cooling unit, it is suitable for a wide range of applications, such as high precision measurements, calibration in corporate metrology labs, and a reference for precision power supplies, etc.

HIGH CURRENT OPTION
Ability to change terminal knobs for measuring the power up to 4W (63A) for 1 mΩ type (see the picture). Add P to the end of model number, when ordering.

Type: LSR-1N0P
The spacing between voltage terminals is 19.05 mm.

SPECIFICATIONS

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<td>1 mΩ</td>
<td>±100 ppm</td>
<td>±2.5 ppm</td>
<td>±20 W</td>
<td>±0.025 ppm/mW</td>
<td>0–50 °C</td>
<td>31.6 A</td>
<td>31.6 mV</td>
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<td>LSR-10N</td>
<td>10 mΩ</td>
<td>±50 ppm</td>
<td>±10 ppm</td>
<td>4 W</td>
<td>0–50 °C</td>
<td>20.0 A</td>
<td>200 mV</td>
<td>6.32 A</td>
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<tr>
<td>LSR-R10</td>
<td>100 mΩ</td>
<td>±25 ppm</td>
<td>4 W</td>
<td>±10 W</td>
<td>0–50 °C</td>
<td>6.32 A</td>
<td>632 mV</td>
<td>18–28 °C</td>
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CONFIGURATION in millimeters
Milliohm Meter Calibration Resistor

FEATURES
- Compact, lightweight, portable and easy to operate
- Excellent performance versus cost
- Resistive pattern designed to minimize difference performance between AC and DC
- Certificate of Calibration and Inspection sheets traceable to NMIJ* are provided only for DC operation at shipment
  *NMIJ: National Metrology Institute of Japan

MASS AND SIZE
- Mass: 150g (0.33 lbs)
- Size: 50 D × 44 H × 65 W mm

CUSTOMIZED SPECIFICATIONS
Available for any customized resistance value. Contact to our sales for more details.

DESCRIPTION
The MSR series is a standard resistor whose internal construction and terminals are designed to optimize AC characteristics and minimize the effect of thermo-electromotive force, respectively. The MSR is a compact suitable standard resistor for daily calibration of milliohm meters, etc. Although the MSR series is a low cost, easy to use product, it offers both high stability and low temperature coefficient. The MSR is most suitable as a standard resistor to be used on the job site.

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<td>MSR-1N0</td>
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<td>500</td>
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<td>±0.3</td>
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<td>0~50</td>
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<td>MSR-10N</td>
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<td>200</td>
<td>±10</td>
<td>±0.1</td>
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<td>3.16</td>
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## I/V Converter

### FEATURES
- Lightweight, compact size
- Full resistance range available from 1Ω to 100 kΩ

### DESCRIPTION
The ATV series is a current / voltage conversion adaptor to measure a current by using a voltage meter. It is small, lightweight, and attached directly to a voltage meter for ease of operation.

### SPECIFICATIONS

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<th>Accuracy</th>
<th>Temperature Coefficient</th>
<th>Max.Working Current</th>
<th>Power Rating</th>
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<td>ATV-1R0</td>
<td>1Ω</td>
<td>±0.1</td>
<td>±2.5</td>
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Precision Programmable Resistance Box
RTD Simulator

FEATURES
- Controllable by PC with GB-IB and RS232C interfaces
- Compact design
- Utilizing ultra precision Bulk Metal® Foil resistor
- Quick response capable of setting desired resistance in as fast as 100 ms
- Accuracy ≤0.01% +2 mΩ in 6½ digit readings
- Temperature coefficient of resistance ≤5 ppm/°C (>100Ω)
- Double electrical shielding protection against noise
- Interface specification open to users

MASS
Approx. 5 kg (11 lbs)

DESCRIPTION
The ADR Digital box is easy to set to any desired resistance value using a PC. The ADR Digital box realizes automated inspection to minimize inspection time while avoiding human error. The ADR Digital is the most efficient product for simulating input resistance values, and panel keys allow local-mode resistance value input. The JIS C1604/IEC60751 Pt thermometer table is stored in memory to facilitate entry of specific temperatures for specific resistance values in the Pt standard table.

