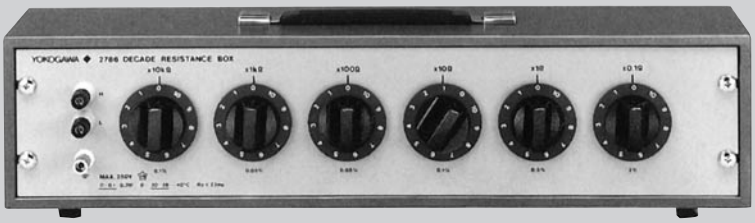
PRECISION MEASURING INSTRUMENTS

Standard Resistors

Decade Resistance Boxes



Decade Resistance Boxes

2792A Series
Standard Resistors

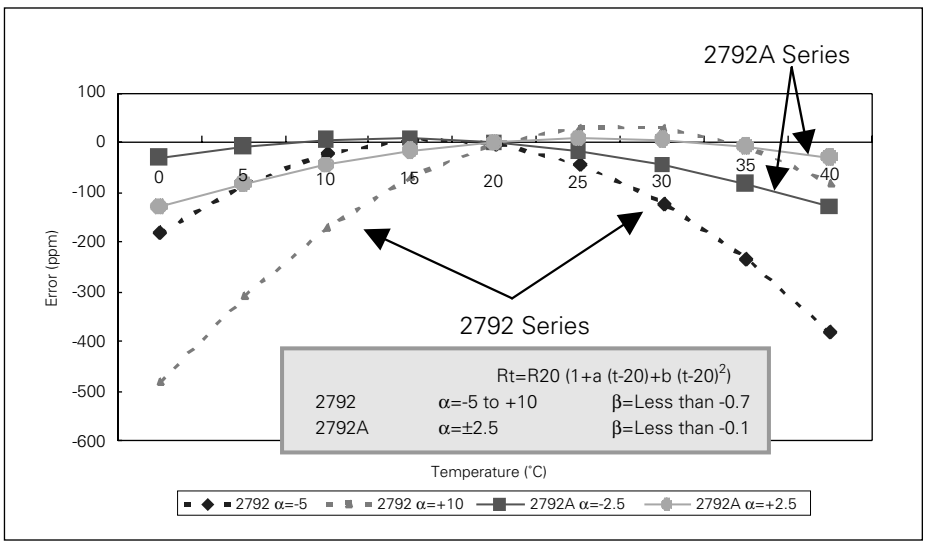
• **Accuracy 40% higher than our previous models! Temperature coefficient down 2/3!**

■ **Main Features**

- Traced to the national standard for high accuracy; test (calibrated) accuracy of ±5 ppm
- Resistance temperature coefficient
  Excellent temperature characteristics in the range of 0 -50°C; resistance temperature coefficient less than ±2.5 ppm/°C
- A variety of models
  Eight models with nominal resistance values ranging between 0.001 Ω and 10 kΩ
- Precision temperature control equipment, such as an oil bath, not needed for calibration due to marked improvement in resistance temperature coefficient
- Included document: Test certificate

The 2972A Series of standard resistors are metal foil resistors, while the previous 2972 Series were winding resistors. The error range of the 2972A Series is much smaller than those of the previous 2972 Series, as demonstrated by the resistance temperature coefficient curves (Graph 1). Precision temperature control equipment such as oil baths, are not needed for measurement and calibration. The 2972A can do these in an air environment.

At development sites, the 2972A serves many purposes, ranging from precision measurement to calibration of equipment. The main body of the 2972A employs the same plastic case as that of the previous series, and the 2972A has a damage-resistant and easy-to-connect terminal block. The 2972A can be even more effective in precision measurement when it is combined with our potentiometer and double bridge.



