ALLEN-BRADLEY CO.

ELECTRONIC COMPONENTS

ALLEN-BRADLEY CO.

ELECTRONIC COMPONENTS

SALES and SERVICE *in all Principal Cities*

ALABAMA
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(Moulthrop & Hunter)

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Tampa 9 ..... 1521 South Dale Mabry Highway ..... Tel. 8-3632

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Rockford ..... 1013 Broadway ..... WOodland 5-8795

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Indianapolis 7 ..... 1491 N. Harding Street ..... MElrose 8-1491

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Davenport ..... Mail: P.O. Box 223, Bettendorf, Ia. ..... Tel. 5-1294
Des Moines 9 ..... 1112 Locust St. ..... ATlantic 8-5721

KENTUCKY
Louisville 17 ..... 2209 S. Floyd St. ..... MElrose 7-3603

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Springfield 3 ..... 172 Chestnut St. ..... REpublic 2-3430

MICHIGAN
Detroit 12 ..... 6750 E. Davison Ave. ..... TWinbrook 3-7500
Flint 4 ..... 829 Stockdale ..... CEdar 2-9341
Grand Rapids 2 ..... 314 Straight, S. W. ..... GLendale 4-1825
Kalamazoo 22 ..... 2519 Lake Street ..... FIreside 4-6163

MINNESOTA
Minneapolis 4 ..... 1302 Fifth Avenue South ..... FEderal 6-6659
(Irvin I. Aaron & Assoc., Inc.)

MISSOURI
Kansas City 8 ..... 1819 Central Street ..... HArrison 1-1668
Saint Louis 6 ..... 904 N. Grand Blvd. ..... JEfferson 5-1901

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East Orange ..... 350 Main Street ..... ORange 2-9693

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New York 17 ..... 630 Third Ave. ..... MUrray Hill 2-6070
Rochester 4 ..... 241 East Avenue ..... BAker 5-7510
Syracuse 3 ..... 820 E. Water Street ..... GRanite 6-2141

NORTH CAROLINA
Charlotte 3 ..... 307 Lincoln Street ..... EDison 4-6334

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Cincinnati 2 ..... 2331 Reading Road ..... UNiversity 1-4445
Cleveland 15 ..... 3416 Prospect Ave. ..... EXpress 1-2855
Dayton 29 ..... 3070 Far Hills Ave. ..... AXminster 8-6121
Toledo 13 ..... 1922 Sylvania Ave. ..... GReenwood 5-2700

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Tulsa 10 ..... 1526 E. Fourth St. ..... DIamond 3-9149

OREGON
Portland 14 ..... 1004 S.E. Belmont Street ..... BElmont 2-1188

PENNSYLVANIA
Erie ..... 1045 W. 26th Street ..... Tel. 4-4966
Philadelphia ..... Mail: 235 Fairfield Ave., Upper Darby, Pa. ..... SH 8-0943
Pittsburgh 16 ..... 2721 W. Liberty Ave. ..... Fieldbrook 1-2822
York ..... 653 W. Market Street ..... Tel. 82-239

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Knoxville 17 ..... 1311-C N. Broadway ..... Tel. 4-2513
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Houston 3 ..... 2105 McKinney Ave. ..... CApitol 5-0747

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Salt Lake City 10 ..... 1482 Major Street ..... INgersoll 7-5489

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Richmond 22 ..... 2016 Second Ave. ..... MIlton 3-8529

WASHINGTON
Seattle 1 ..... 2605 Western Ave. ..... MUtual 2-7444

WEST VIRGINIA
Charleston 1 ..... 918 Kanawha Blvd., E. ..... DIckens 3-1393

WISCONSIN
Milwaukee 4 ..... 224 W. Greenfield Avenue ..... ORchard 1-2000
Milwaukee 2 ..... 829 North Marshall Street ..... BRoadway 6-8515
(Irvin I. Aaron & Assoc., Inc.)

EXPORT
Allen-Bradley Co. ..... 630 Third Ave., N.Y.C. 17 ..... MUrray Hill 2-6070

CANADA
Galt, Ontario ..... 135 Dundas St. ..... Tel. 4660
Calgary, Alberta ..... 1324 11th Ave., West ..... CHerry 4-2736
Edmonton, Alberta ..... 10810 119th St. ..... Tel. 88-4817
Halifax, Nova Scotia ..... 67 Upper Water St. ..... Tel. 2-8407
Hamilton, Ontario ..... 1749 King St., East ..... LIberty 4-2876
Montreal 15, Quebec ..... 7000 Park Ave. ..... CRescent 1-2491
Regina, Saskatchewan ..... 1845 Broad St. ..... LAkeside 3-3323
Saskatoon, Saskatchewan ..... 216 Pacific Ave. ..... Tel. CH 2-2259
Toronto 7, Ontario ..... 214 Merton St. ..... HUdson 1-4475
Vancouver 10, B. C. ..... 399 West 5th Ave. ..... EXpress 3033
Winnipeg 10, Manitoba ..... 875 Wall St. ..... SPruce 2-1219

ALLEN-BRADLEY CO.

GENERAL OFFICES - MILWAUKEE, WISCONSIN

Publication 6014 (February 1959)

Standard Conditions of Sale

Electronic Components

Terms — Terms to customers of satisfactory credit are 1% 10th and 25th, 30 days net from date of invoice. To avoid delay in filling orders, purchasers without previous experience with the Allen-Bradley Company should include credit references with their first order, or remit cash.

Minimum Billing Charge — Orders for fixed and variable resistors amounting to **$10** net or less will be billed at **$10** plus the transportation charges not absorbed by the Allen-Bradley Company.

Orders for all ferrite parts, except non-standard MPA quarter rounds and cracked rings, amounting to **$10** net or less will be billed at **$10** plus the transportation charges not absorbed by us.

Orders calling for non-standard MPA ferrite quarter rounds and cracked rings will carry a billing charge of **$75**.

Orders calling for ceramic capacitors will carry a minimum charge of **$10** per item.

Shipping Terms — Prices on all electronic components except Ferrite Parts and Ceramic Capacitors are f.o.b. Milwaukee, Wisconsin. Terms on Ferrite Parts and Ceramic Capacitors are f.o.b. Milwaukee, Wisconsin, with lowest cost transportation (freight or truck) prepaid and absorbed by us to any recognized freight station within the continental United States, east of the Mississippi River, providing method and routing of shipment are left to the Company's discretion. Title passes with delivery to carrier.

Delivery — Shipping promises are made in good faith; shipping dates appearing on acknowledgments of orders, or given the customer in any other manner, are approximate. Where the customer delays in supplying information necessary to proceeding with the order, the date of shipment may be extended accordingly and determined by the conditions at the Company's factory at the time when the specifications were completed.

The Company shall not be liable for any delay in delivery due to causes beyond its control, such as acts of God, acts of the purchaser, acts of civil or military authority, fires, strikes, floods, epidemics, quarantine restrictions, war, riots, delays in transportation, transportation embargoes, or inability due to causes beyond our control to obtain necessary engineering talent, labor, materials or manufacturing facilities. In the event of such delay, the delivery shall be extended for a period equal to the time lost by reason of the delay.

Damage Claims — Great care is taken in packing all electronic components. Therefore, after the Company has been given "in good order" receipts by the transportation company it cannot be held responsible for damage that occurs in transit. All claims for breakage and damage whether concealed or obvious must be made to the carrier as soon as possible after receipt of the shipment. Allen-Bradley will be glad to render the customer all possible assistance to secure satisfactory adjustment of such damage claims.

When components are received in a damaged condition, but with the shipping container intact, the customer should make a "concealed damage" report from the carrier, on the day of delivery.

Export Packing — Allen-Bradley will supply control apparatus for underdeck overseas shipment packed in accordance with its regular export standard, at no additional charge to the customer. Where such packing for export must conform to definite specifications that differ from the Allen-Bradley standard, the customer will be charged for the extra cost thus incurred.

Quotations — All written quotations automatically expire unless accepted within 15 days from the date quoted. However, all quotations are subject to change, with or without notice, within this fifteen-day period.

Verbal quotations expire the same day they are made.

Quotations to be binding must list the actual quantities involved.

All stenographic and clerical errors are subject to correction.

Firm government quotations guaranteed for a maximum of 60 days.

Price Changes — In the event of a price change, all unshipped orders with the exceptions listed below, will be adjusted to those prices in effect at time of shipment.

Orders accepted and acknowledged at Milwaukee for components which Allen-Bradley can ship within 60 days from the date of the customer's order will be priced on a firm basis. Any customer delivery instructions or lack of information necessary to the engineering, manufacture or delivery of the order that causes a delay beyond the 60 day period will automatically invoke the escalation terms even though the order was originally entered on a firm basis.

Catalog Prices — Prices shown in any Allen-Bradley publication are subject to change without notice and are not to be construed as a definite quotation or offer to sell by the Company. Such literature is maintained only as a source of general information, and any prices shown therein are subject to confirmation with a specific quotation.

Taxes — The Allen-Bradley Company's prices do not include sales, use, excise or similar taxes. Consequently, the amount of any such present or future tax shall be paid by the purchaser, or in lieu thereof the purchaser shall provide the Company with a tax exemption certificate acceptable to the taxing authorities.

Standard Conditions of Sale — Electronic Components

Guarantee — The Allen-Bradley Company guarantees all its electronic components against defective material and workmanship for a period of one year from date of invoice, this guarantee being limited to repair or replacement at our factory of components proving defective. The Company cannot assume responsibility or accept invoices for unauthorized repairs to its components, even though defective. In no case will the Company's responsibility extend to components or equipment not of its manufacture. Under no circumstances shall the Allen-Bradley Company be liable for loss of profits or other damages.

Responsibility — The Allen-Bradley Company is not responsible for damage to components due to improper installation or through attempts to operate the components beyond their rated capacity, intentional or otherwise.

Penalty Clause — No penalty clause of any description, in any specification or order, will be effective unless approved in writing over the signature of an officer of the Company.

Cancellation — Any order placed with the Allen-Bradley Company can be cancelled by the purchaser only upon payment of reasonable cancellation charges, which shall take into account expenses already incurred, and commitments made by the company.

Patents — The Company will defend any suit or proceeding brought against the Purchaser so far as based on a claim that any electronic component, or any part thereof, furnished on a customer's order or under a given contract constitutes an infringement of any patent of the United States, if notified promptly in writing and given authority, information and assistance (at the Company's expense) for the defense of same, and the Company will pay all damages and costs awarded therein against the Purchaser. In case said components, or any part thereof, are in such suit held to constitute infringement and the use of said components or part is enjoined, the Company will, at its own expense, either procure for the Purchaser the right to continue using said components; or replace same with non-infringing components; or modify them so they become non-infringing; or remove said components and refund the purchase price and the transportation and installation costs thereof. The foregoing states the entire liability of the Company for patent infringement by said components or parts thereof.

Returned Material — Any rejections of material are subject to replacement following examination and test at our factory.

Authority for return must be obtained from the Allen-Bradley Co. unless such authority has been granted shipment will be refused.

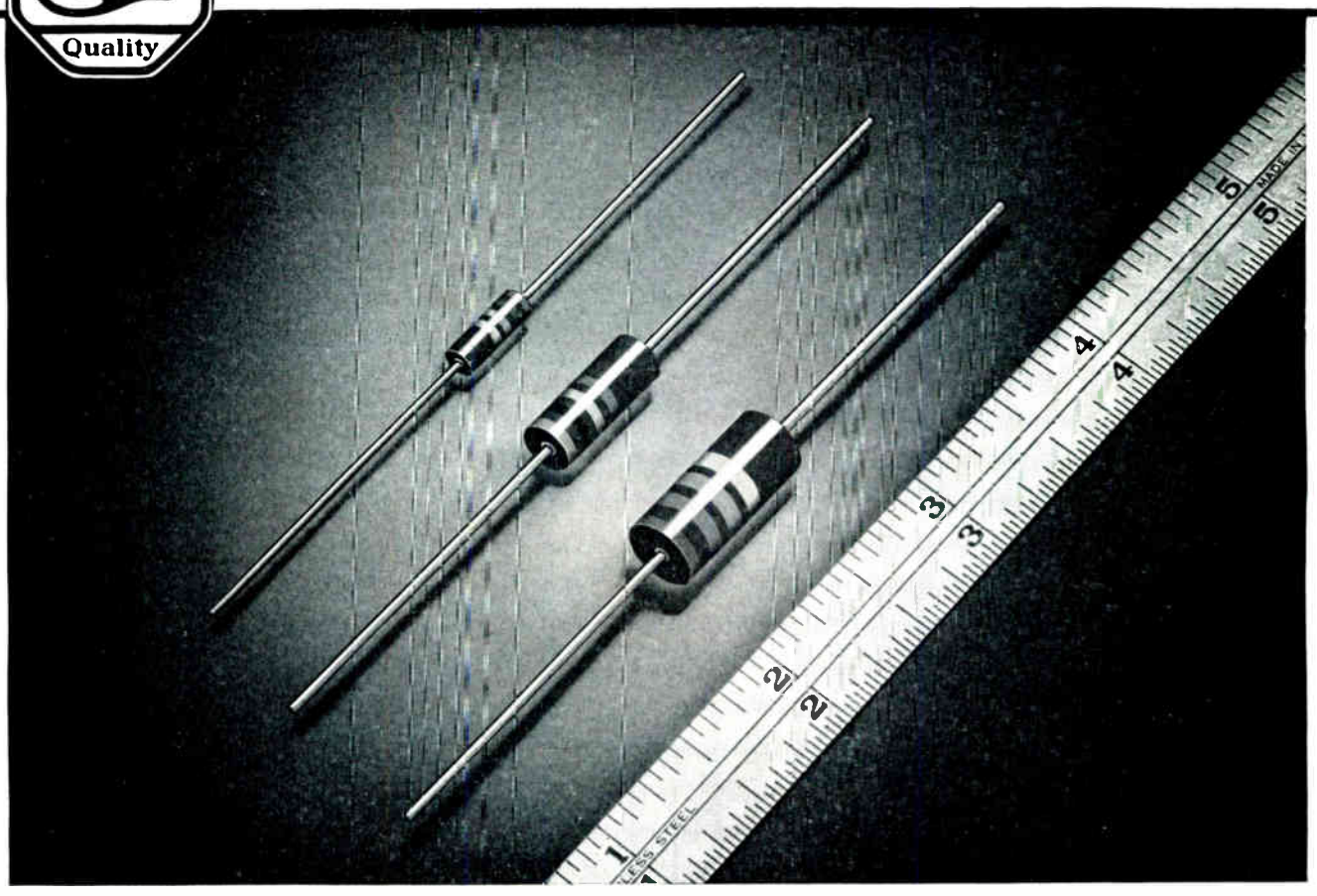
Important Notice — It is distinctly understood that the information contained in this standard conditions of sales form covers all points in connection with terms and conditions under which Allen-Bradley electronic components are sold. No modifications of, or additions to, the terms outlined herein will be recognized by the Allen-Bradley Company unless specifically agreed to in writing and signed by an officer of this Company.

Composition Fixed Resistors

Type EB-½ Watt • Type GB-1 Watt • Type HB-2 Watt

A-B Quality

May 16, 1955 • • • Technical Bulletin **5000**



Outstanding Features

Reliable • • •
These resistors when used according to published ratings and recommendations will not open circuit nor exhibit large erratic changes of resistance value. They are dependable.

Uniform • • •
Rigid quality control insures consistent characteristics.

Small • • •
These resistors are smaller than most competitive products.

Easy to Solder • • •
The hot solder coated lead wires can be soldered with amazing ease even after long periods in stock.

Packaging • • •
Special packaging, as illustrated on page 4, prevents the lead wires from becoming bent and tangled. Also available packed in reels for use in automatic assembly operations.

Rugged Construction • • •
The resistance material, insulation material and lead wires are molded together at one time into one solid integral structure which is mechanically strong without cracks or crevices which might admit moisture. The lead wires are specially hardened in the region immediately adjacent to the resistor body which results in superior performance on vibration tests.

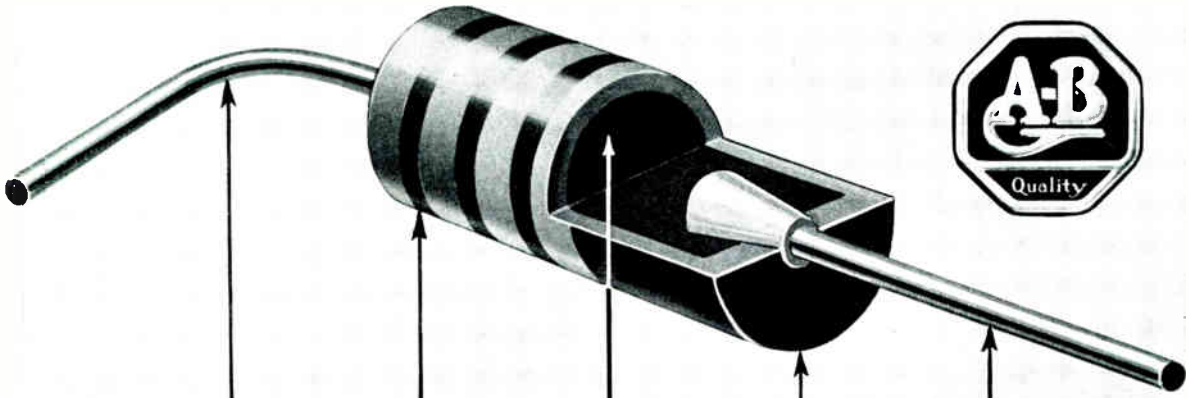
Appearance • • •
The resistors have a smooth, glossy, attractive surface. The color coding is applied in well defined bands which are clear and distinct. The colors adhere permanently to the resistor body and retain their color when resistors are operated at maximum temperature.

Military Specifications • • •
The performance is superior to that specified in JAN-R-11 and MIL-R-11A specifications including the "G" and "F" characteristics.

Noise • • •
Small rapid variations of resistance which in some applications result in noise or other modulation effects are extremely low — being of the same order as those resulting from thermal agitation.

Thermal Shock • • •
Will withstand without damage 10 cycles of the salt water immersion test specified in JAN-R-11 amendment number one, indicating tight seal and good contact between the lead wire and the resistance material.

Composition Fixed Resistors



DIFFERENTIALLY TEMPERED

The lead wires used on these resistors are differentially tempered. This graduated hardness near the body of the resistor minimizes lead wire breakage.

MOLDED RESISTANCE ELEMENT

The resistance material has a large cross section resulting in low current density and high overload capacity. Uniformity of material eliminates "hot spots."

IMBEDDED TINNED LEADS

The lead wires are enlarged at the resistor end to produce a conical section. Ample electrical contact and greater strength are thereby obtained.

STANDARD COLOR CODING

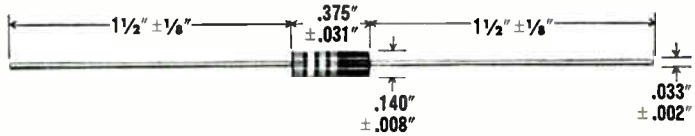
Standard resistors are made in all RETMA, JAN, and MIL specifications, resistance values, and color coding. Tolerances—plus or minus 5%, 10% or 20%.

RUGGED CONSTRUCTION

Resistors are solid molded. The resistance material, insulation material and lead wires are molded together at one time into a solid integral structure.

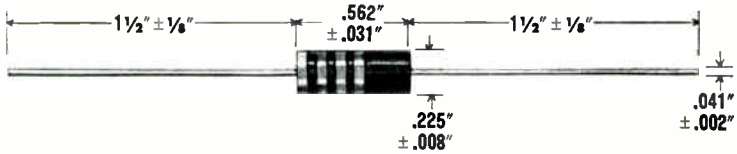
Dimensions

½ Watt Actual Size



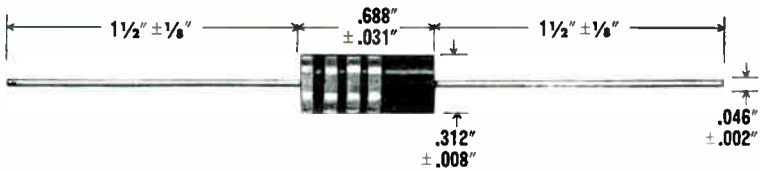
Type EB

1 Watt Actual Size



Type GB

2 Watt Actual Size



Type HB

Performance Characteristics

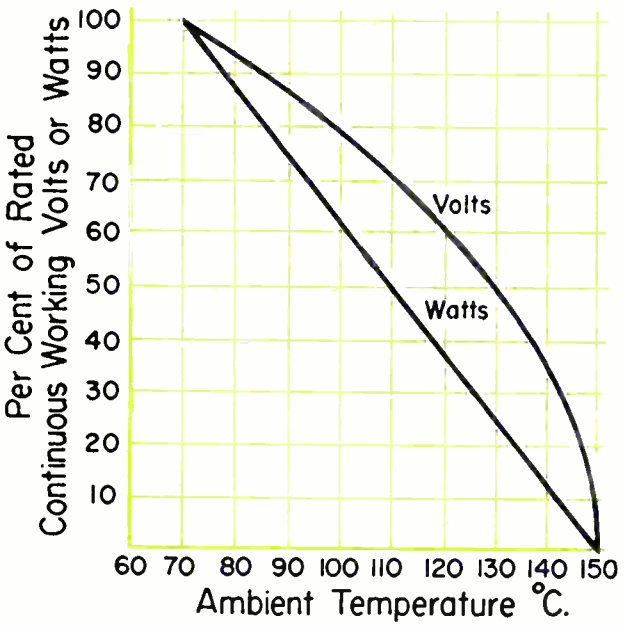
Characteristics	Type EB — ½ Watt	Type GB — 1 Watt	Type HB — 2 Watt
Resistance Values Standard	10 ohms to 22 megs.	2.7 ohms to 22 megs.	10 ohms to 22 megs.
Maximum Continuous Rated Voltage	350-V-RMS	500-V-RMS	750-V-RMS
Maximum Continuous Rated Watts at 70°C Ambient	0.5	1.0	2.0
Insulation Strength	Plus 2 × 350 volts	Plus 2 × 500 volts	Plus 2 × 750 volts
Voltage Coefficient Maximum Resistance Change per Volt			
1000 ohms	.005%	.008%	.008%
10000 ohms	.007%	.011%	.011%
0.1 megohms	.014%	.014%	.014%
1.0 megohms	.020%	.017%	.017%
10.0 megohms	.030%	.020%	.020%

Temperature Characteristics

Maximum Percent Resistance Change from +25°C.

