

Grey Box

2M-2Z-10



Type 1432 DECADE RESISTORS

Type 510 DECADE-RESISTANCE UNITS

USES: Decade resistors are used in circuits where a wide range of resistance values is required or where variable dummy generator and load resistances are needed. The accuracy of General Radio decade resistors easily meets the requirements of these applications and also permits them to be used as laboratory standards and as ratio arms for direct- and alternating-current bridges. Although designed primarily for direct-current and audio-frequency work, many of the models are useful well into the radio-frequency range.

These resistors are available as assemblies of 4, 5, or 6 decades in cabinets for laboratory use, or as shielded single-decade units for building into experimental equipment, production-test instruments, bridges, and other permanent assemblies.

DESCRIPTION: Each TYPE 510 Decade-Resistance Unit is enclosed in an aluminum shield, and a knob and etched-metal dial plate are supplied. The assembly is also available complete except for resistors, as the TYPE 510-P3 and -P3L Switches.

The TYPE 1432 Decade Resistor is an assembly of TYPE 510 Decade-Resistance Units in a single cabinet. Mechanical as well as electrical shielding of the units and switch contacts is provided by the attractive aluminum cabinet and panel. The resistance elements have no electrical connection to the cabinet and panel, for which a separate shield terminal is provided.

Each decade has eleven contact studs and ten resistors, so that the dial values overlap. Positive detent mechanisms and bar-type knobs permit the operator to sense the position of the switches without looking at the panel. Each resistor is adjusted to be accurate within its specified tolerance at its terminals, so that resistance increments are accurate to that tolerance.

Winding methods are chosen to reduce the effects of residual reactances. The 1-ohm steps are Ayrton-Perry wound on molded phenolic forms especially shaped and heat treated to minimize aging effects. The 10- and 100-ohm steps are Ayrton-Perry wound on a form of silicone-fiber-glas laminate. The 0.01- and 0.1-ohm steps are straight wire and hairpin-shaped ribbon, respectively, while the 1000-, 10,000-, 100,000-, and 1,000,000-ohm steps are unifilar wound on thin mica cards.

FEATURES:

- ◆ Low zero resistance.
- ◆ High accuracy.
- ◆ Low temperature coefficient of resistance.
- ◆ Low thermal emf to copper.
- ◆ Resistors are adjusted so that resistance increments are always correctly indicated.
- ◆ Good frequency characteristics.
- ◆ Residual reactances are small and known.
- ◆ Excellent stability.
- ◆ Unaffected by high humidity.

SPECIFICATIONS

Accuracy of Adjustment: Each of the 10 resistors in each decade is adjusted to be accurate at its terminals within the tolerances given in the table. Resistance increments are accurate to this same tolerance.

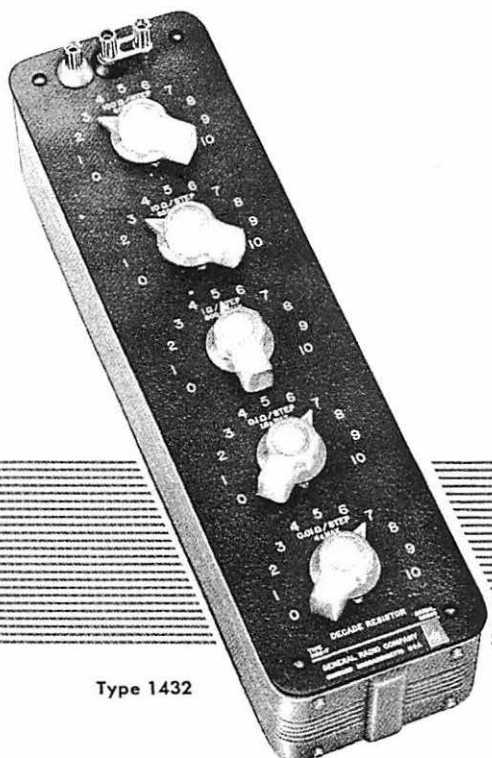
Total Resistance: The resistance at the decade terminals is the sum of the switch resistance (see below) and that indicated by the switch-setting.

Maximum Current: See table. Maximum current is engraved on panels or dial plates.