Utilizing ultra precision Bulk Metal® Foil technology with very low Resistance Temperature Characteristics and excellent long-term stability assures high accuracy and high stability.

AVAILABLE PT STD OF TEMP INPUT
| IEC60751 | Pt100 | Pt200 | Pt300 | Pt500 | Pt1000 |

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>Min. Resistance Value</th>
<th>Max. Resistance Value</th>
<th>Resolution (Ω)</th>
<th>Accuracy</th>
<th>Max. Wattage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADR-3204GR</td>
<td>5.000Ω</td>
<td>1.999999 kΩ</td>
<td>0.001</td>
<td>±(0.01% +2 mΩ)</td>
<td>0.5W</td>
</tr>
<tr>
<td></td>
<td>2.00 kΩ</td>
<td>19.99999 kΩ</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20.0 kΩ</td>
<td>199.999 kΩ</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6-Dial Decade Resistance Box
RTD Simulator

FEATURES
- Accuracy ≤0.005% +2 mΩ
- Temperature coefficient of resistance ≤ 5 ppm/°C
- Long-term stability in resistance ≤50 ppm/year (storage life)
- Low contact resistance switch and three clip-typed contacts in parallel
- Low thermal EMF terminal
- Double electrical shielding protective against noise
- Utilizing Bulk Metal® Foil ultra precision resistance inside

MASS
Approx. 4.5 kg (10 lbs)

DESCRIPTION
The ultra precision resistors, the rotary switches, the output terminals and the double shielded construction are all features of the 6-Dial Decade Resistance Box with 6½ digit readings.

Resistors used in the 6-Dial Decade Resistance Box are ultra precision Bulk Metal® Foil resistors manufactured by Alpha Electronics Corp., assuring high stability over time and environment change. Rotary switches have very low contact resistance as three clip-typed contacts are connected in parallel. The three contacts assure higher mechanical reliability mechanically. Output terminals have very low thermal EMF, using rectangular wires of low thermal resistance material in a well-designed circuit configuration. Double shielded construction inhibits interference of environmental noise.

SPECIFICATIONS

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dial 1</td>
<td>Dial 2</td>
<td>Dial 3</td>
</tr>
<tr>
<td>ADR-6102M</td>
<td>0.10Ω</td>
<td>1.112120 kΩ</td>
<td>0.001</td>
<td>100</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>ADR-6103M</td>
<td>0.1Ω</td>
<td>11.11110 kΩ</td>
<td>0.1</td>
<td>100</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>ADR-6104M</td>
<td>0.1Ω</td>
<td>111.1110 kΩ</td>
<td>0.1</td>
<td>100</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>ADR-6105M</td>
<td>1Ω</td>
<td>1111110 Ω</td>
<td>1</td>
<td>100k</td>
<td>10k</td>
<td>1</td>
</tr>
<tr>
<td>ADR-6106M</td>
<td>10Ω</td>
<td>1111110 Ω</td>
<td>10</td>
<td>1M</td>
<td>100k</td>
<td>10k</td>
</tr>
</tbody>
</table>
1-Dial Resistance Box
RTD Simulator

FEATURES
• Up to 5-digit resistance values on switching contacts may be specified
• Improved work efficiency and elimination of careless mistakes
• Lightweight, compact size
• High precision, high stability

MASS
Approx. 1 kg (2.2 lbs)

TERMINALS AND CONTACTS
• Contacts: Max. 24
• Terminals: 2 to 5

DESCRIPTION
The ADR-1000 series is a standard resistor which is ideally suited for repetitive daily work, the resistance is easily switched from one value to another. This greatly improves work efficiency and helps to avoid careless mistakes, as compared with using a decade standard resistor (6-dial type).

Also suitable as RTD simulator for Pt related products and conductive meters.

The resistance elements utilize Bulk Metal® Foil technology and the connections to a rotary switch are made by using 4-terminal junctions. This ensures that high precision, high stability and low temperature coefficient are achieved.