Resistance Range	Maximum Percent Resistance Change from +25 C Value								
	−55°C	25°C	0°C	25°C	55°C	85°C	110°C	130°C	150°C
Less than 100 ohms	+ 5	+3	+2	0	±2	±2	+3.5	+ 5	+ 6.5
100 ohms to 910 ohms	+ 6.5	+3.5	+2	0	±2	±2.5	+4.5	+ 6.5	+ 8.5
1000 ohms to 9,100 ohms	+ 8.5	+4.5	+2	0	±2	±3	+5.5	+ 8	+10.5
10,000 ohms to 91,000 ohms	+10	+5.5	+2.5	0	±2	±3.5	+6.5	+ 9.5	+12.5
0.1 megohm to 0.91 megohm	+12	+6	+2.5	0	±2	±4.0	+7.5	+11	+15
1 megohm to 9.1 megohm	+14	+7	+3.0	0	±2	±4.5	+8.5	+12.5	+17
10 megohm to 22 megohm	+15	+7.5	+3.0	0	±2	±5.0	+9	+13	+18

Characteristics	Type EB — ½ Watt	Type GB — 1 Watt	Type HB — 2 Watt
Temperature Cycling 5 Cycles as follows: Start at 25°C, Reduce to −55°C, Return to 25°C, Raise to 85°C, Return to 25°C	Less than 2%	Less than 2%	Less than 2%
Humidity Characteristic 113 Hours at 95% Relative Humidity at (55°C)	Less than 10% change	Less than 7½% change	Less than 5% change
Load Life			
a. % Change in Resistance after intermittent application of Rated Continuous Working Voltage for 1000 Hours at 70°C Ambient 1½ hour on — ½ hour off	**a.** Less than 6%.	**a.** Less than 6%.	**a.** Less than 6%.
b. At Ambient Temperature between 70°C and 150°C 1000 Hour Test 1½ hour on — ½ hour off	**b.** Less than 6% when working voltage is derated as per Derating Curve (See Page 4)	**b.** Less than 6% when working voltage is derated as per Derating Curve (See Page 4)	**b.** Less than 6% when working voltage is derated as per Derating Curve (See Page 4)
Short Time Overload 5 Second Test of 2½ Times Rated Continuous Working Voltage	Less than 2.5%	Less than 2.5%	Less than 2.5%
Soldering Characteristic 3 Second Test Leads immersed in Solder to ⅛" of Body at 350°C	Less than 3%	Less than 3%	Less than 3%
Military Specifications **MIL-R-11A** **JAN-R-11**	Meet MIL-R-11A & JAN-R-11 Including Characteristic "GF"	Meet MIL-R-11A & JAN-R-11 Including Characteristic "GF"	Meet MIL-R-11A & JAN-R-11 Including Characteristic "GF"



Derating Curve — At ambient temperatures above 70°C the change in resistance, after 1000 hours, will be less than 6% provided the working voltage is derated in accordance with the above curve.

STANDARD LISTING

The following pages list the Allen-Bradley standard resistance values, tolerances, and color coding which are identical with RETMA, MIL-R11A, and JAN-R-11 specifications.

Special resistors can sometimes be supplied but delivery time and cost will of necessity be increased. Inquiries should indicate quantity and detailed specifications. Type EB resistors have been supplied in special resistance values as high as 500,000 megohms.

WHEN ORDERING

The following information is required when ordering Bradleyunit resistors:

1. **Type or wattage**
2. **Nominal resistance value**
3. **Resistance tolerance**

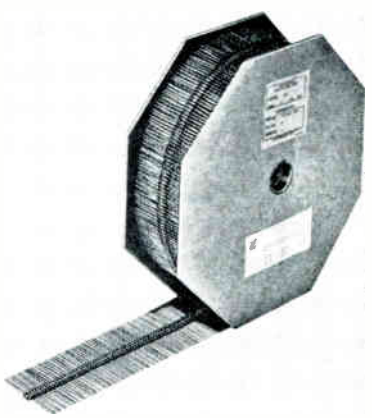
Packaging

Two methods are used in packaging Allen-Bradley resistors, carton packaging or reel packaging. In carton packaging, the resistors are packed in a corrugated paper strip in an upright position and a number of these strips are placed in a carton. The number of resistors in a carton depends on the size of the resistors.

This method of packaging, which is supplied at no extra charge, provides many features which are of great benefit to the user. The resistors are available to the assembler in a neat orderly arrangement, not a tangled mass from which the individual resistor must be untangled. Efficient low cost pre-cutting of resistor leads, to desired lengths, is possible. A single operation can replace many.

The Allen-Bradley method of packing resistors results in a compact package requiring less space in the stock room and enabling efficient handling and accurate control of the number of resistors charged in and out of the stock room. No individual counting is required since each strip in the carton contains a fixed number of resistors.

For chassis automatic assembly operations, resistors can be supplied on reels as illustrated below. The resistors are attached to the adhesive surface of a pressure sensitive tape, which adheres to the body of the resistor, not to the leads. A 12-inch leader precedes the first resistor. There is no extra charge for the reel packaging.



Standard Resistance Values

Nominal Resistance In Ohms			Maximum Continuous RMS Working Voltage			Color Code		
5% Tolerance Fourth Band Gold	10% Tolerance Fourth Band Silver	20% Tolerance No Fourth Band	Type EB ½ Watt	Type GB 1 Watt	Type HB 2 Watt	First Band	Second Band	Third Band
2.7	2.7	—	—	1.64	—	Red	Violet	Gold
3.0	—	—	—	1.73	—	Orange	Black	Gold
3.3	3.3	3.3	—	1.82	—	Orange	Orange	Gold
3.6	—	—	—	1.9	—	Orange	Blue	Gold
3.9	3.9	—	—	1.97	—	Orange	White	Gold
4.3	—	—	—	2.07	—	Yellow	Orange	Gold
4.7	4.7	4.7	—	2.17	—	Yellow	Violet	Gold
5.1	—	—	—	2.26	—	Green	Brown	Gold
5.6	5.6	—	—	2.36	—	Green	Blue	Gold
6.2	—	—	—	2.49	—	Blue	Red	Gold
6.8	6.8	6.8	—	2.6	—	Blue	Gray	Gold
7.5	—	—	—	2.74	—	Violet	Green	Gold
8.2	8.2	—	—	2.86	—	Gray	Red	Gold
9.1	—	—	—	3.02	—	White	Brown	Gold
10	10	10	2.24	3.16	4.47	Brown	Black	Black
11	—	—	2.35	3.32	4.69	Brown	Brown	Black
12	12	—	2.45	3.46	4.90	Brown	Red	Black
13	—	—	2.55	3.61	5.10	Brown	Orange	Black
15	15	15	2.74	3.87	5.48	Brown	Green	Black
16	—	—	2.83	4.00	5.65	Brown	Blue	Black
18	18	—	3.00	4.24	6.00	Brown	Gray	Black
20	—	—	3.16	4.47	6.31	Red	Black	Black
22	22	22	3.32	4.69	6.63	Red	Red	Black
24	—	—	3.46	4.90	6.92	Red	Yellow	Black
27	27	—	3.67	5.19	7.34	Red	Violet	Black
30	—	—	3.87	5.47	7.75	Orange	Black	Black
33	33	33	4.06	5.74	8.11	Orange	Orange	Black
36	—	—	4.24	6.00	8.48	Orange	Blue	Black
39	39	—	4.42	6.25	8.81	Orange	White	Black
43	—	—	4.64	6.55	9.26	Yellow	Orange	Black
47	47	47	4.85	6.85	9.69	Yellow	Violet	Black
51	—	—	5.00	7.14	10.1	Green	Brown	Black
56	56	—	5.29	7.48	10.6	Green	Blue	Black
62	—	—	5.56	7.86	11.1	Blue	Red	Black
68	68	68	5.82	8.25	11.7	Blue	Gray	Black
75	—	—	6.11	8.65	12.2	Violet	Green	Black
82	82	—	6.40	9.05	12.8	Gray	Red	Black
91	—	—	6.75	9.54	13.5	White	Brown	Black
100	100	100	7.07	10.0	14.1	Brown	Black	Brown
110	—	—	7.41	10.5	14.8	Brown	Brown	Brown
120	120	—	7.74	11.0	15.5	Brown	Red	Brown
130	—	—	8.05	11.4	16.1	Brown	Orange	Brown
150	150	150	8.65	12.3	17.3	Brown	Green	Brown
160	—	—	8.95	12.7	17.9	Brown	Blue	Brown
180	180	—	9.48	13.4	19.0	Brown	Gray	Brown
200	—	—	10.0	14.1	20.0	Red	Black	Brown
220	220	220	10.5	14.8	21.0	Red	Red	Brown
240	—	—	11.0	15.5	21.9	Red	Yellow	Brown
270	270	—	11.6	16.4	23.2	Red	Violet	Brown
300	—	—	12.2	17.3	24.5	Orange	Black	Brown
330	330	330	12.8	18.2	25.7	Orange	Orange	Brown
360	—	—	13.4	19.0	26.8	Orange	Blue	Brown
390	390	—	14.0	19.7	27.9	Orange	White	Brown
430	—	—	14.7	20.7	29.3	Yellow	Orange	Brown
470	470	470	15.3	21.7	30.7	Yellow	Violet	Brown
510	—	—	16.0	22.6	31.9	Green	Brown	Brown
560	560	—	16.7	23.7	33.5	Green	Blue	Brown
620	—	—	17.6	24.9	35.2	Blue	Red	Brown
680	680	680	18.4	26.1	36.9	Blue	Gray	Brown
750	—	—	19.4	27.4	38.7	Violet	Green	Brown
820	820	—	20.2	28.6	40.5	Gray	Red	Brown
910	—	—	21.3	30.2	42.7	White	Brown	Brown
1000	1000	1000	22.4	31.6	44.7	Brown	Black	Red
1100	—	—	23.5	33.2	46.9	Brown	Brown	Red
1200	1200	—	24.5	34.6	49.0	Brown	Red	Red

Standard Resistance Values

Nominal Resistance In Ohms			Maximum Continuous RMS Working Voltage			Color Code		
5% Tolerance Fourth Band Gold	10% Tolerance Fourth Band Silver	20% Tolerance No Fourth Band	Type EB ½ Watt	Type GB 1 Watt	Type HB 2 Watt	First Band	Second Band	Third Band
1300	—	—	25.5	36.1	51.0	Brown	Orange	Red
1500	1500	1500	27.4	38.7	54.8	Brown	Green	Red
1600	—	—	28.3	40.0	56.5	Brown	Blue	Red
1800	1800	—	30.0	42.4	60.0	Brown	Gray	Red
2000	—	—	31.6	44.7	63.1	Red	Black	Red
2200	2200	2200	33.2	46.9	66.3	Red	Red	Red
2400	—	—	34.6	49.0	69.2	Red	Yellow	Red
2700	2700	—	36.7	51.9	73.4	Red	Violet	Red
3000	—	—	38.7	54.7	77.5	Orange	Black	Red
3300	3300	3300	40.6	57.4	81.1	Orange	Orange	Red
3600	—	—	42.4	60.0	84.8	Orange	Blue	Red
3900	3900	—	44.2	62.5	88.1	Orange	White	Red
4300	—	—	46.4	65.5	92.6	Yellow	Orange	Red
4700	4700	4700	48.5	68.5	96.9	Yellow	Violet	Red
5100	—	—	50.0	71.4	101.0	Green	Brown	Red
5600	5600	—	52.9	74.8	106	Green	Blue	Red
6200	—	—	55.6	78.6	111	Blue	Red	Red
6800	6800	6800	58.2	82.5	117	Blue	Gray	Red
7500	—	—	61.1	86.5	122	Violet	Green	Red
8200	8200	—	64.0	90.5	128	Gray	Red	Red
9100	—	—	67.5	95.4	135	White	Brown	Red
10000	10000	10000	70.7	100.0	141	Brown	Black	Orange
11000	—	—	74.1	105	148	Brown	Brown	Orange
12000	12000	—	77.4	110	155	Brown	Red	Orange
13000	—	—	80.5	114	161	Brown	Orange	Orange
15000	15000	15000	86.5	123	173	Brown	Green	Orange
16000	—	—	89.5	127	179	Brown	Blue	Orange
18000	18000	—	94.8	134	190	Brown	Gray	Orange
20000	—	—	100.0	141	200	Red	Black	Orange
22000	22000	22000	105	148	210	Red	Red	Orange
24000	—	—	110	155	219	Red	Yellow	Orange
27000	27000	—	116	164	232	Red	Violet	Orange
30000	—	—	122	173	245	Orange	Black	Orange
33000	33000	33000	128	182	257	Orange	Orange	Orange
36000	—	—	134	190	268	Orange	Blue	Orange
39000	39000	—	140	197	279	Orange	White	Orange
43000	—	—	147	207	293	Yellow	Orange	Orange
47000	47000	47000	153	217	307	Yellow	Violet	Orange
51000	—	—	160	226	319	Green	Brown	Orange
56000	56000	—	167	237	335	Green	Blue	Orange
62000	—	—	176	249	352	Blue	Red	Orange
68000	68000	68000	184	261	369	Blue	Gray	Orange
75000	—	—	194	274	387	Violet	Green	Orange
82000	82000	—	202	286	405	Gray	Red	Orange
91000	—	—	213	302	427	White	Brown	Orange
Nominal Resistance In Megohms								
0.1	0.1	0.1	224	316	447	Brown	Black	Yellow
0.11	—	—	235	332	469	Brown	Brown	Yellow
0.12	0.12	—	245	346	490	Brown	Red	Yellow
0.13	—	—	255	361	510	Brown	Orange	Yellow
0.15	0.15	0.15	274	387	548	Brown	Green	Yellow
0.16	—	—	283	400	565	Brown	Blue	Yellow
0.18	0.18	—	300	424	600	Brown	Gray	Yellow
0.20	—	—	316	447	631	Red	Black	Yellow
0.22	0.22	0.22	332	469	663	Red	Red	Yellow
0.24	—	—	346	490	692	Red	Yellow	Yellow
0.27	0.27	—	350	500	734	Red	Violet	Yellow
0.30	—	—	350	500	750	Orange	Black	Yellow
0.33	0.33	0.33	350	500	750	Orange	Orange	Yellow
0.36	—	—	350	500	750	Orange	Blue	Yellow
0.39	0.39	—	350	500	750	Orange	White	Yellow

Standard Resistance Values

Nominal Resistance In Megohms			Maximum Continuous RMS Working Voltage			Color Code		
5% Tolerance Fourth Band Gold	10% Tolerance Fourth Band Silver	20% Tolerance No Fourth Band	Type EB ½ Watt	Type GB 1 Watt	Type HB 2 Watt	First Band	Second Band	Third Band
0.43	—	—	350	500	750	Yellow	Orange	Yellow
0.47	0.47	0.47	350	500	750	Yellow	Violet	Yellow
0.51	—	—	350	500	750	Green	Brown	Yellow
0.56	0.56	—	350	500	750	Green	Blue	Yellow
0.62	—	—	350	500	750	Blue	Red	Yellow
0.68	0.68	0.68	350	500	750	Blue	Gray	Yellow
0.75	—	—	350	500	750	Violet	Green	Yellow
0.82	0.82	—	350	500	750	Gray	Red	Yellow
0.91	—	—	350	500	750	White	Brown	Yellow
1.0	1.0	1.0	350	500	750	Brown	Black	Green
1.1	—	—	350	500	750	Brown	Brown	Green
1.2	1.2	—	350	500	750	Brown	Red	Green
1.3	—	—	350	500	750	Brown	Orange	Green
1.5	1.5	1.5	350	500	750	Brown	Green	Green
1.6	—	—	350	500	750	Brown	Blue	Green
1.8	1.8	—	350	500	750	Brown	Gray	Green
2.0	—	—	350	500	750	Red	Black	Green
2.2	2.2	2.2	350	500	750	Red	Red	Green
2.4	—	—	350	500	750	Red	Yellow	Green
2.7	2.7	—	350	500	750	Red	Violet	Green
3.0	—	—	350	500	750	Orange	Black	Green
3.3	3.3	3.3	350	500	750	Orange	Orange	Green
3.6	—	—	350	500	750	Orange	Blue	Green
3.9	3.9	—	350	500	750	Orange	White	Green
4.3	—	—	350	500	750	Yellow	Orange	Green
4.7	4.7	4.7	350	500	750	Yellow	Violet	Green
5.1	—	—	350	500	750	Green	Brown	Green
5.6	5.6	—	350	500	750	Green	Blue	Green
6.2	—	—	350	500	750	Blue	Red	Green
6.8	6.8	6.8	350	500	750	Blue	Gray	Green
7.5	—	—	350	500	750	Violet	Green	Green
8.2	8.2	—	350	500	750	Gray	Red	Green
9.1	—	—	350	500	750	White	Brown	Green
10.0	10.0	10.0	350	500	750	Brown	Black	Blue
11.0	—	—	350	500	750	Brown	Brown	Blue
12.0	12.0	—	350	500	750	Brown	Red	Blue
13.0	—	—	350	500	750	Brown	Orange	Blue
15.0	15.0	15.0	350	500	750	Brown	Green	Blue
16.0	—	—	350	500	750	Brown	Blue	Blue
18.0	18.0	—	350	500	750	Brown	Gray	Blue
20.0	—	—	350	500	750	Red	Black	Blue
22.0	22.0	22.0	350	500	750	Red	Red	Blue

Color Code

First Band — 1st Digit

Second Band — 2nd Digit

Third Band — Number of Zeroes or Decimal Multiplier

Fourth Band — Tolerance

Color	Digit	Multiplier
Black	0	1
Brown	1	10
Red	2	100
Orange	3	1000
Yellow	4	10,000
Green	5	100,000
Blue	6	1,000,000
Violet	7	10,000,000
Gray	8	100,000,000
White	9	1,000,000,000
Gold	± 5% Tolerance	0.1
Silver	± 10% Tolerance	0.01
No Color	± 20% Tolerance	

ALLEN-BRADLEY CO.

MILWAUKEE, WISCONSIN

Printed in U.S.A.

Reel Packaged Composition Fixed Resistors

May 2, 1955 • • • Technical Bulletin **5000A**

Automatic • • •

When packaged on a reel, resistors are instantly ready for the first operation on automatic assembly lines. Expensive handling is no longer necessary.

Uniform • • •

Each reel is like the next of its size in dimension and quantity of units. Assembly procedures may be safely and economically standardized for reel fed units.

Easily Unwound • • •

Mounted reels may be unwound by drawing out the belting tape. Power-driven unwinding mechanisms are unnecessary.

12 Inch Leader • • •

Preceding the first resistor in each reel is 12 inches of belting tape suitable for splicing on to an emptying reel or to the assembly machine itself.

Clean Delivery • • •

Resistors are delivered in spotless condition. The molded bodies are clean and their coding unmarred. Wire leads remain even and untangled, ready for the trim.

Characteristics Unchanged • • •

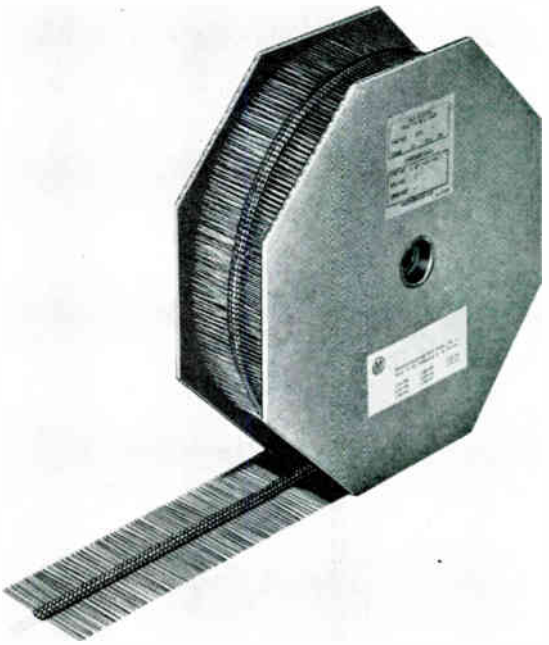
The reel method of packaging resistors does not in any way affect their famous performance standards.