Graph 1 Error characteristics of the 2792 and 2792A Series with respect to temperature

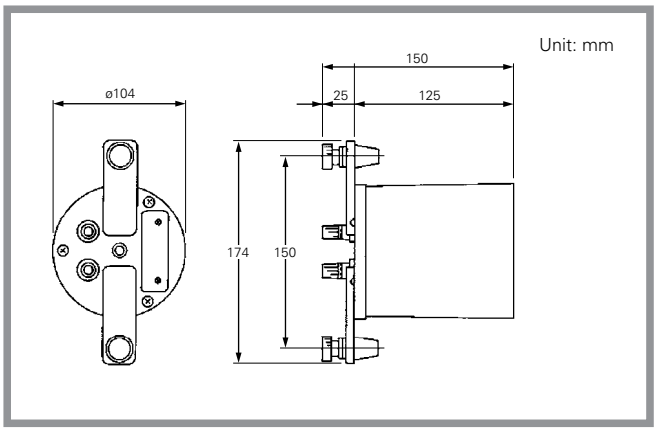
SPECIFICATIONS

Model	Nominal value	Accuracy 23°C±2°C	Temperature coefficient α23 (ppm/°C)	Temperature coefficient β(ppm/°C²)	Drift per year	Maximum allowable current (A)
2792A01	0.001 Ω	±100ppm	-5 to ±15	Less than -0.1	±100 ppm per year	54.7
2792A02	0.01 Ω	±75ppm	±10	Less than -0.1	±75 ppm per year	17.3
2792A03	0.1 Ω	±50ppm	±5	Less than -0.1	±50 ppm per year	5.47
2792A04	1 Ω	±30ppm	±2.5	Less than -0.1	±30 ppm per year	1.73
2792A05	10 Ω	±30ppm	±2.5	Less than -0.1	±30 ppm per year	0.547
2792A06	100 Ω	±30ppm	±2.5	Less than -0.1	±30 ppm per year	0.173
2792A07	1 kΩ	±30ppm	±2.5	Less than -0.1	±30 ppm per year	0.055
2792A08	10 kΩ	±30ppm	±2.5	Less than -0.1	±30 ppm per year	0.017

Standard test conditions: DC current, temperature: 23 ±2°C, power: below 0.1 W (2792A01) and below 0.01 W (2792A02-2792A08)

Operating temperature and humidity ranges
: 0-50°C / 20-80% RH
Storage temperature and humidity ranges
: -20-60°C / 20-80% RH
Maximum allowable power : 3 W
Test (calibrated) accuracy : ±5 ppm
Power characteristics : ±100 ppm/W
Insulation resistance : More than 1000 MΩ at 500 V DC
Withstand voltage : 1.5 kV for one minute between measurement terminal and casing
Terminal construction : 4 terminals
External dimensions : Approximately ø104 × 150 mm (current terminal width: approximately 174 mm)
Weight : Approximately 1.2 kg
Accessories : User'S Manual, One Test Certificate

• External Dimensions



OPERATING PRECAUTIONS

• Temperature

To maintain a high level of measurement accuracy, the Standard Resistor must be used in rooms with a constant ambient temperature or placed in a thermostatic chamber. Measure the ambient temperature accurately and perform compensation according to the temperature coefficient. Ensure that the instrument is not subjected to rapid changes in temperature during storage as changes in resistance or deterioration of the insulator may result. (Instrument can be operated stably for over two hours.)

• Temperature coefficients and resistance

The resistance at temperature *t* is expressed by the following equation:

$R_t = R_{23} \{1 + \alpha_{23}(t -23) + \beta(t -23)^2\}$

where

R_t : Resistance value at t˚C
R_{23}: Resistance value at 23˚C
α_{23}: 1st temperature coefficient at 23˚C
β : 2nd temperature coefficient at 0 to 50˚C

• Current

When electric current flows through the Standard Resistor, its resistance value changes due to the generated heat. To ensure accurate measurement, use the Standard Resistor below the maximum allowable current, which is one of the standard test conditions. When the applied current exceeds the maximum allowable current, the resistance could change, or the internal circuit could be broken.

• Thermal emf and Contact Resistance

To minimize the effects of thermal emf, connect the circuit with copper wire, and take the average of two readings obtained by reversing the direction of the current flowing through the current terminals. Incomplete contact between the lead wire and the terminals causes current change due to contact resistance, and temperature errors due to heat generation.

• Mechanical Shock and Vibration

Mechanical shock and vibration may cause distortion of the resistive elements, which results in instability and changes in the resistance value.

2793
Decade Resistance Boxes

279301
110 x 491 x 140 mm 4.8 kg
(4-3/8 x 19-3/8 x 5-1/2" 10.6lbs)

Model 2793 is a high-accuracy, stable DC variable resistor with 6 dials and is available in two styles: 279301 for medium resistance from 0.1 to 1,111.210Ω in 1mΩ steps (best suited for calibration of resistance thermometers or bridges); 279303 for high resistance from 0 to 111.1110 MΩ in 100Ω steps (suitable for calibration of insulation resistance testers or bridges).