Frequency Characteristics: The accompanying plot shows the maximum percentage change in effective series resistance, as a function of frequency for the individual decade units. For low-resistance decades the error is due almost entirely to skin effect and is independent of switch setting, while for the high-resistance units the error is due almost entirely to the shunt capacitance and its losses and is approximately proportional to the square of the resistance setting.

The high-resistance decades (TYPES 510-E, -F, -G, and -H) are very commonly used as parallel resistance elements in resonant circuits, in which the shunt capacitance of the decades becomes part of the tuning capacitance. The parallel resistance changes by only a fraction, between a tenth and a hundredth, of the series-resistance change, depending on frequency and the insulating material in the switch.

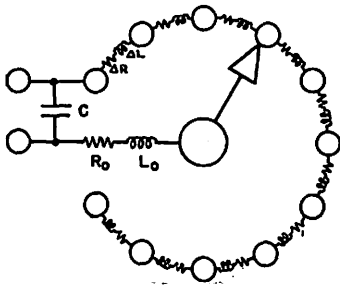
Characteristics of the TYPE 1432 Decade Resistors are similar to those of the individual TYPE 510 units, modified by the increased series inductance, L_s , and shunt capacitance, C , due to the wiring and the presence of more than one decade in the assembly. At total resistance settings of approximately 1000 ohms or less, the frequency characteristic of any of these decade resistors is substantially the same as those shown for the TYPE 510 units. At higher settings, shunt capacitance becomes the controlling factor, and the effective value of this capacitance depends upon the settings of the individual decades.



Type 1432

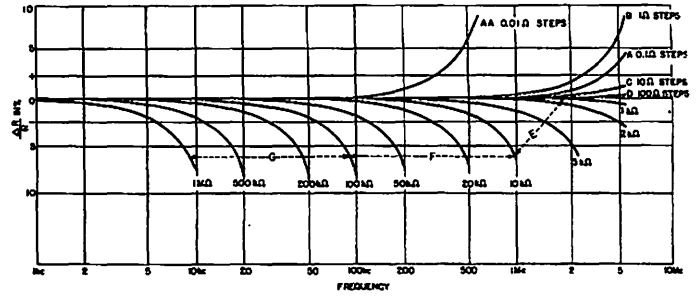


Type 510



(Left) Equivalent circuit of a resistance decade, showing location and nature of residual impedances.

(Right) Maximum percentage change in series resistance as a function of frequency for Type 510 Decade-Resistance Units.



Typical Values of R_0 , L_0 , and C for the Decade Resistors:

Zero Resistance (R_0): 0.002 ohm or less per dial at dc (0.001-ohm switch resistance and 0.001-ohm lead resistance); 0.04 ohm per dial at 1 Mc; proportional to square root of frequency at all frequencies above 100 kc.

Zero Inductance (L_0): 0.10 μ h per dial.

Effective Shunt Capacitance (C): This value is determined largely by the highest decade in use. With the low terminal connected to shield, a value of 15 to 10 pf per decade may be assumed, counting decades down from the highest. Thus, if the third decade from the top is the highest resistance decade in circuit (i.e., not set at zero) the shunting terminal capacitance is 45 to 30 pf. If the highest decade in the assembly is in use, the effective capacitance is 15 to 10 pf, regardless of the settings of the lower-resistance decades.

Temperature Coefficient of Resistance: Less than ± 20 ppm per degree Centigrade at room temperatures for the TYPE 510 Decade-Resistance Units and for the TYPE 1432 Decade Resistors, except for the 0.1- and 0.01-ohm decades, where the box wiring will increase the over-all temperature coefficient.

Switches: Quadruple-leaf brushes bear on lubricated contact studs $\frac{3}{8}$ inch in diameter. Both brushes and studs are of copper alloy. These brushes are bent so as not to be tangent to the arc of travel, thus avoiding cutting and affording a good wiping action. A cam-

type detent is provided. There are eleven contact points (0 to 10 inclusive). The switch resistance is less than 0.001 ohm. The effective capacitance of the switch is of the order of 5 pf, with a dissipation factor of 0.06 at 1 kc for the standard cellulose-filled molded phenolic switch form and 0.01 for the mica-filled phenolic form used in the TYPE 510-G unit.

Terminals: For TYPE 1432, jack-top binding posts on standard $\frac{3}{4}$ -inch spacing. Shield terminal is provided. TYPE 510 units have soldering lugs.