Heavy Duty Construction • • •

The octagonal reels are made from corrugated fiberboard sides glued to a heavy fiber-wound core. The core is plugged with metal bearings having a hole 9/16"±1/64".

Expendable • • •

These reels are one-time dispensers of resistors. There are no storage problems, no returns.



No Extra Charge • • •

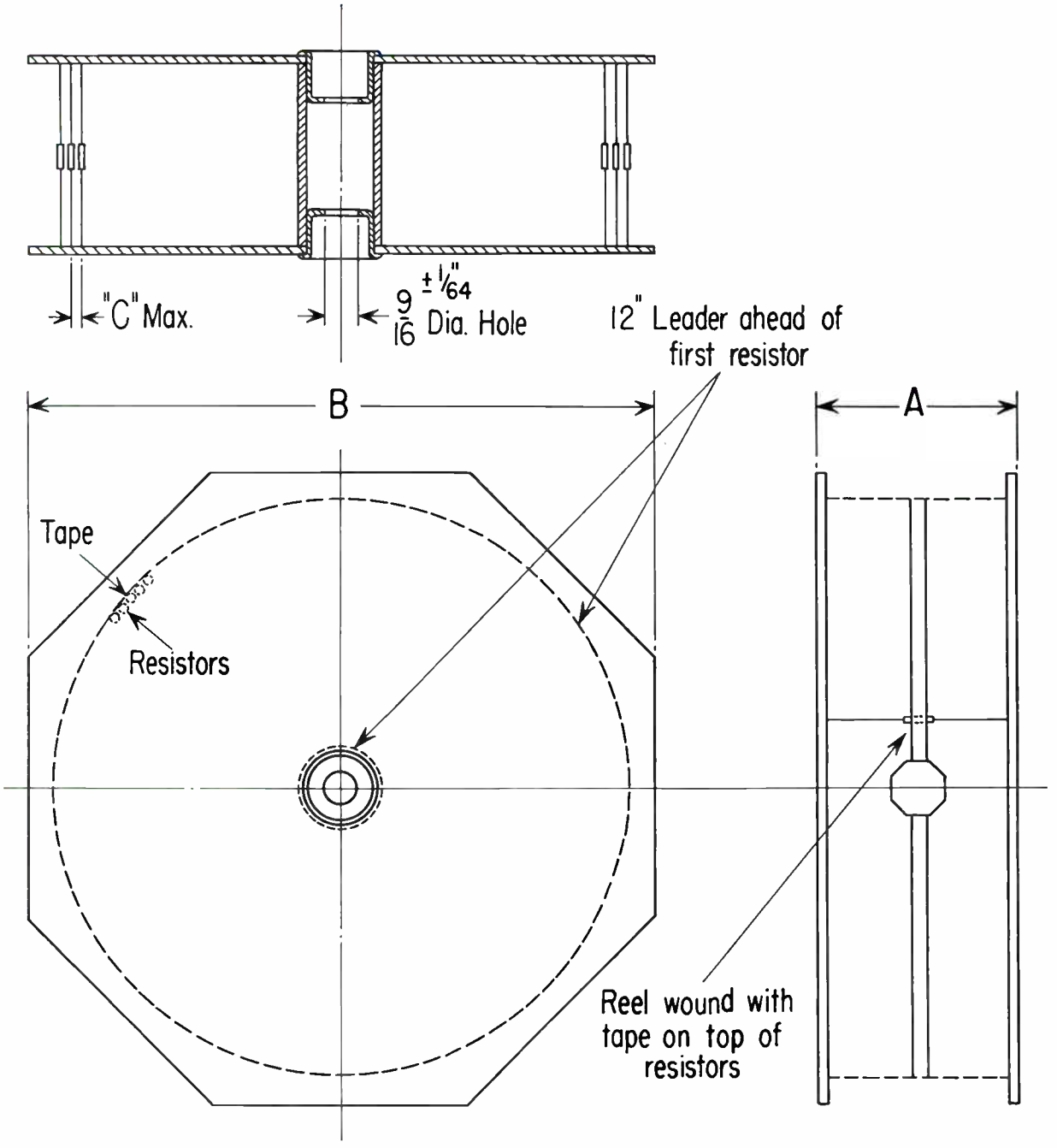
Standard ½ watt, one watt, and two watt resistors, types EB, GB, and HB, respectively, are supplied on reels at no extra cost.

Corrugated Strips • • •

The present method of strip packing will still be available. Each strip is an easy-to-inspect, full-count measure of units. When ordering, specify "Reel," or "Strip" packaging.

Reel Packaged
Composition Fixed Resistors

Dimensions



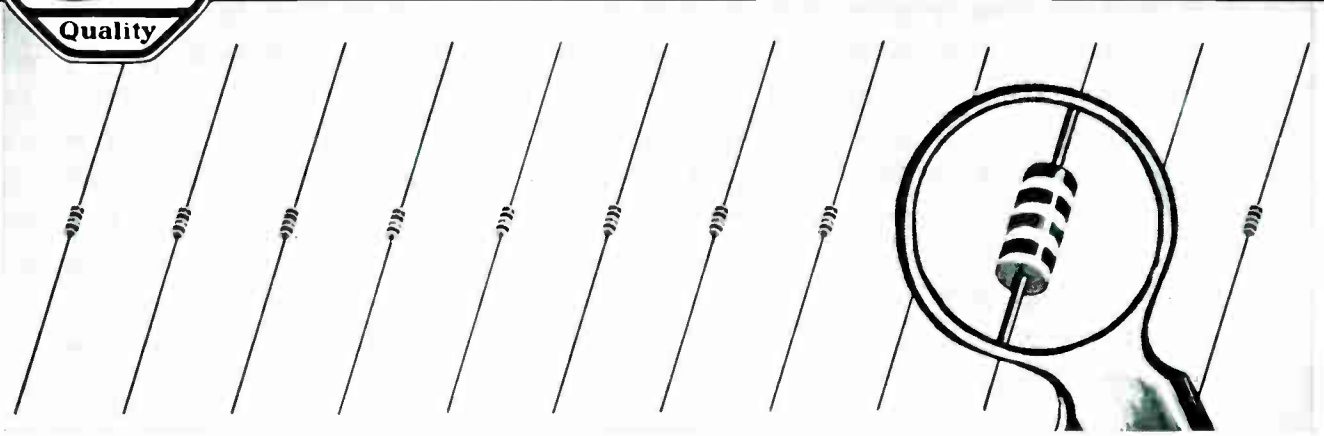
Type	Rating	A	B	C-Max.	Tape Width	Quantity Per Reel
EB	½ W	3¾"	9"	.190"	¼"	2500
GB	1 W	3 15/16"	12 3/16"	.300"	⅜"	2000
HB	2 W	4 1/32"	12 3/16"	.450"	⅜"	1000

Printed in U.S.A.

Composition Fixed Resistors

Type TR — 1/10 Watt

June 1, 1955 • • • Technical Bulletin 5001



Type TR resistors were designed specifically for those applications where small size is the most important requirement. They are suitable for use with transistors, diodes and other small components in miniaturized equipment. They may be used with or without encapsulating casting resins.

Type TR composition fixed resistors are similar to Allen-Bradley Types EB, GB and HB in that leadwires are molded directly within the resistance material thus ensuring permanent reliable electrical contact. The surface of the resistor is coated to provide insulation rated at 200 Volts D.C. maximum for continuous operation. They are color coded over a white background for nominal resistance value and tolerance indication in accordance with RETMA, JAN-R-11 and MIL-R-11A specifications.

Outstanding Features

Small Size—Dimensions of this very small resistor are shown in the drawing. Note leadwires are one (1) inch long.

Reliability—Type TR molded resistors retain the simplicity of construction and are manufactured by means of the same basic techniques as the Types EB, GB and HB resistors which are so well known for their reliability. When used according to published ratings and recommendations they will not open circuit nor exhibit large erratic changes of resistance value. They are dependable.

Uniform—Type TR resistors, because of rigid quality control, exhibit consistent characteristics.

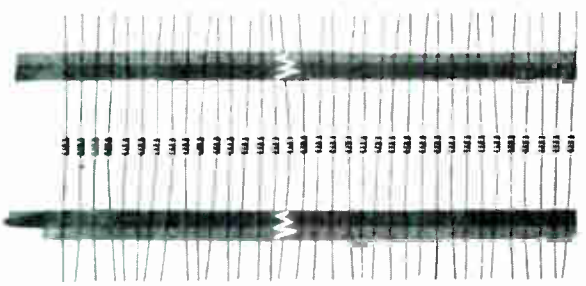
Noise—Small rapid variations of resistance which in some applications result in "noise" or other modulation effects are extremely low in Type TR resistors — being of the same order as those resulting from thermal agitation.

Easy to Solder—The hot solder coated leadwires of TR resistors can be soldered with amazing ease even after long periods in stock.

Rugged Construction—These resistors are solid molded. The resistance material and the lead wires are molded together at one time into one solid integral structure which is mechanically strong. The surface to the resistor is coated to provide insulation.

Packaging—To prevent leadwires from becoming bent and tangled, the Type TR resistors are specially packaged on taped strips accomodating 100 resistors as illustrated below.

Packaging



Type TR resistors are shipped on taped strips as shown in the illustration. Standard strips accommodate 100 resistors and are approximately fourteen (14) inches long.

They are supplied with a free tab at one end to facilitate removal of the strips from the leadwires where the full leadwire length is required. This can be done by placing the strip of resistors on a flat surface and pressing the leadwires against the flat surface with a straight edge at a point between the resistor bodies and the tape thus clamping the leadwires. The free tab should then be pulled in a horizontal plane away from the resistor bodies to remove the tape thus freeing the leadwires. The clamping of the leadwires by the straight edge protects the resistor bodies from excessive strain. To fully accomplish this the straight edge must **not** be in contact with the resistor bodies during this operation.

Generally precutting of resistor leadwires is necessary and the strip method of packaging, which includes 100 resistors on the standard strip, makes it possible to cut the leadwires of the entire 100 resistors in a single operation.

Composition Fixed Resistors
Type TR — 1/10 Watt

Performance Characteristics

Resistance Values — Standard RETMA, JAN-R-11A and MIL-R-11A values — 10 ohms to 22 megohms

Resistance Tolerances — Standard ± 5%, ± 10% and ± 20%

Maximum Continuous Rated Voltage — 150 Volts RMS or DC

Maximum Continuous Rated Wattage at 70° C Ambient — 0.1 Watt

Insulation Strength — 200 Volts DC

Voltage Coefficient

10 ohms to 91,000 ohms, inclusive — Less than .02%/volt
0.1 megohm to 0.91 megohm, inclusive — Less than .03%/volt
1.0 megohm to 22.0 megohm, inclusive — Less than .05%/volt

Temperature Characteristic. Maximum Resistance Change from 25° C

	At −55° C	At +110° C
Less than 100 ohms	+ 5%	+ 5%
100 ohms to 910 ohms, inclusive	+ 6.5%	+ 5%
1000 ohms to 9100 ohms, inclusive	+10.0%	+ 6%
10,000 ohms to 91,000 ohms, inclusive	+10.0%	+ 7.5%
0.1 megohm to 0.91 megohm, inclusive	+15.0%	+10.0%
1.0 megohm to 9.1 megohms, inclusive	+15.0%	+15.0%
10.0 megohms to 22.0 megohms, inclusive	+15.0%	+15.0%

Temperature Cycling. Five Cycles same as MIL-R-11A

Start at 25° C
Reduce to −55° C
Return to 25° C
Raise to 85° C
Return to 25° C
— Resistance change less than 3%

Humidity Characteristic

Relative humidity of 95% at 55° C for 113 Hours — Temporary resistance change less than 12%

Load Life

Rated continuous working voltage for 1000 hours at 70° C ambient — Resistance change less than 6%

At ambient temperatures between 70° C and 110° C for 1000 hours — Resistance change less than 6% when wattage is derated linearly from 0.1 Watt at 70° C to zero at 110° C

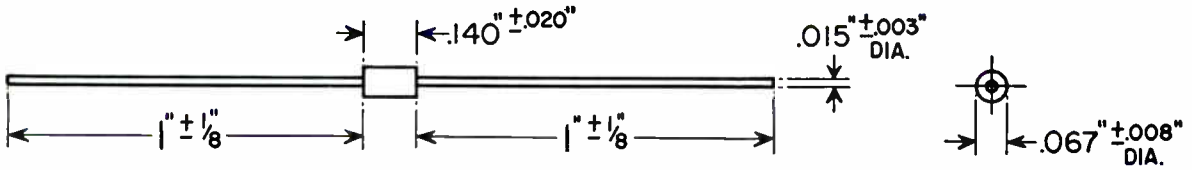
Short Time Overload

5 Seconds at 2½ times rated continuous working voltage — Resistance change less than 2.5%

Soldering Characteristic

3 Second Test — Leads immersed in solder to ⅛" of body at 250° C — Resistance change less than 3%

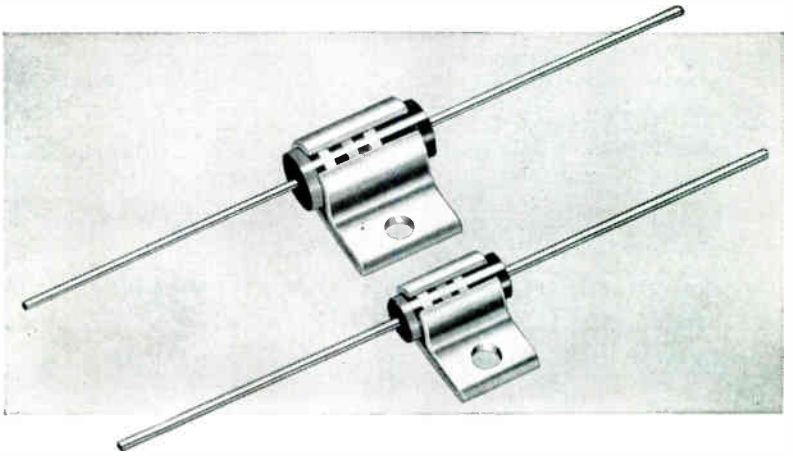
Dimensions



Printed in U.S.A.

Copper Clad Composition Fixed Resistors

May 2, 1955 • • • Technical Bulletin **5002**



The Type GM and HM resistors are insulated molded fixed composition resistor elements in combination with copper clamps or supports which surround the major portion of the resistor elements and which can be mounted directly on metal chassis or panels. The copper supports provide rigid mounting and efficient heat transfer from the resistors to the metal chassis or panels on which they are mounted. When mounted on the equivalent of a steel panel 4 inches square and .05 inches thick, the Type GM resistor has a maximum continuous wattage rating of 3 watts at 70° C ambient and 4 watts at 40° C ambient. The Type HM resistor under the same conditions is rated at 4 watts and 5 watts respectively.

It has been well established that Allen-Bradley fixed composition resistors exhibit superior reliability. When used according to published ratings and recommendations they do not open circuit nor exhibit large erratic changes of resistance value. Heretofore, they have been available only up to and including 2 watt ratings. The addition of Type GM and HM resistors now make reliable performance available up to and including 5 watts. These composition resistors do not incorporate pressure contacts nor fine resistance wire which cause so much difficulty in wirewound resistors.

Performance Characteristics

Resistance Values—Both the type GM and HM are available in 5% and 10% tolerances only. The range of standard resistance values for the GM is 2.7 ohms to 22.0 megohms; for the HM, 10 ohms to 22.0 megohms.

Rating—The maximum continuous rated RMS voltage is 500 for the GM and 750 for the HM.

The maximum continuous rated wattages for type GM and HM resistors when mounted on steel panels 4 inches by 4 inches and .050 inches thick are as follows:

Type	70° C Ambient Temperature	40° C Ambient Temperature
GM	3 Watts	4 Watts
HM	4 Watts	5 Watts

Insulation Strength—The electrical insulation between the resistor leads and the copper clamp is capable of withstanding 1500 volts without breakdown. The insulation resistance is greater than 100,000 megohms.

Voltage Coefficient—The voltage coefficient for resistance values under 1000 ohms is less than 0.2%. For resistance values greater than 1000 ohms, it is less than .02% per volt.

Temperature Characteristic—The maximum change in resistance from the resistance at 25° C is as follows:

	−55° C	+110° C
Less than 100 ohms	+ 5%	+ 5%
Plus 100 ohms to 1000 ohms	+ 6.5%	+ 5%
Plus 1000 ohms to 10,000 ohms	+ 10.0%	+ 6%
Plus 10,000 ohms to 0.1 meg.	+ 10.0%	+ 7.5%
Plus 0.1 meg. to 1.0 meg.	+ 15.0%	+ 10.0%
Plus 1.0 meg. to 10.0 meg.	+ 15.0%	+ 15.0%
Plus 10.0 meg.	+ 15.0%	+ 15.0%

Temperature Cycling—The resistance change is less than 2% after 5 cycles as follows: Start at 25° C, reduce to −55° C, return to 25° C, raise to 85° C, and return to 25° C.

Performance Characteristics

Humidity Characteristic—The resistance change is less than 5% as the result of 113 hours exposure to 95% relative humidity at 55° C.

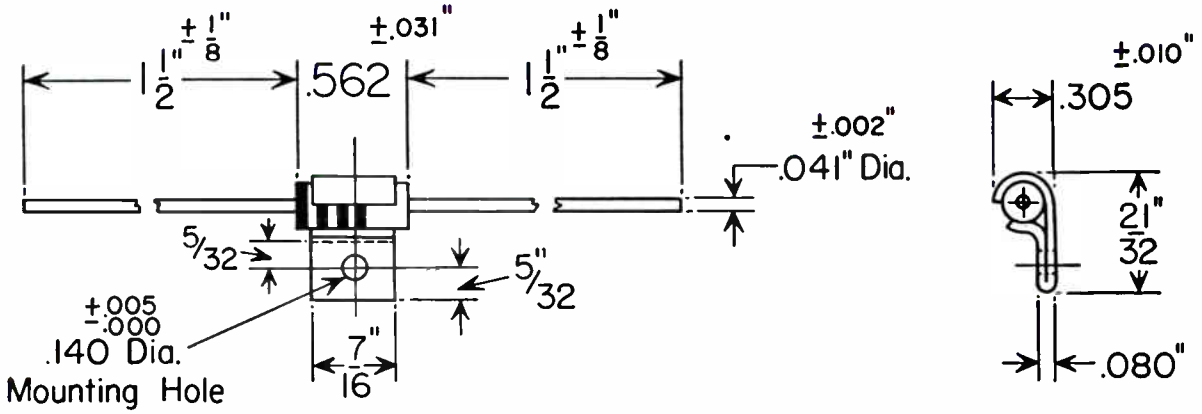
Load Life—When mounted on steel panels 4 inches by 4 inches and .050 inches thick, the resistance change of GM and HM resistors is less than 10% maximum as a result of intermittent (1½ hours on and ½ hour off) application for 1000 hours of the rated continuous working voltage at 70° C ambient temperature.

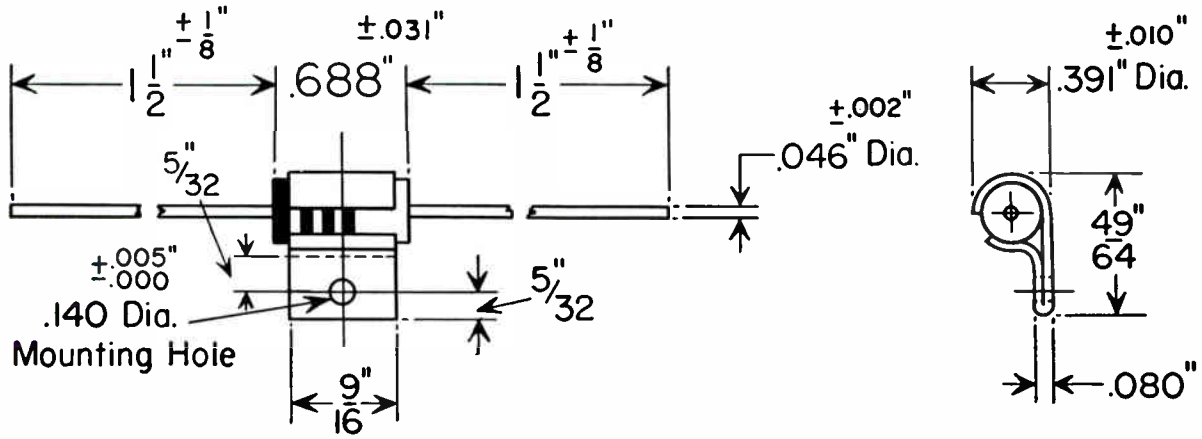
Short Time Overload—The resistance change is less than 2.5% as a result of the application of two times the rated continuous working voltage (not exceeding 1000 volts DC or peak AC) for five seconds.