279301

- **High accuracy and stability**
- **High reproducibility**
  Excellent reproducibility is obtainable because dial switches with low contact resistance are used. For example, changes in contact resistance is within ±1.1mΩ at 0.1Ω setting.
- **1mΩ resolution**
- **Simple, quick dial operation**
- **In-line display for easy reading**
- **Ideal for calibration of resistance thermometers and bridges**
  Due to its high accuracy and a dial system, various types of resistance thermometers and bridges can be calibrated accurately and promptly.
- **Excellent anti-shock and -vibration properties**

279303

- **Up to 100MΩ in 100Ω step**
- **Low voltage coefficient**
  Variation of the resistance value is less than ±0.1% at 1MΩ and 10MΩ steps against 100V application, and less than ±0.04% at 100Ω, 1kΩ, 10kΩ, and 100kΩ steps against 10V application.
- **Shock- and vibration-proof construction**
- **Easy-to-read in-line indication**
- **Best suited for calibration of insulation resistance testers and bridges**

SPECIFICATIONS

279301

Resistance Range: 0.100 to 1,111.210 Ω (Minimum resistance is 0.100Ω).
Dial Composition: 0.001Ω×10+0.01Ω×10+0.1Ω×11+1Ω ×10+10Ω×10+100Ω×10
Resolution: 0.001 Ω
Accuracy: ±(0.01% +2 mΩ) at temperature 23 ±2°C, humidity 45 to 75%, and 0.1 W power application
Max. Allowable Input Power: 0.25 W/step. Within 1 W for overall instrument.
Max. Allowable Input Current:
50 mA (100 Ω steps), 150 mA (10 Ω steps), 500 mA (1 Ω steps), and 1.5 A (0.1 Ω steps).
Insulation Resistance: More than 500 MΩ at 500 V DC between panel and circuit.
Dielectric Strength: 1,000 V AC for one minute between panel and circuit.
Temperature Coefficient:

Dial / Temperature coefficient	100 Ω step	10 Ω step	1 Ω step	0.1 Ω step
α_{20} (x 10^{-6}/°C)	−5 to +10	−5 to +20	Approx. 20 to 90	Approx. 90 to 900
β (x 10^{-6}/°C^2)	−0.3 to −0.7		—	—

Variation of resistance with temperature change is given by the following equation:

$$Rt = R_{20} [1 + \alpha_{20}(t - 20) + \beta (t - 20)^2]$$

where, Rt : Resistance value at t°C
R_{20} : Resistance value at 20°C

279303

Resistance Range: 0 to 111.1110 MΩ.
Dial Composition: 100 Ω x 10 + 1 kΩ x 10 + 10 kΩ x 10 + 100 kΩ x 10 + 1 MΩ x 10 + 10 MΩ x 10.
Accuracy: 100 Ω, 1 kΩ, 10 kΩ and 100 kΩ steps . . . ±(0.05% + 0.05 Ω)
1 MΩ and 10 MΩ steps . . . ±0.2%
(At temperature 23 ±2°C, humidity below 75%, including residual resistance of approx. 0.05Ω).
Max. Allowable Input:
100 Ω step . . . . . 100 mA
1 kΩ step . . . . . 30 mA
10 kΩ step . . . . . 10 mA
100 kΩ step . . . . . 3 mA (100 to 600 kΩ)
2,000 V (700 kΩ to 1 MΩ)
1 MΩ step . . . . . 2,000 V
10 MΩ step . . . . . 2,000 V
Temperature Coefficient:
100 Ω, 1 kΩ step . . . . . α_{20} = (−2 to +20) x 10^{-6}/°C
β = −(0.3 to 0.7) x 10^{-6}/°C^2
10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ step ±30 x 10^{-6}/°C
Variation of resistance with temperature change is given by the following equation:

$$Rt = R_{20} [1 + \alpha_{20}(t - 20) + \beta (t - 20)^2]$$

where, Rt : Resistance value at t°C
R_{20} : Resistance value at 20°C
Insulation Resistance: More than 10^{11} Ω at 1,000 V DC between panel and circuit.
Dielectric Strength: 2,500 V AC for one minute between panel and circuit.