PRODUCT MODEL NUMBER
ADR - *1xxx
*1xxx is our internal code which is determined at order receipt

NOMINAL VALUE, TOLERANCE, TEMPERATURE COEFFICIENT

<table>
<thead>
<tr>
<th>Resistance Value Range (Ω)</th>
<th>Tolerance (%)</th>
<th>Temperature Coefficient (ppm/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–1M</td>
<td>±0.02 ±0.05 ±0.1</td>
<td>0±2.5 0±5</td>
</tr>
</tbody>
</table>

Tolerance and temperature coefficient varies with resistance values. For detailed specifications, contact our sales office.

www.alpha-elec.co.jp

For any questions, contact
sales-alpha@alpha-elec.co.jp

Document No.: 67029
Revision: 15-Apr-2015
Resistance Transfer Standard

FEATURES

• Using Bulk Metal® Foil as a resistive element
• Usable in air without oil bath due to superior temperature coefficient
• Very tight matching accuracy
• Excellent long-term stability and usable as a standard resistor

MASS AND SIZE

• Weight: Approx. 3 kg (6.67 lbs)
• Size: 180 D × 70 H × 332 W mm

OPTIONS

• ATS-LC Lead Compensator
• ATS-SB Shorting Bar

DESCRIPTION

The ATS series is a resistance transfer standard to calibrate working standard resistors by using a primary standard. The ATS consists of the same 10 nominal value resistors connected in series known as Haymon bridge construction.

A maximum resistance ratio of 1:100 is obtainable in high precision, using either a lead compensator or a shorting bar. Configurations consist of from "10 resistors connected in parallel (1/10R)" to "10 resistors connected in series (10R)".

The ATS uses Bulk Metal® Foil technology as a resistive element, ensuring very tight matching accuracy.

The ATS can be used as a standard resistor due to the special features of Bulk Metal® Foil technology (low temperature coefficient and high stability).

SPECIFICATIONS

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ω</td>
<td>Ω/step</td>
<td>Absolute</td>
<td>Matching</td>
<td>Absolute</td>
<td>Tracking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ppm</td>
<td>ppm</td>
<td>ppm/ °C</td>
<td>ppm/ °C/yr</td>
<td>ppm/mW</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>ATS-1E1</td>
<td>1~100</td>
<td>10</td>
<td>±20</td>
<td>±5</td>
<td>±5</td>
<td>±2.5</td>
<td>±10</td>
<td>23 ±10</td>
<td>4 terminals</td>
</tr>
<tr>
<td>ATS-1E2</td>
<td>10~1k</td>
<td>100</td>
<td>±10</td>
<td>±5</td>
<td>±1</td>
<td>±1</td>
<td>±10/ element 100/unit</td>
<td>±0.1/ element</td>
<td></td>
</tr>
<tr>
<td>ATS-1E3</td>
<td>100~10k</td>
<td>1k</td>
<td>±10</td>
<td>±5</td>
<td>±1</td>
<td>±1</td>
<td>±10/ element 100/unit</td>
<td>±0.1/ element</td>
<td></td>
</tr>
<tr>
<td>ATS-1E4</td>
<td>1k~100k</td>
<td>10k</td>
<td>±10</td>
<td>±5</td>
<td>±1</td>
<td>±1</td>
<td>±10/ element 100/unit</td>
<td>±0.1/ element</td>
<td></td>
</tr>
<tr>
<td>ATS-1E5</td>
<td>10k~1M</td>
<td>100k</td>
<td>±20</td>
<td>±5</td>
<td>±1</td>
<td>±1</td>
<td>±10/ element 100/unit</td>
<td>±0.1/ element</td>
<td></td>
</tr>
<tr>
<td>ATS-1E6</td>
<td>100k~10M</td>
<td>1M</td>
<td>±10</td>
<td>±10</td>
<td>±1</td>
<td>±1</td>
<td>±10/ element 100/unit</td>
<td>±0.1/ element</td>
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</tr>
<tr>
<td>ATS-1E7</td>
<td>1M~100M</td>
<td>10M</td>
<td>±50</td>
<td>±10</td>
<td>±5</td>
<td>±1</td>
<td>±10/ element 100/unit</td>
<td>±0.1/ element</td>
<td></td>
</tr>
</tbody>
</table>
Custom Products

Products for Standard Resistors

ADR-7102KS
Dial Resistor with following functions
• 5-Dial, ultra low resistance (0Ω~111 mΩ, 0.01Ω~1 mΩ/step)
• 5-Dial variable shunt resistor (30A)
• 7-Dial variable shunt resistor (100 mΩ~11.111 mΩ, 1 mΩ/step)

ADS SERIES
National Standard Laboratory Level AC Shunt Standard Resistor
• Maxum ±5 ppm difference between AC operations @ 10 kHz and DC operations
  (Joint development with JEMIC: Japan Electric Meter Inspection Corp.)