Soldering Characteristic—The resistance change is less than 3% as the result of immersing the leads one at a time to ⅛ inch of the resistor body in 350° C solder for three seconds.

Capacitance—The capacitance between the lead wires and the copper clamp is approximately 5.6 MMF for type GM and 9 MMF for type HM.

Dimensions





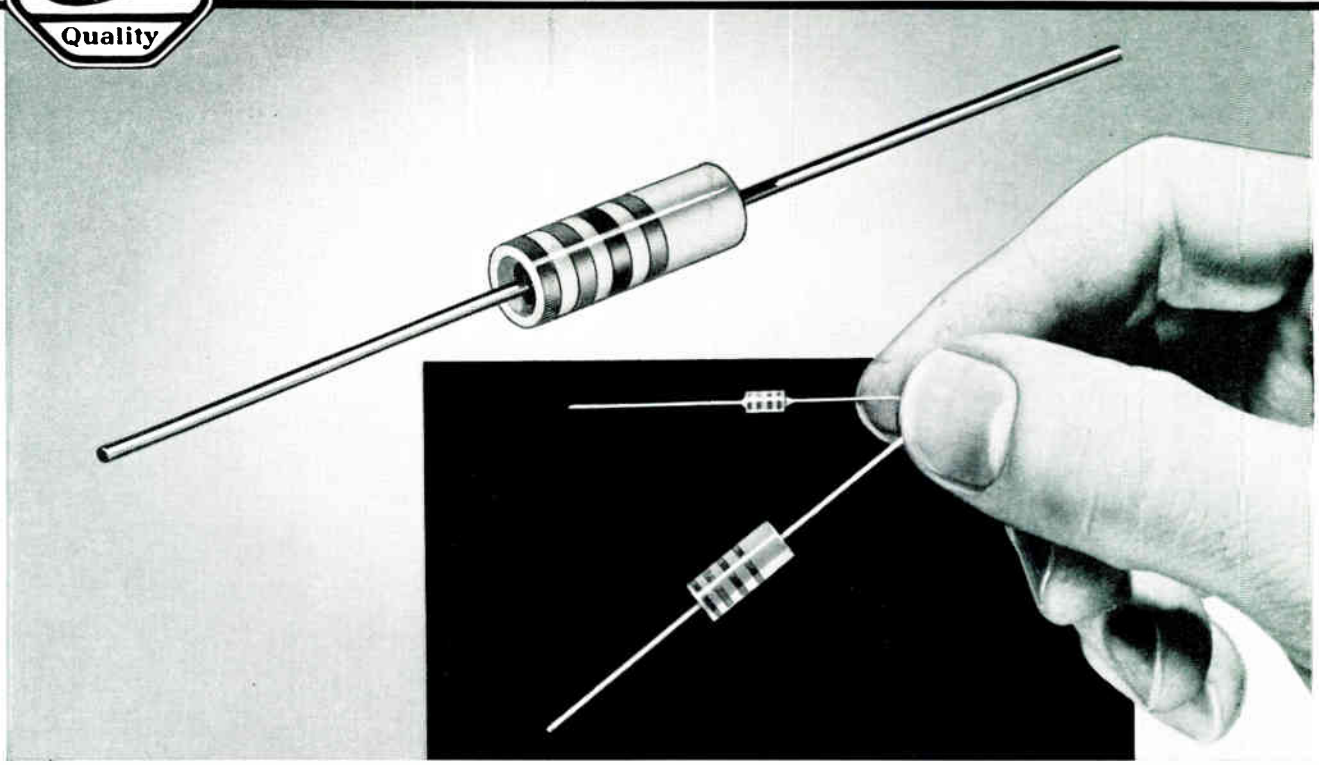
Printed in U.S.A.

Hermetically Sealed Resistors • Ceramic Encased

Type TS - 1/8 Watt • • • Type ES - 1 Watt

A-B Quality

May 16, 1956 • • • Technical Bulletin **5003**



These hermetically sealed resistors are unique in that they combine the well established reliability of Allen-Bradley molded fixed composition resistors with superior stability of resistance value with respect to humidity, temperature cycling, short time overload and soldering. Changes of resistance are LESS THAN ONE PERCENT for these characteristics with the usual conventional tests. These resistors are recommended for those applications where reliability and resistance stability are both of paramount importance. They can be used in computers, RC circuits and other calibrated applications.

They are companion products to the well known Allen-Bradley Types EB, GB and HB resistors which have proven so reliable. The resistor elements of these hermetically sealed resistors have the same basic design and rugged solid molded construction. The resistance material, insulation material, and leadwires are all molded together at one time into one solid integral structure which is mechanically strong without cracks or crevices which might admit moisture. They are then specially processed and are hermetically sealed in ceramic enclosures, which provide complete protection with respect to moisture as well as additional mechanical strength and electrical insulation.

These hermetically sealed resistors are presently available in two physical sizes with specifications as indicated on the reverse side of this sheet. Standard resistors are supplied with tolerances of ± 2% and ± 5% in the RETMA, standard resistance values. Special values and tolerances can be supplied. Nominal resistance values and tolerances are indicated by the standard color code.

Outstanding Features

Reliable—When used according to published ratings and recommendations they will not open circuit nor exhibit large erratic changes of resistance value. They are dependable and not subject to catastrophic failure.

Humidity—As a result of exposure for 250 hours at 95% relative humidity and +40°C. ambient temperature, the temporary **change of resistance is less than one percent.**

Noise—Small rapid variations of resistance which in some applications result in noise or other modulation effects are extremely low in these sealed resistors—being of the same order as those resulting from thermal agitation.

Temperature Cycling—The standard 5 cycle test results in **less than one percent resistance change.**

Safety Factor—While these resistors have nominal wattage ratings as indicated they are designed for substantially higher safety factors than normal. The Type ES resistor for example can be operated continuously at one watt at +70°C. ambient. Derate linearly to zero at **+165°C.**

Short Time Overload—A 5 second test at 2½ times rated continuous working voltage produces **changes of resistance of less than one percent.**

Insulation—Ceramic enclosure provides excellent insulation which can be subjected to high potentials continuously.

Easy to Solder—The hot solder coated leadwires of these sealed resistors can be soldered with amazing ease even after long periods in stock.

Hermetically Sealed Resistors • Ceramic Encased

Type TS - ⅛ Watt • • • Type ES - 1 Watt

Performance Characteristics

Resistance Values—Standard RETMA, JAN-R-11A and MIL-R-11B Values—10 ohms to 22 megohms inclusive.

Resistance Tolerance —Plus or minus 2% or plus or minus 5%.

Maximum Continuous Wattage Rating—

Type ES + 70°C. 1.0 watt; +120°C. 0.5 watt; +165°C. zero } Derate linearly from + 70°C. rating to zero at + 165°C.

Type TS + 40°C. 0.25 watt; + 70°C. 0.125 watt; +110°C. zero } Derate linearly from + 70°C. rating to zero at + 110°C.

Maximum Continuous Rated Voltage Provided Wattage Rating Is Met.

Type ES—350 Volts RMS

Type TS—150 Volts RMS

Insulation Strength—

Type ES—700 Volts RMS 60 cycle maximum.

Type TS—200 Volts RMS 60 cycle maximum.

Voltage Coefficient—Maximum Resistance Change per Volt—

Type ES—		**Type TS**—	
1000 ohms	.005%	1000 ohms	.020%
10000 ohms	.007%	10000 ohms	.035%
0.1 megohm	.014%	0.1 megohm	.040%
1.0 megohm	.020%	1.0 megohm	.045%
10.0 megohms	.030%	10.0 megohms	.050%

Temperature Characteristics—

Resistance Range	Maximum Percent Resistance Change from + 25°C. Value								
	−55°C.	−25°C.	0°C.	+25°C.	+55°C.	+85°C.	+110°C.	+130°C.	+150°C.
Less than 100 ohms	+ 5	+ 3	+ 2	0	± 2	± 2	+ 3.5	+ 5	+ 6.5
100 ohms to 910 ohms	+ 6.5	+ 3.5	+ 2	0	± 2	± 2.5	+ 4.5	+ 6.5	+ 8.5
1000 ohms to 9,100 ohms	+ 8.5	+ 4.5	+ 2	0	± 2	± 3	+ 5.5	+ 8	+ 10.5
10,000 ohms to 91,000 ohms	+ 10	+ 5.5	+ 2.5	0	± 2	± 3.5	+ 6.5	+ 9.5	+ 12.5
0.1 megohm to 0.91 megohm	+ 12	+ 6	+ 2.5	0	± 2	± 4.0	+ 7.5	+ 11	+ 15
1 megohm to 9.1 megohms	+ 14	+ 7	+ 3.0	0	± 2	± 4.5	+ 8.5	+ 12.5	+ 17
10 megohms to 22 megohms	+ 15	+ 7.5	+ 3.0	0	± 2	± 5.0	+ 9	+ 13	+ 18

Temperature Cycling—Five cycles −55°C. to +85°C. —See MIL-R-11B or MIL-R-10509A for details—both types change less than 1% from initial resistance value with no mechanical damage.

Humidity and Moisture Resistance Characteristics—After 250 hours at 95% relative humidity and +40°C. ambient temperature, or test in accordance with MIL-R-11B or MIL-R-10509A change less than 1% from initial resistance value.

Load Life—After 1000 hours at maximum wattage ratings for specified ambient temperatures, change of resistance for both types less than 6% from initial resistance value.

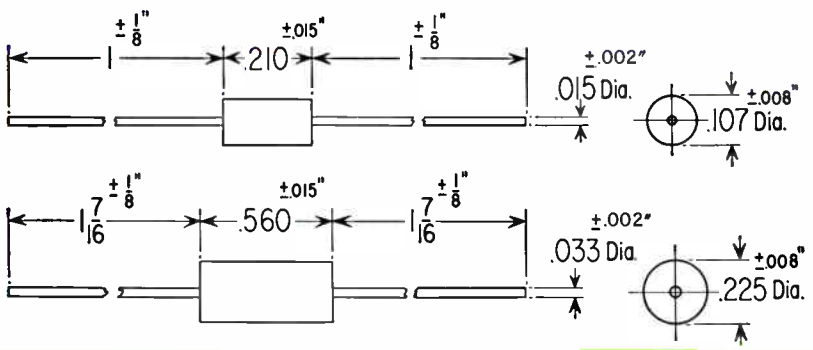
Short Time Overload—After 5 seconds at 2½ times rated continuous working voltage —See MIL-R-11B or MIL-R-10509A for details—both types change less than 1% from initial resistance value.

Soldering Characteristics—After leadwires immersed in solder within ⅛" of resistor body for 3 seconds less than 1% change for both types. Solder temperature for Type ES + 350°C. and for Type TS + 250°C.

Vibration—Change of resistance for both types less than 1% with either MIL-R-11B test or vibration part of MIL-R-10509A moisture resistance test.

Marking—Standard RETMA or MIL color coding. Fourth band red for ±2%.

Dimensions



Printed in U. S. A.

Composition Fixed Resistors

September 24, 1956 • • • Price Sheet 5080

Type	Tolerance Plus or Minus	Price per Hundred				Price per Thousand	
		1–99	100–249	250–499	500–999	1000–4999	5000 or More
TR 0.1 Watt	5% 10% 20%	**$40.00** **20.00** **18.00**	**$24.00** **12.00** **10.80**	**$20.00** **10.00** **8.80**	**$19.50** **9.70** **8.40**	**$115.00** **58.00** **51.00**	**$105.00** **53.00** **46.00**
EB 0.5 Watt	5% 10% 20%	**20.00** **10.00** **9.00**	**10.00** **6.00** **5.00**	**8.00** **4.00** **3.60**	**6.60** **3.00** **2.80**	**37.00** **18.00** **15.00**	**34.00** **17.00** **13.00**
GB 1.0 Watt	5% 10% 20%	**30.00** **15.00** **14.00**	**18.00** **9.00** **8.00**	**13.50** **6.70** **5.70**	**11.00** **5.50** **4.80**	**59.00** **30.00** **25.00**	**55.00** **27.00** **22.00**
HB 2.0 Watt	5% 10% 20%	**40.00** **20.00** **18.00**	**24.00** **12.00** **10.80**	**20.00** **10.00** **8.80**	**19.50** **9.70** **8.40**	**115.00** **58.00** **51.00**	**105.00** **53.00** **46.00**
GM 3.0 Watt ❶	5% 10%	**51.00** **31.00**	**32.00** **23.00**	**24.00** **17.00**	**18.00** **12.00**	**100.00** **70.00**	**95.00** **65.00**
HM 4.0 Watt ❶	5% 10%	**56.00** **35.00**	**38.00** **26.00**	**30.00** **21.00**	**24.00** **17.00**	**160.00** **100.00**	**150.00** **95.00**
TS ⅛ Watt	2% ❷ 5%	**150.00** **112.00**	**108.00** **82.00**	**98.00** **74.00**	**90.00** **68.00**	**810.00** **610.00**	**780.00** **580.00**
ES 1 Watt	2% ❷ 5%	**100.00** **75.00**	**81.00** **62.00**	**75.00** **57.00**	**71.00** **54.00**	**660.00** **500.00**	**640.00** **480.00**

❶ These ratings apply only when resistor is mounted on a metal panel at least 4" x 4" and .050" thick, or the thermal equivalent thereof, at an ambient temperature of 70° C.
❷ Plus or minus 2% tolerance available only in the resistance values which are standard for the ± 5% tolerance.

Listed prices apply only for the STANDARD RETMA, JAN-R-11 and MIL-R-11 resistance values and tolerances between the following limits:

Type EB, ES, HB, HM, TR, TS — 10.0 ohms to 22.0 megohms inclusive.
Type GB, GM — 2.7 ohms to 22.0 megohms inclusive.

Special resistance values take special prices, determined for the individual order. Orders for such special values are subject to acceptance by the home office.

The quantity to be used in determining the price must consist of identical resistors. Various resistance values cannot be combined to determine the quantity price.

Part shipments specified by the purchaser will be billed on the basis of the quantity requested for each individual shipment. Part shipments made at the seller's convenience will be billed on the basis of the quantity per item ordered for "one time" shipment.

When "source inspection" is required, add **$1.00** per M to the listed prices. Minimum additional charge for "source inspection" **$2.50** per order.

Where simultaneous shipments are specified for several destinations, add **$2.50** net per order for each destination beyond one.

Minimum billing charge **$10.00**.

Terms are 1% 10th and 25th, net 30 days. F.O.B. Milwaukee, Wisconsin.

All prices, terms and conditions subject to change without notice.

Supersedes Price Sheet 5080 of October 14, 1955
Printed in U. S. A.

Composition Fixed Resistors

January 2, 1957 • • • Price Sheet 5080

Type	Tolerance Plus or Minus	Price per Hundred				Price per Thousand	
		1-99	100-249	250-499	500-999	1000-4999	5000 or More
TR 0.1 Watt	5%	$40.00	$24.00	$20.00	$19.50	$115.00	$105.00
	10%	20.00	12.00	10.00	9.70	58.00	53.00
	20%	18.00	10.80	8.80	8.40	51.00	46.00
EB 0.5 Watt	5%	20.00	10.00	8.00	6.60	37.00	34.00
	10%	10.00	6.00	4.00	3.00	18.00	17.00
	20%	9.00	5.00	3.60	2.80	15.00	13.00
GB 1.0 Watt	5%	30.00	18.00	13.50	11.00	59.00	55.00
	10%	15.00	9.00	6.70	5.50	30.00	27.00
	20%	14.00	8.00	5.70	4.80	25.00	22.00
HB 2.0 Watt	5%	40.00	24.00	20.00	19.50	115.00	105.00
	10%	20.00	12.00	10.00	9.70	58.00	53.00
	20%	18.00	10.80	8.80	8.40	51.00	46.00
GM 3.0 Watt ❶	5%	51.00	32.00	24.00	18.00	100.00	95.00
	10%	31.00	23.00	17.00	12.00	70.00	65.00
HM 4.0 Watt ❶	5%	56.00	38.00	30.00	24.00	160.00	150.00
	10%	35.00	26.00	21.00	17.00	100.00	95.00
TS ⅛ Watt	2% ❷	150.00	108.00	98.00	90.00	810.00	780.00
	5%	112.00	82.00	74.00	68.00	610.00	580.00
ES 1 Watt	2% ❷	100.00	81.00	75.00	71.00	660.00	640.00
	5%	75.00	62.00	57.00	54.00	500.00	480.00

❶ These ratings apply only when resistor is mounted on a metal panel at least 4" x 4" and .050" thick, or the thermal equivalent thereof, at an ambient temperature of 70° C.

❷ Plus or minus 2% tolerance available only in the resistance values which are standard for the ± 5% tolerance.

Listed prices apply only for the STANDARD RETMA, JAN-R-11 and MIL-R-11 resistance values and tolerances between the limits of 10 ohms & 22 megohms inclusive.

Types EB, ES, GB and GM available in preferred number resistance values from 2.7 ohms to 10 ohms at **double** the above listed prices.

All listed types available in preferred number resistance values above 22 megohms, up to and including 100 megohms, at **double** the above listed prices.

Special resistance values take special prices, determined for the individual order. Orders for such special values are subject to acceptance by the home office.

The quantity to be used in determining the price must consist of identical resistors. Various resistance values cannot be combined to determine the quantity price.

Part shipments specified by the purchaser will be billed on the basis of the quantity requested for each individual shipment. Part shipments made at the seller's convenience will be billed on the basis of the quantity per item ordered for "one time" shipment.

When "source inspection" is required, add **$1.00** per M to the listed prices. Minimum additional charge for "source inspection" **$2.50** per order.

Where simultaneous shipments are specified for several destinations, add **$2.50** net per order for each destination beyond one.

Minimum billing charge **$10.00**.

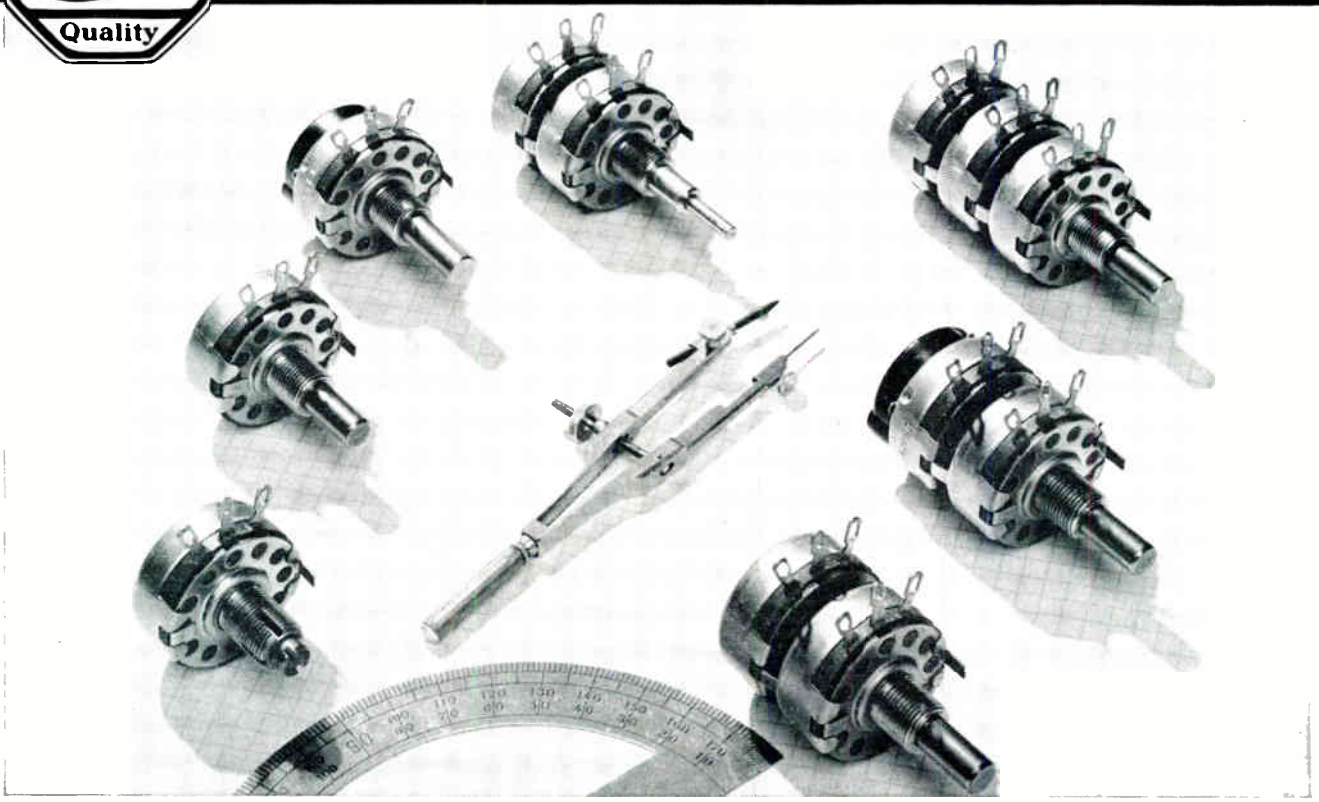
Terms are 1% 10th and 25th, net 30 days. F.O.B. Milwaukee, Wisconsin.