2786
Decade Resistance Boxes

2786

116 x 497 x 120 mm 3.5 kg
(4-5/8 x 19-5/8 x 4-3/4" 7.7 lbs)

Models 278610 and 278620 six-dial decade resistance boxes allow quick and easy setting of a wide range of resistance. These resistance boxes are used in combination with voltage or current standards to adjust voltage or current, as dummy load resistances or as an arm of AC bridges.

SPECIFICATIONS

Available Models:

Model Number	Resistance Range
278610	0.1 to 111,111Ω (six decade dials)
278620	1 to 1,111,110Ω (six decade dials)

Residual Resistance: Less than 23mΩ.
Power Rating: 0.3W/step, within 3W for overall instrument.
Maximum Allowable Input: 0.5W/step, 5W for overall instrument.
Maximum Circuit Voltage: 250V.
Operating Temperature Range: 0 to 40°C (32 to 104°F).
Storage Temperature Range: −10 to 50°C (14 to 122°F).
Humidity Range: 25 to 85%, relative humidity.
Insulation Resistance: More than 500MΩ at 500V DC.
Dielectric Strength: 1,500V AC for one minute.

Accuracy and Temperature Coefficient (2786):

Step	Accuracy *1	Temperature Coefficient *2		Reference Data	
		α_{23} (x 10^{-6}/°C)	β (x 10^{-6} /°C^2)	Current Rating	Max. Allowable Input Current *3
0.1Ω	±2	±250	−0.4 to −0.8	1.7A	2.2A
1Ω	±0.5	±100	−0.4 to −0.8	550mA	710mA
10Ω	±0.1	±20	−0.4 to −0.8	170mA	220mA
100Ω	±0.05	±10	−0.4 to −0.8	55mA	71mA
1kΩ	±0.05	±10	−0.4 to −0.8	17mA	22mA
10kΩ	±0.1	±50	±0.1	5.5mA	7.1mA (10kΩ to 30kΩ) 250V (40kΩ to 100kΩ)
100kΩ	±0.1	±50	±0.1	250V (200kΩ to 1MΩ) 1.7mA (100kΩ)	250V

Notes:

*1. At standard reference conditions of 23±3°C ambient temperature, 45 to 75% humidity and less than 0.1W application.

*2. The resistance value at t°C can be expressed by the following equation:

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

Where, R_t : Resistance value at t°C.
R_{23} : Resistance value at 23°C.

*3. Within five minutes.

⚠NOTICE
● Before using the product, read the instruction manual carefully to ensure proper and safe operation

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YOKOGAWA TEST & MEASUREMENT CORPORATION
Global Sales Dept. /Phone: +81-42-690-8810 E-mail: tm@cs.jp.yokogawa.com
Facsimile: +81-42-690-8826

YOKOGAWA CORPORATION OF AMERICA	Phone: +1-800-888-6400	E-mail: tmi@us.yokogawa.com	
YOKOGAWA EUROPE B.V.	Phone: +31-88-4641429	E-mail: tmi@nl.yokogawa.com	
YOKOGAWA TEST & MEASUREMENT (SHANGHAI) CO., LTD.	Phone: +86-21-6239-6363	E-mail: tmi@cs.cn.yokogawa.com	Facsimile: +86-21-6880-4987
YOKOGAWA ELECTRIC KOREA CO., LTD.	Phone: +82-2-2628-3810	E-mail: TMI@kr.yokogawa.com	Facsimile: +82-2-2628-3899
YOKOGAWA ENGINEERING ASIA PTE. LTD.	Phone: +65-6241-9933	E-mail: TMI@sg.yokogawa.com	Facsimile: +65-6241-9919
YOKOGAWA INDIA LTD.	Phone: +91-80-4158-6396	E-mail: tmi@in.yokogawa.com	Facsimile: +91-80-2852-1442
YOKOGAWA ELECTRIC CIS LTD.	Phone: +7-495-737-7868	E-mail: info@ru.yokogawa.com	Facsimile: +7-495-737-7869
YOKOGAWA AMERICA DO SUL LTDA.	Phone: +55-11-3513-1300	E-mail: eproc@br.yokogawa.com	
YOKOGAWA MIDDLE EAST & AFRICA B.S.C(c)	Phone: +973-17-358100	E-mail: help.ymatmi@bh.yokogawa.com	Facsimile: +973-17-336100