Mounting: TYPE 1432, lab bench cabinet; TYPE 510, complete with dial plate, knob, template, and mounting screws.

Dimensions: TYPE 1432 — width 4 $\frac{5}{16}$ inches (110 mm), height 4 $\frac{3}{4}$ inches (120 mm); length 13 inches (330 mm) for 4-dial, 15 $\frac{3}{4}$ inches (400 mm) for 5-dial, and 18 $\frac{1}{4}$ inches (470 mm) for 6-dial box. TYPE 510 — over-all diameter 3 $\frac{1}{16}$ inches (78 mm), depth behind panel 3 $\frac{5}{16}$ inches (85 mm).

Net Weight: TYPE 1432 — 5 pounds, 4 ounces (2.4 kg) for 4-dial; 6 pounds, 5 ounces (2.9 kg) for 5-dial; and 7 pounds, 8 ounces (3.4 kg) for 6-dial box. TYPE 510 units — 11 ounces (310 grams); TYPE 510-P switches — 9 $\frac{1}{2}$ ounces (270 grams).

Shipping Weight: TYPE 1432 — 7 pounds (3.2 kg) for 4- and 5-dial, 9 pounds (4.1 kg) for 6-dial box. TYPE 510 units and switches, 2 pounds (1.0 kg).

Type	Total	Multiple of	No. of Dials	Type 510 Decades Used	Code Number
1432-U	111.1 ohms	0.01 ohm	4	AA, A, B, C	1432-9721
1432-K	1111	0.1	4	A, B, C, D	1432-9711
1432-J	11,110	1	4	B, C, D, E	1432-9710
1432-L	111,100	10	4	C, D, E, F	1432-9712
1432-Q	1,111,000	100	4	D, E, F, G	1432-9717
1432-T	1111.1	0.01	5	AA, A, B, C, D	1432-9720
1432-N	11,111	0.1	5	A, B, C, D, E	1432-9714
1432-M	111,110	1	5	B, C, D, E, F	1432-9713
1432-P	1,111,100	10	5	C, D, E, F, G	1432-9716
1432-Y	11,111,000	100	5	D, E, F, G, H	1432-9725
1432-X	111,111	0.1	6	A, B, C, D, E, F	1432-9724
1432-Z	11,111,100	10	6	C, D, E, F, G, H	1432-9726

Type	Total Resistance Ohms	Resistance Per Step (ΔR) Ohms	Accuracy of Resistance Increments	Maximum Current 40° C Rise	Power Per Step Watts	ΔL μ h	C^{**} pf	L_0 μ h	Code Number
510-AA	0.1	0.01	$\pm 2\%$	4 amp	0.16	0.01	7.7-4.5	0.023	0510-9806
510-A	1	0.1	$\pm 0.5\%$	1.6 amp	0.25	0.014	7.7-4.5	0.023	0510-9701
510-B	10	1	$\pm 0.15\%$	800 ma	0.6	0.056	7.7-4.5	0.023	0510-9702
510-C	100	10	$\pm 0.05\%$	250 ma	0.6	0.11	7.7-4.5	0.023	0510-9703
510-D	1000	100	$\pm 0.05\%$	80 ma	0.6	0.29	7.7-4.5	0.023	0510-9704
510-E	10,000	1000	$\pm 0.05\%$	23 ma	0.5	3.3	7.7-4.5	0.023	0510-9705
510-F	100,000	10,000	$\pm 0.05\%$	7 ma	0.5	9.5	7.7-4.5	0.023	0510-9706
510-G	1,000,000	100,000	$\pm 0.05\%$	2.3 ma	0.5	—	7.7-4.5	0.023	0510-9707
510-H	10,000,000	1,000,000	$\pm 0.025\%$	0.7 *ma	0.5	—	13.5-5.0	0.023	0510-9708
510-P3	Switch only	(Black Phenolic Frame)							0510-9603
510-P3L	Switch only	(Low-Loss Phenolic Frame)							0510-9833

* Or a maximum of 4000 volts, peak.

** The larger capacitance occurs at the lowest setting of the decade. The values given are for units without the shield cans in place. With the shield cans in place, the shunt capacitance is from 10 to 20 pf greater than indicated here, depending on whether the shield is tied to the switch or to the zero end of the decade.