All prices, terms and conditions subject to change without notice.

Supersedes Price Sheet 5080 of September 24, 1956

Composition Variable Resistors
Type J — 2 Watt

March 1, 1956 • • • Technical Bulletin **5200**



Outstanding Features

Exceptional Reliability • • •

Type J controls when used according to Allen-Bradley published ratings and recommendations will not open circuit nor exhibit large erratic changes of resistance value. The combination of a MOLDED COMPOSITION RESISTOR ELEMENT with a cooperating molded composition movable contact brush and high contact pressure provides superior reliability. The simple design including few parts and large safety factors has been proven thoroughly reliable through actual field experience with large numbers of controls over a period of many years.

Small Size VS Rating • • •

Type J variable resistors which are approximately one inch (1") in diameter are rated at 2.25 watts with the entire resistor element in the circuit.

Long Life With Low Noise • • •

These controls have extremely long life in excess of 100,000 cycles. The "noise level" is low initially and becomes still lower with use.

Uniformity • • •

Rigid quality control throughout the entire manufacturing process results in Type J controls exhibiting uniform and consistent characteristics.

Humidity • • •

Less than 5% temporary change of resistance after exposure for 100 hours at +40° C. and 95% relative humidity.

Superior Lock Types • • •

Standard J controls of the shaft locking type can be reset over and over again without deterioration of the mounting bushing threads. JAM NUTS ARE NOT USED.

Corrosion • • •

Type J controls and hardware are made of corrosion resistant materials which pass 200 hour salt-spray tests. See Federal Specification QQ-M-151.

Easy to Solder • • •

For easy soldering, the terminals of Type J controls are hot solder dipped except switch terminals which are tinned.

Specifications • • •

The performance of Type J controls exceeds the highest requirements of the currently available RETMA, JAN-R-94 and MIL-R-94A Specifications.

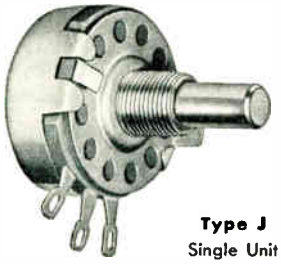
Ideal Tapers • • •

The rate of change of resistance with respect to shaft rotation is continuously controlled to better approximate ideal nominal resistance characteristics. There are five standard tapers including CLOCKWISE EXACT LOGARITHMIC — ATTENUATION IN DECIBELS DIRECTLY PROPORTIONAL TO SHAFT ROTATION.

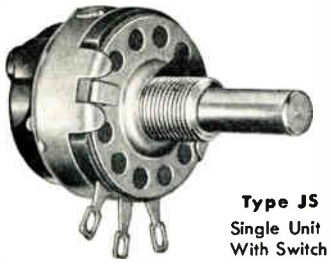
Non-Magnetic • • •

Type J variable resistors and hardware are made of non-magnetic materials.

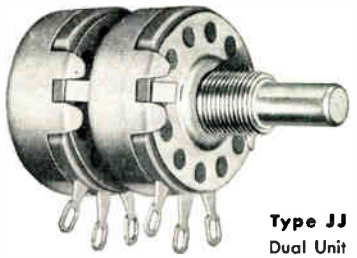
Composition Variable Resistors
Type J — 2 Watt



Type J
Single Unit



Type JS
Single Unit
With Switch



Type JJ
Dual Unit

Application

Allen-Bradley Type J variable resistors are recommended for use as rheostats or potentiometers in ground, marine and airborne military electronic end equipments and in industrial or commercial electronic apparatus where superior performance is desired. They are also recommended for use in home entertainment devices such as radio receivers, television receivers, tape recorders and high fidelity equipments, etc., where the high quality of these devices is the prime consideration. They are designed for continuous operation over the ambient temperature range from −55° C. to +120° C.

Construction

Allen-Bradley does NOT manufacture any film-type variable resistors made by painting or spraying a very thin layer of resistance material onto the surface of insulation material. Such controls often exhibit a relatively short operational life with a rapidly increasing "noise" characteristic. They normally use only two or three linear resistance sections to approximate ideal tapers with the result that control action is often critical and "noisy" at some shaft positions. They are generally susceptible to large resistance changes with changes of ambient relative humidity. Because they usually incorporate rivets, soldered or welded connections, conducting paints or pressure contacts in the fixed electrical circuits, they often prove "noisy" and unreliable. ALLEN-BRADLEY CONTROLS INCLUDE NONE OF THESE UNDESIRABLE FEATURES.

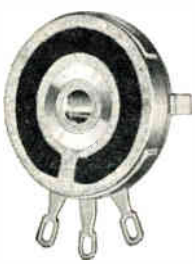
The Allen-Bradley patented Type J variable resistor is a stepless continuously adjustable composition type resistor which incorporates a unique solid molded element. The resistance material, collector ring, the mineral filled insulation material, terminals, face plate and mounting bushing are all molded together at one time into a single solid integral structure. There are no cracks or crevices to admit moisture. The resistivity of the resistance material along the track can be continuously controlled consequently the rate of change of resistance with respect to shaft rotation can be designed to better approximate nominal resistance rotation specifications or tapers. The resistance track has a relatively large molded cross section which results in low current densities and absence of localized high temperatures. The construction also involves considerable mass so temperature changes are relatively slow with the result that excellent performance is obtained with respect to short time overloads of several times rating. The resistance track can be provided with electrical taps at various points with terminals molded integrally. Standard locations correspond to shaft positions of 35%, 50% and 65% of effective clockwise rotation. Single Type J controls with 50% taps and modified logarithmic tapers, back to back, are widely used as fader controls.

Bushings which are molded integrally with the resistance element are offered in five basic types—plain, bevelled shaft lock, plain shaft lock, watertight-shaft and watertight shaft-panel. The Allen-Bradley standard bevelled shaft lock type can be reset over and over again without deterioration of the mounting bushing threads because locking is accomplished by the pressure of a smooth bevelled or conical surface on the inside of a special locking nut against a similar smooth bevelled or conical surface on the end of the bushing. JAM NUTS ARE NOT USED WITH THIS SUPERIOR DESIGN. Bushings are also supplied with slots but without the bevelled surface, for use with jam nuts but are not recommended where subsequent resetting of the shaft position may be necessary. Shaft watertight bushings include an O ring between shaft and bushing. Shaft-panel watertight bushings include one O ring between shaft and bushing and a second O ring to provide a seal between the bushing and the surface on which the control is mounted. Watertight bushings will sustain from zero to thirty foot head of water (differential pressure from zero to 15 PSI) without leakage. A total of twelve standard bushings in the five basic types are listed all of which are ⅜″ in diameter with 32-NEF-2A threads. Special bushings can be supplied.

The face plate which is molded integrally with the resistor element is provided with two locating lugs which are for the purpose of indexing the control with respect to the surface on which it is mounted. As either or both of these lugs can be readily bent over, any one of four options can be supplied. Option #1 is ordinarily followed unless otherwise specified. See Dimensional Drawing No. 5290A.

Shafts are ¼″ in diameter and can be supplied as standard in various lengths in increments of ⅛″ as measured from the mounting face. Standard shaft endings are plain round, screwdriver slot in line with the movable contact or flat diametrically opposite the movable contact. See Dimensional Drawing No. 5290A. Special shaft lengths or shafts with special endings can be supplied.

Type J
With Cover
Removed

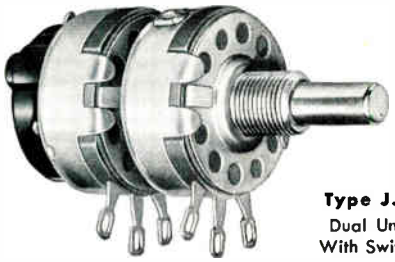


Molded
Resistor
Element

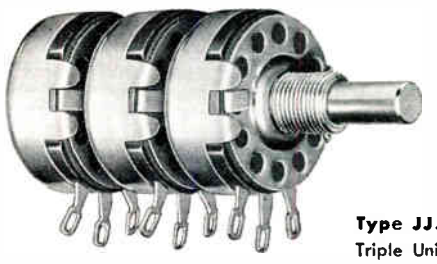
Cross section of resistor element showing connection to resistance material.

Cross section of resistor element showing center terminal connection.

Composition Variable Resistors
Type J — 2 Watt



Type JJS
Dual Unit
With Switch



Type JJJ
Triple Unit

The rotating mechanism which is attached to the operating shaft consists of a metal actuator provided with insulation which supports the pressure spring. The latter maintains the movable composition contact brush in intimate contact with the resistance track and also provides electrical connection between the brush and the collector ring which is molded as an integral part of the element.

All current carrying parts are insulated from the shaft, bushing and enclosure. All metal parts including hardware are made of non-magnetic materials which will pass 200 hour salt-spray corrosion tests. See Federal Specification QQ-M-151.

A metal cover which is sealed to the element with a synthetic resin incorporating a non-mercurial fungicide which meets MIL-V-173A, effectively encloses, electrically shields and mechanically protects the rotating mechanism. As there are no holes in the enclosure Type J variable resistors are dust-tight and splashproof. A depression in the cover cooperates with a projection of the actuator to provide fixed stops.

Type J variable resistors can be ganged to provide dual or triple controls operated by a single shaft. Such controls, in some cases in combination with other components, can be used as L, T and H pad attentuators. Dual controls are also available in concentric shaft construction to enable independent operation of each variable resistor for applications where panel space is at a premium.

Single and dual Type J controls can be supplied with a single pole single throw snap switch, which turns on at start of clockwise rotation only. The switch is shielded.

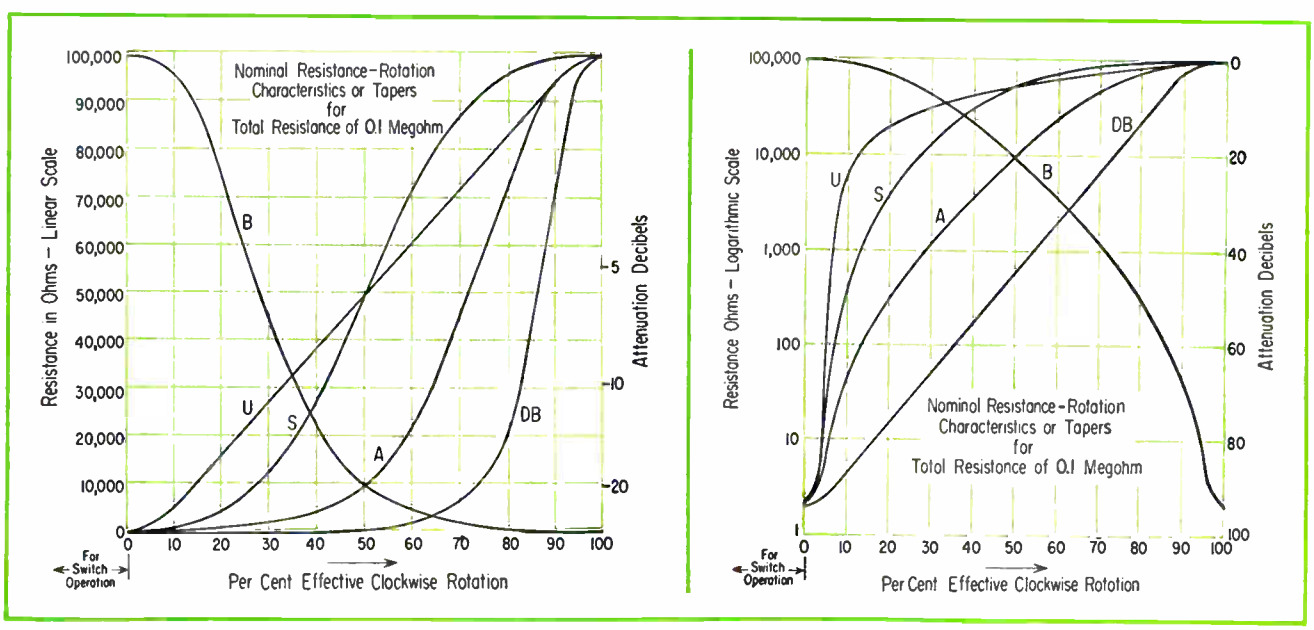
Resistor terminals are hot solder coated and switch terminals are tinned for easy soldering.

All Type J controls are marked with the Allen-Bradley octagon trademark, "Type J", or "Type JS" and "Made in U. S. A." In addition it is customary to indicate an arbitrary specification or catalog number, the resistance rotation characteristic or taper and the total resistance value in ohms or megohms. This marking constitutes a complete description and can be used for reordering purposes. Special marking can be supplied. Special marking data cannot be used for reordering unless the name of the originator is also supplied. Customers commercial specifications are not available to others without the originating customers approval.

Hardware as listed in the detailed specifications can be supplied when specified.

Tapers

Five standard resistance rotation characteristic tapers are offered. The "U" linear taper can be supplied in total resistance values from 50 ohms to 5.0 megohms inclusive. The "A" clockwise modified logarithmic taper, the "B" counterclockwise modified logarithmic taper, the "S" modified linear taper and the "DB" clockwise exact logarithmic taper can be furnished in total resistance values from 100 ohms to 5.0 megohms. The "DB" taper provides voltage attentuation in decibels directly proportional to rotation. Nominal tapers vary somewhat with respect to total resistance values. Special resistance tapers and special total resistance values can be supplied if required.



Small Size VS Rating • • •

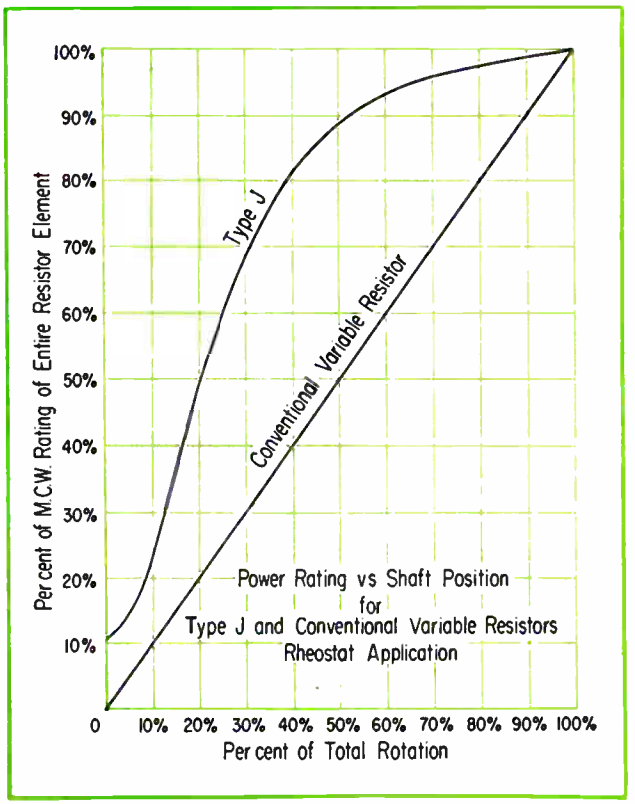
Type J variable resistors which are approximately one inch (1") in diameter, have capabilities because of their unique design, which are not characteristic of conventional controls. The excellent thermal performance of Type J controls results in temperature rise of bushings of **less than 20°C. at FULL RATING** under the specified standard conditions. Further, they are rated for maximum continuous operation at 2.25 watts with 100% of the resistor element in the circuit, **2.0 watts, (89% of full rating) with only 50% of the resistor element and 1.3 watts (58% of full rating) with only 25% of the resistor element.** (Rheostat application, metal panel mounting, +70°C. ambient temperature, "U" linear taper). See curve on this page.

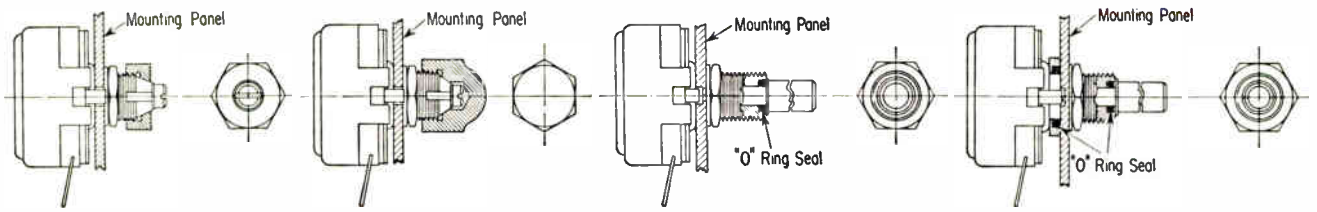
With conventional linear controls the continuous wattage rating is DIRECTLY proportional to the percent of the resistor element in the circuit. Conventional controls rated at 2 watts with 100% of the resistor element would customarily be rated at 1 watt with 50% and 0.5 watt with 25% of the resistor element compared to ratings of 2.0 watts and 1.3 watts respectively for Type J controls. A conventional control meeting the Type J rating of 2.0 watts with only 50% of the resistor element in the circuit would necessarily have a rating of 4 watts with the entire resistor element and would be at least 75% larger in diameter and occupy at least three times the cubic space of the Type J control. Similarly a conventional control meeting the Type J rating of 1.3 watts with only 25% of the resistor element in the circuit would necessarily have a rating with the entire resistor element of at least 5.2 watts and of course would be still larger.

There are no competitive composition type variable resistors, currently available, conventional or otherwise, REGARDLESS OF SIZE which can meet or even come close to the Type J ratings. Therefore, the foregoing size comparisions are based upon relatively unreliable wire wound types which in addition to large size have the disadvantage of resistance steps—they are not continuously adjustable. Such controls are also generally limited to maximum resistance values of the order of 25,000 ohms whereas Allen-Bradley Type J controls are listed as standard in resistance values up to and including 5.0 megohms.

In most applications when variable resistors are used as rheostats maximum power dissipation in the variable resistor does NOT take place when the entire resistor element is in the circuit. Usually maximum power dissipation occurs considerably below the maximum resistance value and it is therefore apparent that the Type J design offers very real advantages with respect to size and wattage rating—advantages which are not immediately obvious.

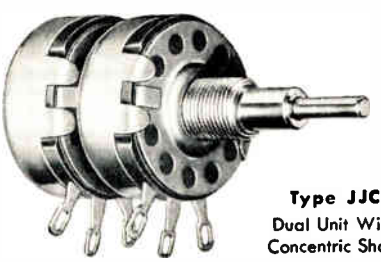
The full power dissipation capabilities of Allen-Bradley Type J variable resistors may not be required in many applications. In these instances the additional safety factor which Type J variable resistors provide without penalty of any kind contributes materially to over all reliability.



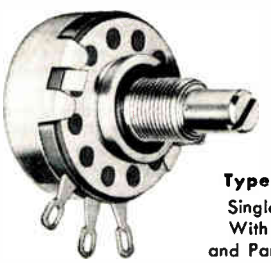


Maximum pile up of mounting panel, mounting lock washer and mounting nut ¼".

Type JL
Single Unit
With Lock
Type Bushing



Type JJC
Dual Unit With
Concentric Shaft



Type JWP
Single Unit
With Shaft
and Panel Seal

General Specifications

Ambient Temperatures — Mechanically and electrically suitable for continuous use throughout temperature range −55° C. to +120° C.

Voltage — Maximum continuous RMS 60 cycle voltage across entire resistor element 500 volts sea level, 300 volts high altitude (3.4" Hg. approximately 50,000 foot altitude). Power and voltage ratings must be met simultaneously.

Power Rating — Refer to page 8 for complete information on power ratings.

Insulation— Current carrying parts are insulated from all metal parts including cover, face plate, shaft and mounting bushing. Maximum continuous potential between current carrying parts and metal parts or ground is 500 volts sea level, 300 volts high altitude (3.4" Hg. approximately 50,000 foot altitude). Hi pot test 1000 volts for 1 second at sea level, 500 volts for 1 second at high altitude. All potentials are RMS 60 cycle and are specified for dry controls.

Current—Maximum continuous 0.25 amperes RMS provided wattage rating met.

Resistance—Maximum or total resistance values from 50 ohms to 5.0 megohms inclusive. Lowest clockwise or counterclockwise minimum specification "4 ohms or less".

Standard Total Resistance Values

50 Ohms	25,000 Ohms
100 Ohms	50,000 Ohms
250 Ohms	0.1 Megohm
500 Ohms	0.25 Megohm
1,000 Ohms	0.5 Megohm
2,500 Ohms	1.0 Megohm
5,000 Ohms	2.5 Megohms
10,000 Ohms	5.0 Megohms

Special values can be supplied.

Tapers or Curves—Standard "U" linear taper available in all standard total resistance values from 50 ohms to 5.0 megohms inclusive.