AVR SERIES
DC Voltage Divider
• DC voltage divider which calibrates low range of a digital voltage meter
• Divide 50V by 1/1000 or 1/100 in ±0.001% accuracy

ATB SERIES
• Various custom resistance boxes
• Resistance box to calibrate ohm meters
• Linearity checker for resistance temperature meters
• Available any resistance value, specification
Custom Products

Products for Standard Resistors

**APS SERIES**
High Power Shunt Resistor
- Available for any current and resistance value
- Usable in air without any cooling system
- Max. working current available up to 1000A

**TYPE PZ**
AC Coaxial Shunt Resistor
- Coaxial construction for frequency characteristics
- Case has built-in heat sink for heat radiation

**TYPE PKA, PKB**
High Accuracy, High Power Shunt Resistor
- Shunt resistor with superior temperature coefficient
- Very low drift under high power usage

**TYPE HC, HD, HG**
Resistive Element
- Ultra precision/stable Bulk Metal® Foil hermetically sealed resistor
  * Calibration for resistance element is not available
Traceability Chart

National Standards

- AIST
  National Institute of Advanced Industrial Science and Technology (Japan)
- NPL
  National Physical Laboratory (UK)

Secondary Standards or Accredited Laboratory

- JEMIC
  Japan Electric Meters Inspection Corporation
- Accredited Laboratory

Reference Standards

- Standard Resistors
- Multi-function Calibrator
- Calibration System (DCCB)
- Resistance Transfer Standards

Measuring Instrument Calibration

- Working Standards
- Digital Multimeters
- Digital Resistance Meter

Calibration/Inspection

- Standard Resistor Calibration
  100 μΩ–1 GΩ
  (Air Type 23°C)
- Inspection of DC Resistance
  100 μΩ–100 MΩ
  Resolution: 5-1/2–7-1/2 digits

For any questions, contact sales-alpha@alpha-elec.co.jp

Document No.: 67034
Revision: 30-Mar-2015
Calibration/Calibration Room/Options

**CALIBRATION**
- Traceability chart
- Certificate of calibration
- Inspection sheet

**CALIBRATION LABORATORY**

**OPTIONS**

**TYPE AND APPLICATIONS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrying Case</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC-2000</td>
<td></td>
<td>Two ASR's</td>
</tr>
<tr>
<td>CC-3200GR</td>
<td></td>
<td>ADR Digital type</td>
</tr>
<tr>
<td>CC-6100</td>
<td></td>
<td>ADR 6-Dial type</td>
</tr>
<tr>
<td>CC-8000</td>
<td></td>
<td>Eight CSR's</td>
</tr>
<tr>
<td>Rack Mount Adapter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM-3200</td>
<td></td>
<td>ADR Digital type</td>
</tr>
<tr>
<td>AM-6100</td>
<td></td>
<td>ADR 6-Dial type</td>
</tr>
</tbody>
</table>

![Typical calibration room setup with equipment and technicians at work.]

![Close-up images of calibration equipment, including carrying cases and rack mount adapters.]

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For any questions, contact sales-alpha@alpha-elec.co.jp

www.alpha-elec.co.jp
Global Contact Map

Product and Contact Information

PRODUCT LISTING
Bulk Metal® Foil Ultra Precision Resistors
Precision Thin Film Resistors
Thermosensitive Resistors
Standard Resistors

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Germany:
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PRODUCT LISTING
Bulk Metal® Foil Ultra Precision Resistors
Precision Thin Film Resistors
Thermosensitive Resistors
Standard Resistors
VPG Brands

Foil Technology Products
Alpha Electronics  |  Micro-Measurements  |  Powertron  |  Vishay Foil Resistors

Force Sensors
VPG Transducers

Weighing and Control Systems
BLH Nobel  |  KELK  |  VPG Onboard Weighing

vpgsensors.com