Standard "A" clockwise modified logarithmic taper, "B" counterclockwise modified logarithmic taper, "S" modified linear taper and "DB" clockwise exact logarithmic taper available in all standard total resistance values from 100 ohms to 5.0 megohms inclusive. The "DB" taper provides voltage attentuation in decibels directly proportional to rotation.

Special tapers and total resistance values can be supplied.

Resistance Tolerances—STANDARD TOLERANCES—On single, dual or triple controls ±10% or ±20% on total resistance values from 50 ohms to 0.5 megohm inclusive. Higher values ±20% only. Midpoint resistance—shaft 156° ±10° from most clockwise position, nominal resistance value ±20%.

SPECIAL TOLERANCES—Single controls total resistance above 0.5 megohm to and including 5.0 megohms ±10%. Dual and triple controls total resistance above 0.5 megohm to and including 1.0 megohm ±10%.

Bushings—All 3/8" diameter 32-NEF-2A thread.
Standard Plain 1/8", 1/4", 3/8" and 1/2" long.
Standard Shaft Lock 1/2" long ONLY—slotted randomly and bevelled. (For shaft locking with special A-B lock nut).
Special Slotted Shaft Lock 3/8" and 1/2" long—slotted randomly. (For shaft locking with jam nut).
Standard Watertight Shaft 1/4", 3/8" and 1/2" long.
Standard Watertight Shaft-Panel 9/32" and 13/32" long.

All bushing lengths are measured from the mounting face of the control and include the bushing washer. Watertight types include O ring seals which withstand from zero to thirty foot head of water (differential pressure of zero to 15 PSI). In shaft-panel watertight controls the mounting face or surface is understood to be the front of the O ring retainer which is in contact with the panel when the control is mounted. See Dimensional Drawing No. 5290A. Allen-Bradley bevelled shaft lock type bushings will prevent shaft rotation with torques up to 40 inch ounces after locknuts have been tightened with torque of 10 inch pounds.

Special bushings can be supplied.

Shafts—Diameter of shafts 1/4". Standard lengths every 1/8" from 3/8" minimum up to 6.0" maximum except shaft-panel watertight every 1/8" from 13/32" minimum up to 5 29/32" maximum.

All shaft lengths are measured from the mounting face of the control to the free end of the shaft. (See preceding comments under BUSHINGS regarding mounting face of shaft-panel watertight controls). All shafts are supplied with a maximum chamfer of 1/32" x 45° at the end. Standard shaft endings include plain round, screwdriver slot in line with movable contact or flat opposite movable contact. See Dimensional Drawing No. 5290A. Special shaft lengths or shafts with special endings can be supplied.

Enclosure—The metal enclosures are sealed with a synthetic resin incorporating a non-mercurial fungicide which meets MIL-V-173A. Type J controls are dust-tight and splashproof.

Turning Torque—Maximum torque required to rotate shaft of single controls 6 inch ounces, plain dual controls 8 inch ounces, concentric shaft dual controls each 6 inch ounces, triple controls 12 inch ounces. Minimum in all cases one inch ounce. (+25°C. ambient).

Stop Torque Rating—Mechanical stops at extreme rotation positions will withstand without damage shaft rotation torque of 12" pounds.

Backlash—Maximum single controls ± 1 1/2°, dual controls 3°, triple controls 6°.

(Continued on Page 6)

General Specifications

(Continued from Page 5)

Rotation—Total rotation without switch 312 degrees plus or minus 3 degrees. With switch, 333 degrees plus or minus 3 degrees. Effective rotation in all cases 312 degrees plus or minus 3 degrees.

Switch—Single pole single throw snap switch available only for "turns on at start of clockwise rotation". Underwriter rating 2 Amperes 125 volts RMS 60 cycle. Underwriter Laboratories approval file number E-10392. Also rated 10 Amperes 10 volts direct current non-inductive. Meets 3 Ampere 117 volts JAN-R-94 and MIL-R-94A specification.

Terminals—For easy soldering resistor terminals hot solder dipped. Switch terminals tinned.

Shielding—Complete—metal cover, metal faceplate, shaft and bushing electrically connected.

Taps—The resistor elements of Type J controls can be provided with single electrical taps at standard locations corresponding to shaft positions of 35%, 50% or 65% of effective clockwise rotation all ± 3%. Two electrical taps can be supplied provided one is between 0 and 50% and the other between 50% and 100% of effective clockwise rotation. The terminal for the 35% tap is located immediately adjacent to terminal No. 1. The terminal for the 50% tap is located diametrically opposite terminal No. 2. The terminal for the 65% tap is located immediately adjacent to terminal No. 3. See Dimension Drawing No. 5290A.

Type J controls with 50% taps and modified logarithmic tapers back to back are widely used as fader controls.

Special tap positions can be supplied.

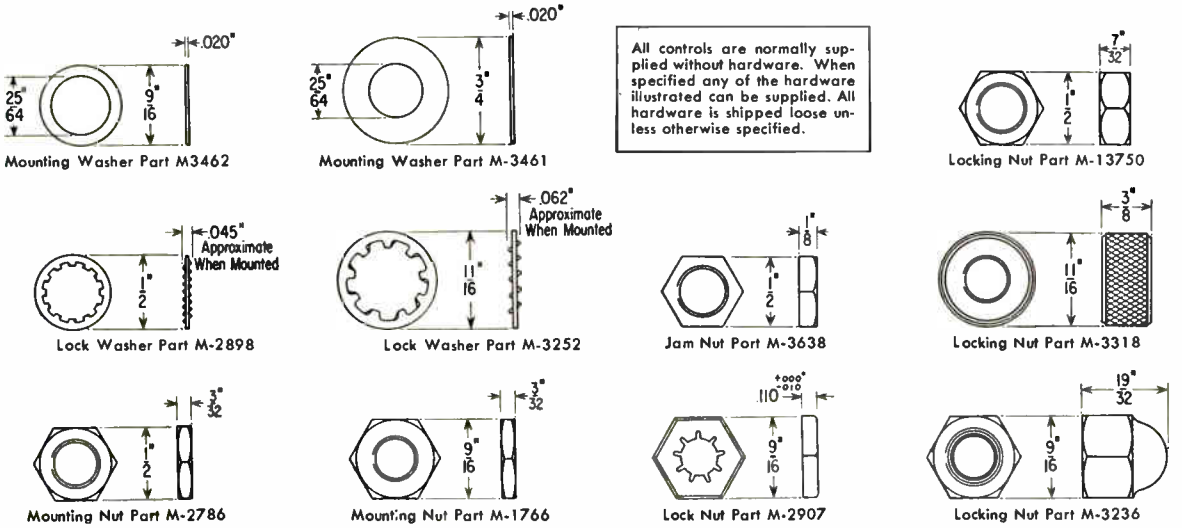
Locating Lugs—Two locating lugs are provided so Type J controls can be indexed with respect to the surface on which they are mounted. Either or both these lugs can be bent over the face plate. Unless otherwise specified controls are supplied in accordance with Option No. 1—one lug up at "9 o'clock" facing shaft with terminals down. See Dimension Drawing No. 5290A.

Marking—All Type J controls are marked with the Allen-Bradley octagon trademark, "Type J", or "Type JS" and "Made in U.S.A.". Unless otherwise specified the back or side of the metal cover includes an arbitrary Allen-Bradley specification number, the resistance rotation characteristic or taper and the nominal total resistance value expressed in ohms or megohms. Special marking can be supplied—space permitting a maximum of 26 characters—13 to a line. Characters approximately 1/16" high. Cover marking data is sufficient for reordering provided in the case of special marking the name of the originator is also supplied. Customers commercial specifications are not available to others without the originating customers approval.

Hardware—ALL TYPE J CONTROLS ARE NORMALLY SUPPLIED WITHOUT HARDWARE. When specified any of the hardware shown below can be supplied. Usually one mounting nut M-2786 and one internal lock washer M-2898 are specified for plain single, dual, or triple controls. One mounting nut M-2786, one internal lock washer M-2898 and one lock nut B-13750 are usually specified for the Allen-Bradley standard shaft lock type controls. Knurled lock nut M-3318 can be used in place of lock nut B-13750. Acorn lock nut M-3236 can be specified in place of lock nut B-13750 provided the maximum shaft extension beyond the bushing does not exceed 1/8". Ordinary slotted bushing controls are usually specified with one mounting nut M-2786, one internal lock washer M-2898 and one jam type lock nut M-3638. Acorn nut M-3236, knurled nut M-3318 and lock nut B-13750 cannot be used with such controls.

All hardware made of non-magnetic materials which will pass 200 hour salt-spray corrosion tests. (See Federal Specification QQ-M-151).

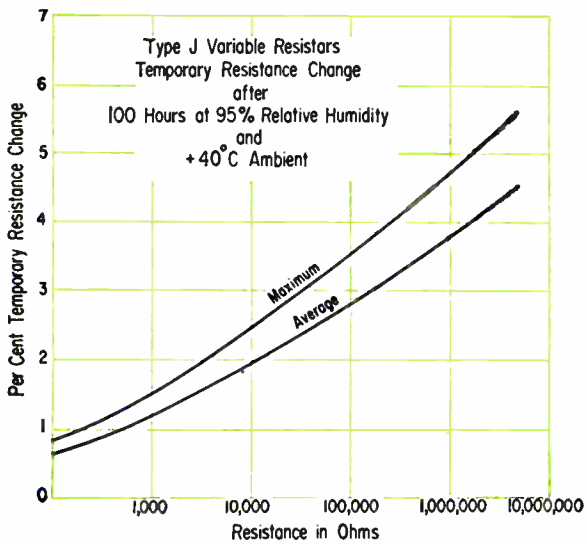
All hardware is shipped loose—not assembled, unless assembly is specified.



Performance Specifications

Load Life—Less than 10% permanent change of resistance after 1000 hours at the recommended continuous working voltage or 2.25 watts with ambient temperature of + 70° C. (Linear taper, entire element in circuit, metal panel mounting).

Humidity Characteristic—Temporary changes of resistance less than 5% after 100 hours at + 40° C. 95% relative humidity.



Temperature Cycling—After five cycles from − 55° C. to + 85° C. less than 2% permanent resistance change.

Voltage Coefficient—Low values negligible—high values less than 0.005% per volt.

Noise—Transient resistance changes with shaft rotation are small initially and become less with use which is contrary to the performance of most conventional variable resistors.

Vibration—Simple harmonic motion with amplitude of 0.03 inches over frequency range 10 to 55 cycles per second for five hours with movable contact at mid position, no mechanical damage and resistance change between any two terminals comparing initial and final readings less than 1½%.

Soldering—After terminals immersed in +350°C. solder pot within ⅛" of element for three seconds, temporary change of resistance less than 2%.

Operational Life—In excess of 100,000 cycles of operation with less than 10% change of resistance. (No load test).

Corrosion Resistance—Type J controls and hardware are made of corrosion resistant non-magnetic materials which pass 200 hour salt-spray tests. (See Federal Specification QQ-M-151).

Specifications—The performance of Type J controls exceeds the highest requirements of RETMA, JAN-R-94 and MIL-R-94A specifications.

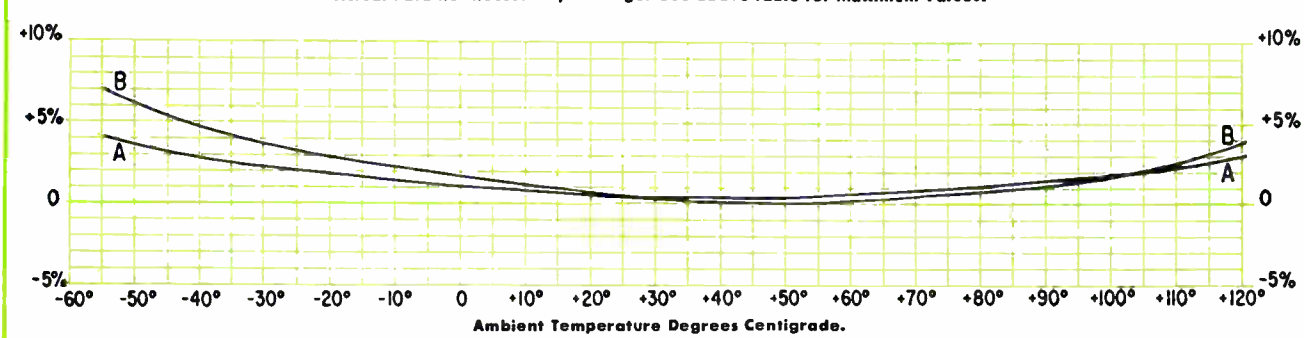
Temperature Characteristic
"U" Linear Taper Type J Variable Resistors

Nominal Resistance	Moximum Percent Temporary Resistonce Change From +25° C. Value (Terminals #1 and #3)						
	−55° C	−25° C	0° C	+25° C	+55° C	+85° C	+120° C
100 Ohms	+ 4.5	+2.5	+1.5	0	±1.0	±1.5	+3.5
1,000 Ohms	+ 5.5	+3.0	+1 5	0	±1.0	±2.0	+4.5
10,000 Ohms	+ 7.0	+3.5	+2.0	0	±1.0	±2.5	+5.5
100,000 Ohms	+ 8.0	+4.0	+2.0	0	±1.5	±3.0	+6.0
1 Megohm	+10.0	+5.0	+2.5	0	±1.5	±3.5	+7.5

Above for "U" linear taper. For "A", "B", "S" and "DB" tapers multiply percentage figures shown by 1.25.

Curves Showing Per Cent Temporary Resistance Changes from Plus 25° Centigrade Values.

A=Total Resistance 10,000 Ohms; B=Total Resistonce 0.5 Megohms.
Actual data not necessarily average. See above table for Maximum Values.



Power Ratings

Power Ratings—The power ratings and other information listed below are based upon "U" linear resistance rotation characteristics or tapers, metal panel mountings, ambient temperature of +70° C. and entire resistor elements in circuit. NOTE last paragraph for important derating information when the above standard conditions do not apply.

Single Controls — Maximum continuous power rating in watts entire resistor element in circuit is 2.25 watts.

Dual Controls—The permissable power dissipation in one resistor element is a function of the power dissipation in the other resistor element. Maximum continuous power ratings in watts with both entire resistor elements in the circuit are as follows:

	WATTS									
Panel Resistor	2.25	2.0	1.75	1.5	1.25	1.0	0.75	0.5	0.25	0
Rear Resistor	0	0.83	1.13	1.34	1.49	1.61	1.7	1.76	1.79	1.8

(The panel resistor is the resistor element immediately adjacent the mounting panel.)

These maximum relationships must be maintained and at all times meet the requirement that:

$$\left(\frac{W_1}{2.25}\right)^2 + \left(\frac{W_2}{1.8}\right)^2 = 1 \text{ (Maximum)}$$

Where W_1 = Watts in entire panel resistor element.
W_2 = Watts in entire rear resistor element.

See nomograph page 9.

For best results the panel resistor element should always be selected for the highest wattage requirement.

Triple Controls—If either the middle or rear resistor element of a triple control operates at no load then the triple control can be treated as a dual and the ratings specified in the preceding paragraph for the panel resistor element can be used for the panel resistor element of the triple control. Also the ratings specified for the rear resistor element of the dual can be used for either the middle or the rear resistor element of the triple whichever carries load. When all three resistor elements carry load, the maximum continuous power rating of any one resistor element is a function of the power dissipation in the other two. The relative power relationship must be maintained and at all times meet the requirement

that $\left(\frac{W_1}{2.25}\right)^2 + \left(\frac{W_2}{1.8}\right)^2 + \left(\frac{W_3}{1.8}\right)^2 = 1 \text{ (Maximum)}$

Where W_1 = Watts in entire first or panel resistor element.
W_2 = Watts in entire second or middle resistor element.
W_3 = Watts in entire third or rear resistor element.

See nomograph page 9.

A few examples which meet the requirement follow:

First or Panel Resistor Element W_1	Second or Middle Resistor Element W_2	Third or Rear Resistor Element W_3
0.5 watts	0.5 watts	1.68 watts
0.5 watts	1.0 watts	1.44 watts
0.5 watts	1.5 watts	.90 watts
1.0 watts	0.5 watts	1.53 watts
1.0 watts	1.0 watts	1.27 watts
1.0 watts	1.5 watts	.59 watts
1.5 watts	0.5 watts	1.24 watts
1.5 watts	1.0 watts	.89 watts
2.0 watts	0.5 watts	.65 watts

For best results the panel resistor element should always be selected for the highest wattage requirement. The third or rear resistor element should be selected for the second highest wattage requirement.

Derating — The ratings for all controls whether single, dual or triple as determined from the preceding paragraphs apply specifically for the standard conditions ONLY which are "U" linear tapers, metal panel mountings, ambient temperatures of +70° C. and entire resistor elements in circuit.

To determine ratings for other conditions the following derating factors should be applied independently.

Derating with Respect to Ambient Temperature — Derate linearly from +70° C. wattage rating determined above to zero at +120° C. ambient temperature.

Ambient Temperature	Derating Multiplier	Ambient Temperature	Derating Multiplier
+70°C.	1.00	+100°C.	.40
+80°C.	.80	+110°C.	.20
+90°C.	.60	+120°C.	0

Derating with Respect to Rotation—Rheostat Application

Percent Rotation	Multiply Wattage Rating By	Percent Rotation	Multiply Wattage Rating By
100	1.0	40	.81
90	.99	30	.68
80	.98	20	.49
70	.96	10	.23
60	.93	0	.11
50	.89		

Derating with Respect to Taper—For "A", "B", "S" and "DB" tapers multiply wattage ratings determined above by 0.5.

Derating with Respect to Mounting — For phenolic or ceramic mounting in place of metal panel multiply wattage ratings determined above by 0.5.

Dual or Triple Variable Resistors
Maximum Continuous Power Ratings in Watts
Based On
Metal Panel Mountings, + 70° C. Ambient Temperatures
Linear Tapers and Entire Resistor Elements.

Dual Controls

For best results select the first resistor element immediately adjacent the mounting panel for the highest wattage requirement W_1.

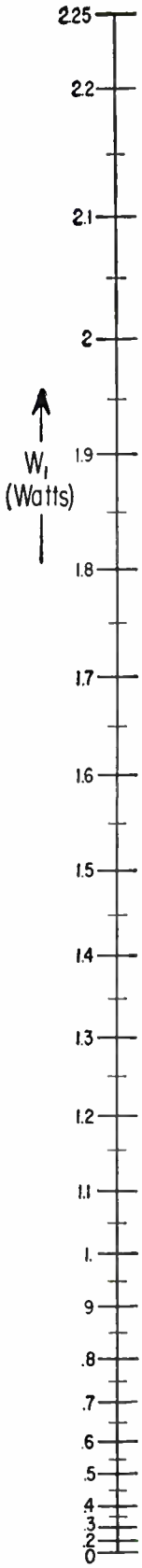
The maximum permissable continuous watts for the second or rear resistor element, under the specified conditions, can then be determined by the STRAIGHT edge intersection with scale W_2 on the graph when the straight edge intersects the value of W_1 on scale W_1 and the point where $W_3 = 0$ on scale W_3.

Triple Controls

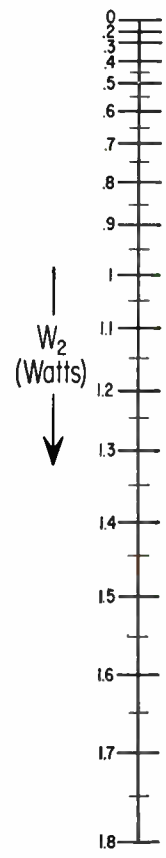
Where three resistor elements are required best results are obtained when the first resistor element immediately adjacent the mounting panel is selected for the highest wattage requirement W_1. The second or middle resistor element should be selected for the lowest wattage requirement W_2 and the third or rear resistor element should be selected for the second highest wattage requirement W_3.

If the load in watts for any two resistor elements is known the permissable maximum continuous watts for the third resistor element under the specified conditions can be determined by the intersection of the STRAIGHT edge on the "unknown" scale when the straight edge passes through the two known values on their respective scales.

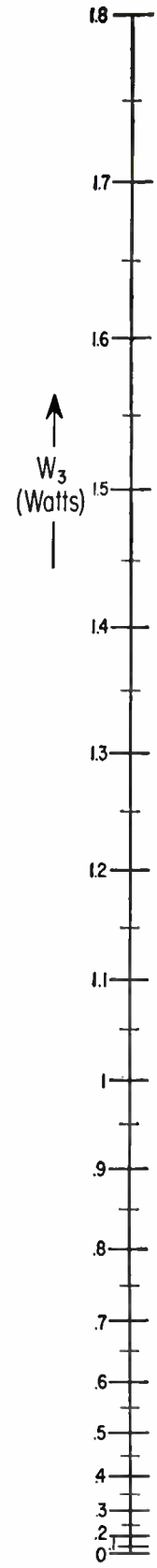
(See page 8 for important derating information.)



W_1 = Watts in first resistor element. (Immediately adjacent panel when control is mounted.)



W_2 = Watts in second resistor element. (Rear in case of dual, middle in case of triple.)



W_3 = Watts in third resistor element. (Rear of triple.)

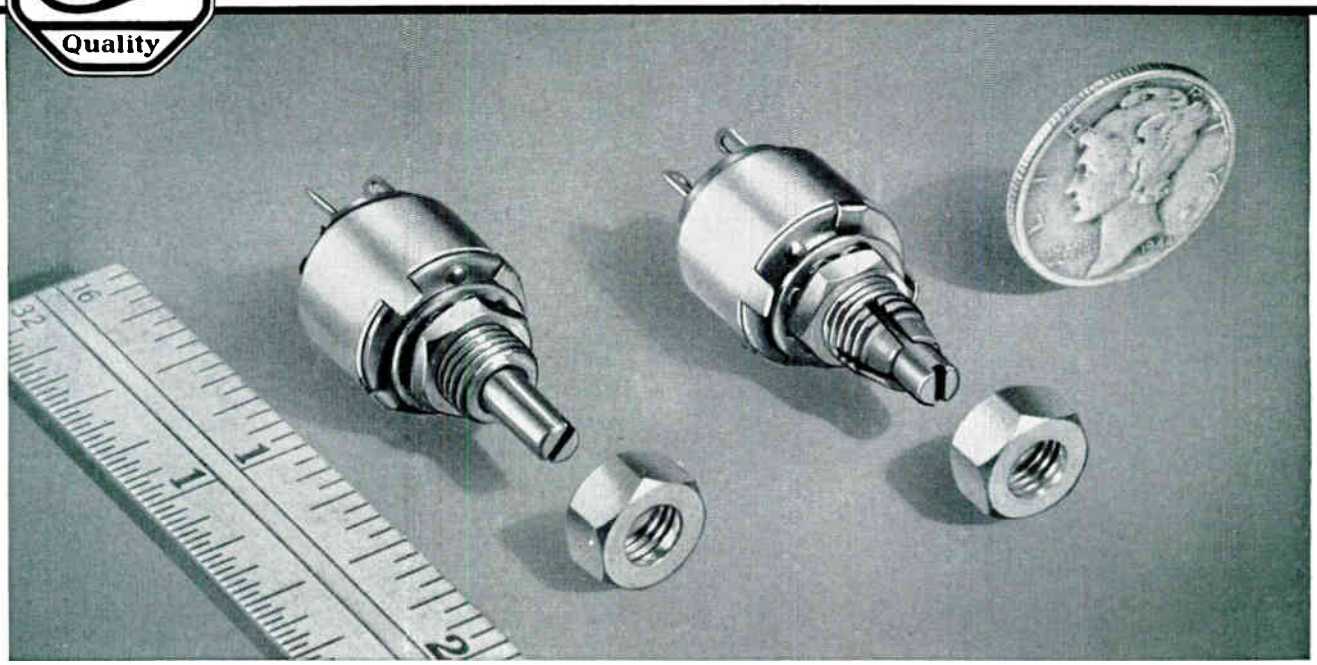
ALLEN-BRADLEY CO.

MILWAUKEE, WISCONSIN

Printed in U. S. A.

Composition Variable Resistors
Type G — 1/2 Watt

July 1, 1955 • • • Technical Bulletin **5201**



Outstanding Features

Exceptional Reliability • • •

Type G controls when used according to published ratings and recommendations will not open circuit nor exhibit large erratic changes of resistance value. The combination of a molded composition resistor and molded composition collector with a cooperating molded composition movable contact brush and high contact pressure provides vastly superior reliability. The simple design including few parts and large safety factors is based upon the Allen-Bradley Type J control which has proven so reliable over a period of many years.

Small Size • • •

Type G composition type variable resistors are the smallest currently available. They are only ½ inch in diameter.

Long Life with Low Noise • • •

The molded composition contact brush, in cooperation with the molded resistor track and the molded collector track provides extremely long life in excess of 50,000 cycles with low noise level—initially—**decreasing with use.**

Uniformity • • •

Rigid quality control throughout the entire manufacturing process results in Type G controls exhibiting uniform and consistent characteristics.

Humidity • • •

After exposure for 100 hours at 40 degrees Centigrade and 95% relative humidity the temporary changes of resistance are less than 5%.

Corrosion • • •

Allen-Bradley Type G controls and hardware are made of corrosion resistant materials, which pass 200 hour salt-spray tests. (See military specification QQ-M-151.)

Superior Shaft Lock Design • • •

The Allen-Bradley shaft lock design permits resetting of the shaft position over and over again without damage or deterioration of the bushing threads. JAM NUTS ARE NOT USED.

Easy to Solder • • •

The terminals of Type G controls are gold plated so that they can be soldered easily when the controls are new or after they have been in stock for a long time.

Specifications • • •

The performance of Type G controls exceeds the highest requirements of the currently available RETMA, JAN-R-94 and MIL-R-94A specifications.

Ideal Tapers • • •

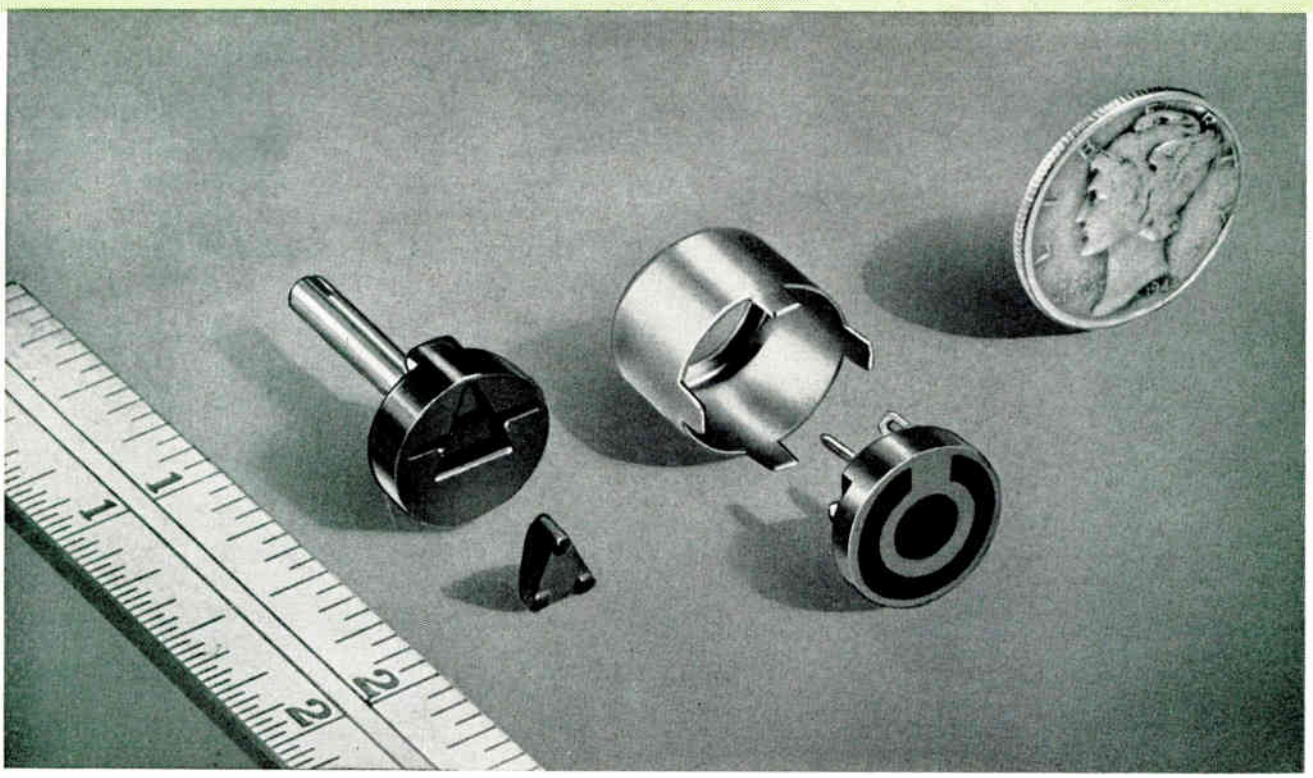
Paint or film type controls normally use two or three linear resistance sections to approximate ideal tapers with the result that control action is usually critical at some shaft positions. This is not true of Type G controls because the rate of change of resistance is continuously controlled and almost any ideal nominal resistance characteristic can be supplied. There are three standard tapers—linear, clockwise and counter-clockwise modified logarithmic.

Ratings • • •

In spite of their small size Type G controls have a maximum continuous power rating of 0.5 watts at 70°C ambient with the entire element in the circuit—metal panel mounting. Maximum continuous voltage rating across the resistor element or between current carrying parts and metal parts or ground is 350 volts R.M.S. (The power and voltage ratings must be met simultaneously.)

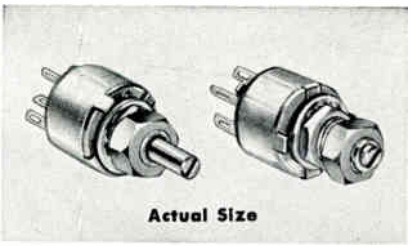
Composition Variable Resistors

Type G — ½ Watt



Application

Type G continuously adjustable molded composition resistors can be used for rheostat or potentiometer applications in electronic equipment. Their small size (½ inch in diameter) and the fact that they can be encapsulated make them ideally suited for subminiature assemblies. They are available with plain or shaft locking bushings. Shafts available include plain, flatted or screwdriver slotted.



Actual Size

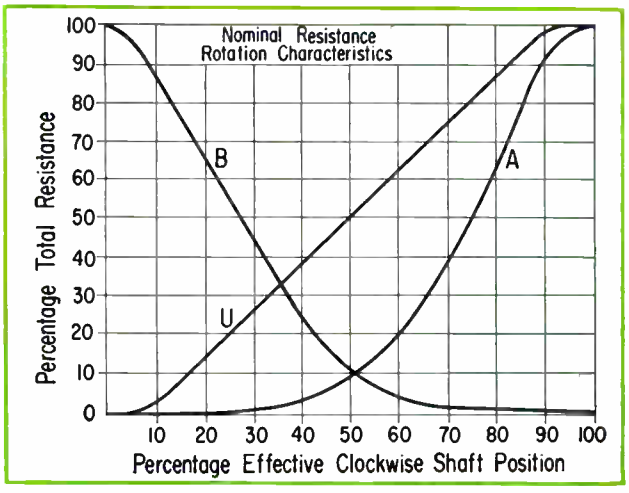
Construction

Allen-Bradley does NOT manufacture any film-type variable resistors made by painting or spraying resistance material on to the surface of insulation material. Such controls often exhibit a relatively short operational life and are generally susceptible to large resistance changes with changes of ambient relative humidity. Because they usually incorporate rivets, soldered or welded connections conducting paints or pressure contacts in the fixed electrical circuits, they often prove unreliable. **Allen-Bradley controls include none of these undesirable features.** The unique design of the Type G variable resistor incorporates a **molded** composition resistor track and a molded composition low resistance collector track, bridged by a single movable molded composition brush. The resistance material, collector track material, insulation material and the terminals are all molded together at one time into a single solid integral structure. There are no cracks or crevices to admit moisture. The molded resistor track has a relatively large cross section which results in low current densities. This construction involves considerable mass with consequent excellent performance with respect to short time overloads. The rotor is molded integrally with the shaft and is recessed to receive the molded composition brush and pressure springs. The insulation material, used throughout the control, is a mineral filled molding compound which possesses excellent dielectric properties. There are no metal sliding contacts in the electrical circuits and no lubricant on the composition sliding contact surfaces.

All Type G controls incorporate an "O" Ring seal between shaft and bushing and are watertight at this point. The metal enclosures are sealed with a synthetic resin incorporating a fungicide approved under JAN-C-173 Amend. #1 (non-mercurial). Type G controls are dust-tight and splashproof.

Tapers

Three standard resistance rotation characteristic tapers are offered. The "U" linear taper is listed as standard in total resistance values from 100 ohms to 5.0 megohms inclusive. The "A" clockwise modified logarithmic taper and the "B" counter-clockwise modified logarithmic taper are listed as standard in total resistance values from 500 ohms to 2.5 megohms. Special tapers and resistance values can be supplied.



General Specifications

Ambient Temperatures—Mechanically and electrically suitable for use throughout temperature range from minus 55 degrees C. to plus 120 degrees C.

Dimensions—See dimensional drawing #5291.

Power—Maximum continuous entire element in circuit 0.5 watts. Fifty per cent of element 0.25 watts, 25% of element 0.13 watts; based on linear taper control, mounted on metal panel ambient temperature 70 degrees C. Derate linearly to zero at 120 degrees C. ambient. Derate 50% for Type A and B tapers.

Voltage—Maximum continuous R.M.S. 60 cycle voltage across entire element 350 volts sea level, 200 volts high altitude (3.4" Hg.—approximately 50,000 ft.). Power and voltage ratings must be met simultaneously.

Insulation—Current carrying parts are insulated from all metal parts including cover, face plate, shaft and mounting bushing. Maximum continuous potential between current carrying parts and metal parts or ground is 350 volts sea level, 200 volts high altitude (3.4" Hg.). Hi Pot test 750 volts for 1 second at sea level, 350 volts for 1 second at high altitude. All potentials are R.M.S. 60 cycle and are specified for dry controls.

Current—Maximum continuous 0.1 amperes R.M.S. provided wattage rating met.

Resistance—Maximum or total resistance values from 100 ohms to 5.0 megohms inclusive. Lowest minimum specification "15 ohms or less".

Standard Total Resistance Values

100 Ohms	0.1 Megohm
250 Ohms	0.25 Megohm
500 Ohms	0.5 Megohm
1,000 Ohms	1.0 Megohm
2,500 Ohms	2.5 Megohms
5,000 Ohms	5.0 Megohms
10,000 Ohms	
25,000 Ohms	
50,000 Ohms	

Special resistance values can be supplied.

Tapers or Curves—Standard "U" linear taper available in all standard total resistance values from 100 ohms to 5.0 megohms inclusive.

Standard "A" clockwise modified logarithmic taper available in all standard total resistance values from 500 ohms to 2.5 megohms.

Standard "B" counter-clockwise modified logarithmic taper available in all standard total resistance values from 500 ohms to 2.5 megohms.

Special tapers and resistance values can be supplied.

Tolerances—Standard tolerance on total resistance value, plus or minus 10% or plus or minus 20% up to and including 0.5 megohm. Higher values plus or minus 20% only. Midpoint 147 degrees, plus or minus 10 degrees, from most clockwise knob position nominal resistance, plus or minus 20%. Total resistance values above 0.5 megohm can be supplied on a special basis with tolerance of plus or minus 10%.

Noise—Transient resistance changes with shaft rotation are small initially and less **after use.**

Plain Bushing—¼" diameter 32-NEF-2A, standard ¼", ⅜" and ½" long measured from mounting face to end of bushing. Special bushings can be supplied.

Lock Type Bushing—¼" diameter 32-NEF-2A standard ⅜", ½" and ⅝" long measured from mounting face to end of bushing. These bushings are randomly slotted. After lock nuts are tightened with torque of 10" lbs. shafts will not turn with torques up to 25" ounces.

Standard G controls of the shaft locking type can be reset over and over again without deterioration of the bushing threads. The Allen-Bradley shaft locking design includes a smooth conical surface on the inside of the special locking nut which engages a similar smooth conical surface on the end of the bushing. When the locking nut is tightened pressure is applied through the conical surface to force the slotted bushing against the shaft thus locking it in the desired position. JAM NUTS ARE NOT USED WITH THIS SUPERIOR DESIGN.

Shafts—Diameter of shafts ⅛". Minimum length 5/16", maximum length 2½". Standard lengths 5/16", ⅜", 7/16", ½", 9/16", ⅝", 11/16", ¾", ⅞", 1", 1⅛", 1¼", 1⅜", 1½", 1⅝", 1¾", 1⅞", 2", 2⅛", 2¼", 2⅜", 2½". All shaft lengths are measured from the mounting face of the control to the free end of the shaft. All shafts are supplied with a maximum chamfer of 1/64" x 45° at the end. Standard shaft endings include plain round, screw driver slot in line with movable contact or flat opposite movable contact. See dimension drawing No. 5291. Special shaft lengths or shafts with special endings can supplied.

Seal—All Type G controls incorporate an "O" Ring seal between shaft and bushing and are watertight at this point (zero to thirty foot head of water —zero to 15 p.s.i.).

Enclosure—The metal enclosures are sealed with a synthetic resin incorporating a fungicide approved under JAN-C-173 Amend. #1 (non-mercurial). Type G controls are dust-tight and splashproof.

Turning Torque—Torque required to rotate shaft 3 inch ounces maximum, (+25 degrees C. ambient), 5 inch ounces maximum (-55 degrees C. ambient).

Stop Breaking Torque—Mechanical stops at extreme rotation positions will withstand without damage shaft rotation torque of 4" pounds.

Rotation—Total rotation 295 degrees plus or minus 3 degrees.

(Continued on Page 4)

Composition Variable Resistors

Type G — ½ Watt

General Specifications

(Continued from Page 3)

Backlash—Maximum 3 degrees.

Terminals—Terminals are gold plated so they can be soldered easily when controls are new or after they have been in stock for a long time.

Locating Lugs—Two locating lugs are provided so Type G controls can be indexed with respect to the surfaces on which they are mounted. See dimension drawing No. 5291. Either or both of these lugs can be bent over the face plate.

Hardware—All Type G controls are normally supplied without hardware. If specified, plain controls can be supplied with one mounting nut M4721 and one internal lock washer, M4748. If specified, lock type controls can be supplied with one mounting nut M4721, one internal lock washer M4748, and one lock nut M4761. Lock type controls with maximum shaft extension 1/16" beyond the bushing can be supplied with acorn lock nut M4768 instead of lock nut M4761. See dimension drawing No. 5291. All hardware shipped loose—not assembled unless otherwise specified.

Corrosion Resistance—Type G controls and hardware are made of corrosion resistant materials, which pass 200 hour salt-spray tests. (See military specification QQ-M-151.)

Marking—Standard Allen-Bradley marking on the side of the metal enclosure includes an arbitrary specification number, a letter to indicate the resistance rotation characteristic or taper and the nominal total resistance value expressed in ohms or megohms.

Special marking can be supplied space permitting a maximum of 26 characters, 13 to a line on the side of the enclosure.

All marking of necessity is done with approximately 1/16" characters.

All Type G controls are marked with the Allen-Bradley octagon trademark.

Non-Magnetic—Type G variable resistors and hardware are made of non-magnetic materials.

Ganged Controls—Type G controls are NOT available in dual or triple construction.

Taps—Type G controls because of their small size cannot be supplied with electrical taps.

Performance Specifications

Load Life—Less than 10% permanent change of resistance after 1000 hours at the recommended continuous working voltage (0.5 watt maximum) with ambient temperature of 70 degrees C. (the entire element in circuit, metal panel mounting, linear taper).

Temperature Cycling—After five cycles from minus 55 degrees C. to plus 85 degrees C. less than 2% permanent resistance change.

Humidity Characteristic—Temporary changes of resistance less than 5% after 100 hours at 40 degrees C. 95% relative humidity.

Voltage Coefficient—Low values negligible—high values less than 0.005 per cent per volt.

Vibration—After simple harmonic motion with amplitude of 0.03 inches over frequency range 10 to 55 cycles per second for five hours with movable contact at mid position, no mechanical damage and resistance change between any two terminals less than 1½%.

Soldering—After terminals immersed in 350 degrees C. solder pot within 1/8" of element for three seconds, temporary change of resistance is less than 2%.

Operational Life—In excess of 50,000 cycles of operation with less than 10% change of resistance.

Temperature Characteristic
"U" Linear Taper Type G Variable Resistors

Nominal Resistance	MAXIMUM PERCENT TEMPORARY RESISTANCE CHANGE FROM +25°C VALUE (TERMINALS #1 & #3)						
	−55°C	−25°C	0°C	+25°C	+55°C	+85°C	+120°C
100 Ohms	+ 4.5	+2.5	+1.5	0	±1.0	±1.5	+3.5
1,000 Ohms	+ 5.5	+3.0	+1.5	0	±1.0	±2.0	+4.5
10,000 Ohms	+ 7.0	+3.5	+2.0	0	±1.0	±2.5	+5.5
100,000 Ohms	+ 8.0	+4.0	+2.0	0	±1.5	±3.0	+6.0
1 Megohm	+10.0	+5.0	+2.5	0	±1.5	±3.5	+7.5

For "A" and "B" tapers multiply percentage figures shown above by 1.25.

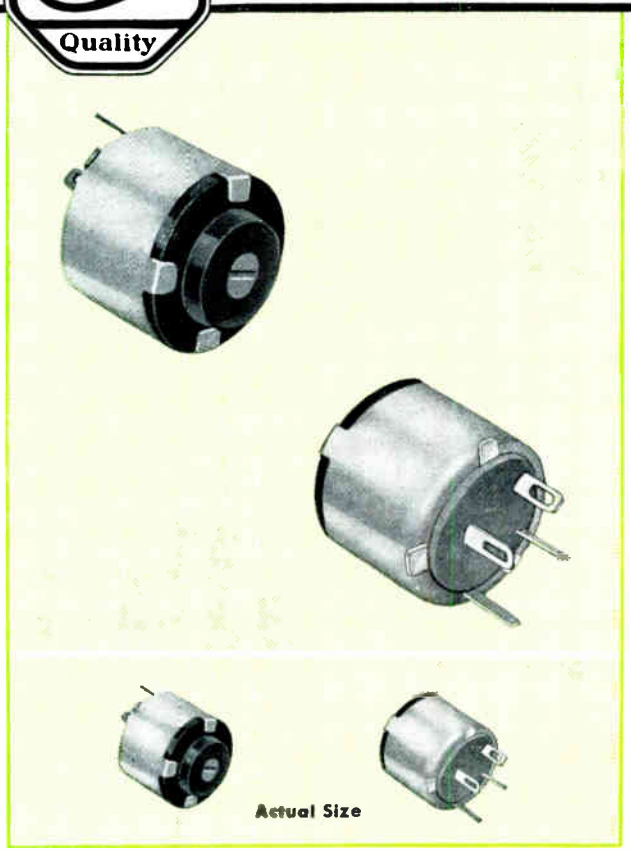
Printed in U.S.A.

ALLEN-BRADLEY COMPANY • MILWAUKEE, WISCONSIN

Composition Variable Resistors

Type F — 1/4 Watt

November 15, 1955 • • • Technical Data 5202



Application • • •

Type F continuously adjustable molded composition resistors can be used for rheostat or potentiometer applications in electronic equipment. Their small size (½ inch in diameter) and the fact that they can be encapsulated make them ideally suited for subminiature assemblies. They are intended specifically for printed circuit applications and are available for screwdriver operation only.

Construction • • •

Allen-Bradley does NOT manufacture any film-type variable resistors made by painting or spraying resistance material on to the surface of insulation material. Such controls often exhibit a relatively short operational life and are generally susceptible to large resistance changes with changes of ambient relative humidity. Because they usually incorporate rivets, soldered or welded connections conducting paints or pressure contacts in the fixed electrical circuits, they often prove unreliable. Allen-Bradley Controls include none of these undesirable features. The unique design of the Type F variable resistor incorporates a molded composition resistor track and a molded composition low resistance collector track, bridged by a single movable molded composition brush. The resistance material, collector track material, insulation material and the terminals are all molded together at one time into a single solid integral structure. There are no cracks or crevices to admit moisture. The molded resistor track has a relatively large cross section which results in low current densities. This construction involves considerable mass with conse-

Outstanding Features

Exceptional Reliability • • •

Type F controls when used according to published ratings and recommendations will not open circuit nor exhibit large erratic changes of resistance value.

Small Size • • •

Type F composition type variable resistors are only ½ inch in diameter.

Low Noise • • •

Small rapid variations of resistance which in some applications result in noise or other modulation effects are extremely low when controls are new and become less with use.

Uniformity • • •

Rigid quality control throughout the entire manufacturing process results in Type F controls exhibiting uniform and consistent characteristics.

Humidity • • •

After exposure for 100 hours at 40 degrees Centigrade and 95% relative humidity the temporary changes of resistance are less than 5%.

Corrosion • • •

Allen-Bradley Type F controls are made of corrosion resistant materials, which pass 200 hour salt-spray tests. (See military specification QQ-M-151.)

Easy to Solder • • •

Terminals are gold plated and grounding lugs are hot solder dipped so they can be soldered easily when controls are new or after they have been in stock for a long time.

Specifications • • •

The performance of Type F controls exceeds the highest requirements of the currently available RETMA, JAN-R-94 and MIL-R-94A specifications.

Ideal Tapers • • •

Paint or film type controls normally use two or three linear resistance sections to approximate ideal tapers with the result that control action is usually critical at some rotation positions. This is not true of Type F controls because the rate of change of resistance is continuously controlled and almost any ideal nominal resistance characteristic can be supplied. There are three standard tapers—linear, clockwise and counter-clockwise modified logarithmic.

Ratings • • •

In spite of their small size Type F controls have a maximum continuous power rating of 0.25 watts at +70° C ambient with the entire element in the circuit—phenolic panel mounting. Maximum continuous voltage rating across the resistor element or between current carrying parts and metal parts or ground is 350 volts R.M.S., 60 cycle. (The power and voltage ratings must be met simultaneously.)

quent excellent performance with respect to short time overloads. The rotor or actuator is recessed to receive the molded composition brush and pressure springs. The insulation material, used throughout the control, is a mineral filled molding compound which possesses excellent dielectric properties. There are no metal sliding contacts in the electrical circuits and no lubricant on the composition sliding contact surfaces.

All Type F controls incorporate an "O" Ring seal between actuator and faceplate and are watertight at this point. The metal enclosures are sealed with a synthetic resin incorporating a fungicide approved under JAN-C-173 Amend. #1 (non-mercurial). Type F controls are dust-tight and splashproof. The design of Type F controls is similar to that of Type G controls. See Technical Bulletin 5201.

Tapers

Three standard resistance rotation characteristic tapers are offered. The "U" linear taper is listed as standard in total resistance values from 100 ohms to 5.0 megohms inclusive. The "A" clockwise modified logarithmic taper and the "B" counter-clockwise modified logarithmic taper are listed as standard in total resistance values from 500 ohms to 2.5 megohms. Special tapers and resistance values can be supplied. See Technical Bulletin 5201 for curve chart.

General Specifications

Ambient Temperatures — Mechanically and electrically suitable for use throughout temperature range from — 55 degrees C. to + 120 degrees C.

Power—Maximum continuous entire element in circuit 0.25 watts. Fifty per cent of element 0.13 watts, 25% of element 0.07 watts; based on linear taper control mounted on a phenolic panel and an ambient temperature of + 70° C. Derate linearly to zero at + 120° C. ambient. Derate 50% for Type A and B tapers. The safety factors in the foregoing ratings are highest when maximum heat conduction thru the terminals and the grounding lug is attained.

Voltage—Maximum continuous R.M.S. 60 cycle voltage across entire element 350 volts sea level, 200 volts high altitude (3.4" Hg.—approximately 50,000 ft.). Power and voltage ratings must be met simultaneously.

Current — Maximum continuous 0.1 amperes R.M.S. provided wattage rating met.

Insulation—Current carrying parts are insulated from all metal parts including cover. Maximum continuous potential between current carrying parts and metal parts or ground is 350 volts sea level, 200 volts high altitude (3.4" Hg.). Hi Pot test 750 volts for 1 second at sea level, 350 volts for 1 second at high altitude. All potentials are R.M.S. 60 cycle and are specified for dry controls.

Grounding—Metal covers of Type F controls are supplied with a grounding lug to enable electrical connection between the cover and ground.

Tapers or Curves—Standard "U" linear taper available in all standard total resistance values from 100 ohms to 5.0 megohms inclusive.

Standard "A" clockwise modified logarithmic taper available in all standard total resistance values from 500 ohms to 2.5 megohms.

Standard "B" counter-clockwise modified logarithmic taper available in all standard total resistance values from 500 ohms to 2.5 megohms.

Special tapers and resistance values can be supplied.

Mounting—Type F controls are mounted by means of the terminals and the grounding lug which are spaced for 0.1" printed circuit layout.

Resistance—Maximum or total resistance values from 100 ohms to 5.0 megohms inclusive. Lowest minimum specification "15 ohms or less".

Standard Total Resistance Values

100 Ohms	10,000 Ohms	0.1 Megohm
250 Ohms	25,000 Ohms	0.25 Megohm
500 Ohms	50,000 Ohms	0.5 Megohm
1,000 Ohms		1.0 Megohm
2,500 Ohms		2.5 Megohms
5,000 Ohms		5.0 Megohms

Special resistance values can be supplied.

Tolerances—Standard tolerance on total resistance value plus or minus 10% or plus or minus 20% up to and including 0.5 megohm. Higher values plus or minus 20% only. Midpoint 147 degrees, plus or minus 10 degrees, from most clockwise position, nominal resistance, plus or minus 20%. Total resistance values above 0.5 megohm can be supplied on a special basis with tolerance of plus or minus 10%.

Noise—Transient resistance changes with rotation are small initially and less **after use.**

Operation—Type F variable resistors are supplied for screwdriver operation only. The screwdriver slot is molded in an extension of the plastic piece which serves as the rotor.

Seal—All Type F controls incorporate an "O" Ring seal between the screwdriver slotted plastic actuator and the plastic faceplate and are watertight at this point. (Zero to thirty foot head of water —Zero to 15 p.s.i.).

Enclosure—The metal enclosures are sealed with a synthetic resin incorporating a fungicide approved under JAN-C-173 Amend. #1 (non-mercurial). Type F controls are dust-tight and splashproof.

Torque Ratings—Mechanical stops at extreme rotation positions will withstand without damage rotation torque of four inch pounds.

Screwdriver slot will withstand without damage torque of ten inch **ounces.**

Torque required to rotate actuator three inch ounces maximum (+25 degrees C. ambient), five inch ounces maximum (— 55 degrees C. ambient).

General Specifications

Rotation—Total rotation 295 degrees plus or minus 3 degrees.

Backlash—Maximum 3 degrees.

Easy to Solder—Terminals are gold plated and grounding lugs are hot solder dipped so they can be soldered easily when controls are new or after they have been in stock for a long time.

Corrosion Resistance—Type F controls are made of corrosion resistant materials, which pass 200 hour salt-spray tests. (See military specification QQ-M-151.)

Marking—Standard Allen-Bradley marking on the side of the metal enclosure includes an arbitrary specification number, a letter to indicate the resistance rotation characteristic or taper and the nominal total resistance value expressed in ohms or megohms.

Special marking can be supplied space permitting a maximum of 26 characters, 13 to a line on the side of the enclosure.

All marking of necessity is done with approximately 1/16" characters.

All Type F controls are marked with the Allen-Bradley octagon trademark.

Non-Magnetic—Type F variable resistors are made of non-magnetic materials.

Ganged Controls—Type F controls are NOT available in dual or triple construction.

Taps—Type F controls because of their small size cannot be supplied with electrical taps.

Performance Specifications

Load Life—Less than 10% permanent change of resistance after 1000 hours at recommended continuous working voltage (0.25 watt maximum) with ambient temperature of + 70 degrees C. (entire element in circuit, phenolic panel mounting, linear taper).

Temperature Cycling—After five cycles from — 55 degrees C. to + 85 degrees C. less than 2% permanent resistance change.

Humidity Characteristic—Temporary changes of resistance less than 5% after 100 hours at 40 degrees C. 95% relative humidity.

Voltage Coefficient—Low values negligible—high values less than 0.005 per cent per volt.

Vibration—After simple harmonic motion with amplitude of 0.03 inches over frequency range 10 to 55 cycles per second for five hours with movable contact at mid position, no mechanical damage and resistance change between any two terminals less than 1½%.

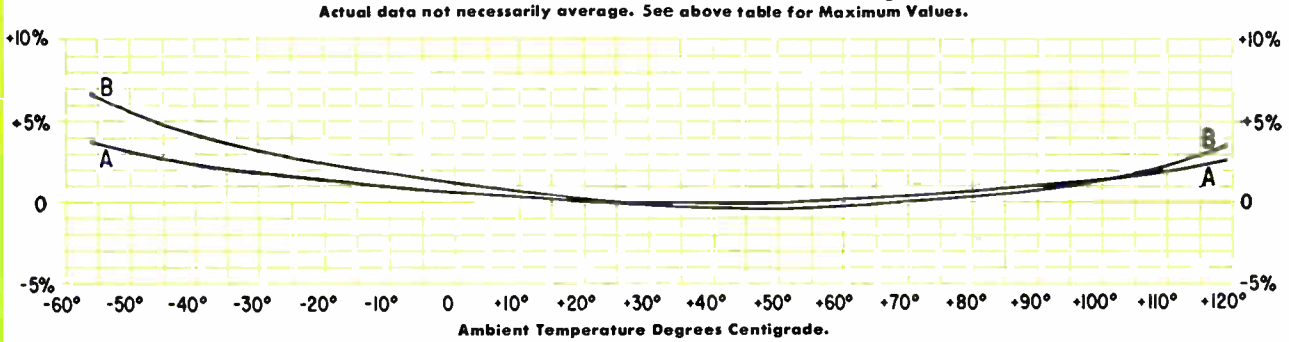
Soldering—After terminals immersed in 350 degrees C. solder pot within ⅛" of element for three seconds, temporary change of resistance less than 2%.

Temperature Characteristic
"U" Linear Taper Type F Variable Resistors

Nominal Resistance	Maximum Percent Temporary Resistance Change From +25° C. Value (Terminals #1 and #3)						
	−55° C	−25° C	0° C	+25° C	+55° C	+85° C	+120° C
100 Ohms	+ 4.5	+2.5	+1.5	0	±1.0	±1.5	+3.5
1,000 Ohms	+ 5.5	+3.0	+1.5	0	±1.0	±2.0	+4.5
10,000 Ohms	+ 7.0	+3.5	+2.0	0	±1.0	±2.5	+5.5
100,000 Ohms	+ 8.0	+4.0	+2.0	0	±1.5	±3.0	+6.0
1 Megohm	+10.0	+5.0	+2.5	0	±1.5	±3.5	+7.5

For "A" and "B" tapers multiply percentage figures shown above by 1.25.

Curves Showing Per Cent Temporary Resistance Changes from Plus 25° Centigrade Values.
A=Total Resistance 10,000 Ohms; B=Total Resistance 0.5 Megohms.
Actual data not necessarily average. See above table for Maximum Values.



ALLEN-BRADLEY CO.

MILWAUKEE, WISCONSIN

Printed in U. S. A.

Composition Variable Resistors
Type T — 1/2 Watt

September 4, 1956 • • •

Technical Bulletin 5203

Outstanding Features

Exceptional Reliability • • •

Type T variable resistors when used according to published ratings and recommendations will not open circuit nor exhibit large erratic changes of resistance value. The combination of a molded composition resistor, molded composition collector, cooperating molded composition movable contact brush and high contact pressure provides vastly superior reliability. The simple design including few parts and large safety factors is based upon the Allen-Bradley Type J control which has proven so reliable over a period of many years.

Small Size • • •

Type T controls with screwdriver slot actuator have a maximum diameter of .790 inches and a maximum extension from the mounting surface of only .340 inches.

Type T controls with knurled actuator have a maximum diameter of .840 inches and a maximum extension from the mounting surface of only .280 inches.

Long Life With Low Noise • • •

The molded composition movable contact brush, molded resistor track and molded collector track make possible extremely long life in excess of 50,000 cycles. The "noise level" is low initially and becomes still lower with use which is contrary to the performance of most conventional variable resistors.

Uniformity • • •

Rigid quality control throughout the entire manufacturing process results in Type T controls exhibiting uniform and consistent characteristics.

Humidity • • •

After exposure for 100 hours at + 40 degrees Centigrade and 95% relative humidity the temporary changes of resistance are less than 5%.

Corrosion • • •

Type T controls and hardware are made of corrosion resistant materials, which pass 200 hour salt-spray tests. (See Federal Specification QQ-M-151).

Easy to Solder • • •

The lead wire terminals of Type T controls are hot solder dipped. Bushings are electro-tin plated.

Specifications • • •

The PERFORMANCE of Type T controls exceeds the highest requirements of the currently available RETMA, JAN-R-94 and MIL-R-94A specifications.

Ideal Tapers • • •

Paint or film type controls normally use two or three linear resistance sections to approximate ideal tapers with the result that control action is usually critical and "noisy" at some shaft positions. Such undesirable performance is not encountered with Type T controls because the rate of change of resistance is continuously controlled to better approximate ideal nominal resistance characteristics. There are three standard tapers — linear, clockwise and counter-clockwise modified logarithmic.

Non-Magnetic • • •

Type T variable resistors and hardware are made of non-magnetic materials.

Ratings • • •

In spite of their small size Type T controls have a maximum continuous power rating of 0.5 watt at + 70° C. ambient with the entire element in the circuit, linear taper, phenolic panel mounting. Maximum continuous voltage rating across the resistor element is 500 volts R.M.S. sea level and dry. (Power and Voltage ratings must be met simultaneously).

Composition Variable Resistors
Type T — ½ Watt

Application

Type T continuously variable molded composition resistors are recommended for rheostat or potentiometer applications in military or commercial electronic equipments where superior performance is desired. Their small size and shape make them ideally suited for subminiature assemblies, PRINTED CIRCUITS, etc. They are designed for operation over the ambient temperature range from −55° C. to + 120° C. They are available with plain bushings or lock type bushings and are supplied for either direct hand or screwdriver operation of the contactor.

Construction

Allen-Bradley does NOT manufacture any film-type variable resistors made by painting or spraying a very thin layer of resistance material onto the surface of insulation material. Such controls often exhibit a relatively short operational life with a rapidly increasing "noise" characteristic. They are generally susceptible to large resistance changes with changes of ambient relative humidity. Because they usually incorporate rivets, soldered or welded connections, conducting paints or pressure contacts in the fixed electrical circuits, they often prove "noisy" and unreliable. ALLEN-BRADLEY CONTROLS INCLUDE NONE OF THESE UNDESIRABLE FEATURES.

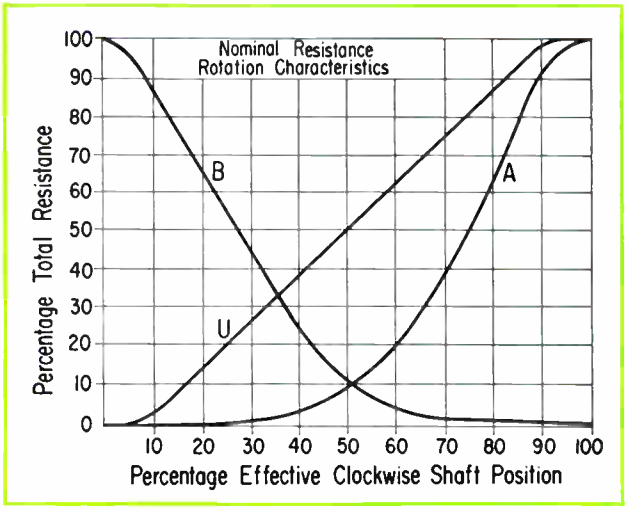
The unique design of the Type T variable resistor incorporates a molded composition resistor track and a molded composition low resistance collector track, bridged by a single movable molded composition brush. The resistance material, collector track material, mounting bushing, mineral filled insulation material and wire terminals are all molded together at one time into a single solid integral structure. There are no cracks or crevices in the molded element to admit moisture. The resistivity of the resistance material along the track can be continuously controlled consequently the rate of change of resistance with respect to shaft rotation can be designed to approximate practically any nominal resistance rotation specification or taper. The molded resistor track has a relatively large cross section which results in low current densities. This construction involves considerable mass with consequent excellent performance with respect to short time overloads. The insulating rotor or actuator which is used as an enclosure and also as a means of operating the control is molded integrally with the shaft and is recessed to receive the molded composition brush and pressure spring. The insulation material, used throughout the control, is a mineral filled molding compound which possesses excellent dielectric properties. There are no metal sliding contacts in the electrical circuits and no lubricant on the composition sliding contact surfaces.

As operation of Type T controls is accomplished by direct action on the molded rotor which has the dual function of serving as a rotor or actuator and as an enclosure these controls are not ordinarily supplied for shaft operation. In the Type T control the bushing serves as a bearing for the rotor shaft and as a means of mounting the control. The shaft serves only to support the rotor and allow its rotation.

The bushings of Type T controls are electrically connected to the movable contact so they are best suited for PRINTED CIRCUIT applications where they are mounted directly on an insulating board or panel. Supplementary insulation must be provided for metal panel mounting unless the movable contact can be at the same potential as the metal surface on which the control is mounted.

Tapers

Three standard resistance rotation characteristic tapers are offered. The "U" linear taper can be supplied in standard total resistance values from 100 ohms to 5.0 megohms inclusive. The "A" clockwise modified logarithmic taper and the "B" counter-clockwise modified logarithmic taper can be furnished in standard total resistance values from 500 ohms to 2.5 megohms. Special tapers and resistance values can be supplied.



General Specifications

Ambient Temperatures — Mechanically and electrically suitable for continuous use throughout temperature range from minus 55 degrees C. to plus 120 degrees C.

Power—Maximum continuous entire element in circuit 0.5 watt. Fifty per cent of element 0.25 watt, 25% of element 0.13 watt: based on linear taper control, mounted on phenolic panel, ambient temperature + 70 degrees C. Derate linearly to zero at + 120 degrees C. ambient. Derate 50% for Type A and B tapers.

Voltage—Maximum continuous R.M.S. 60 cycle voltage across entire element 500 volts sea level, 300 volts high altitude (3.4 Hg. approximately 50,000 feet). Power and voltage ratings must be met simultaneously.

Insulation—The mounting bushing is electrically connected to the movable contact. The maximum continuous potential between current carrying parts and ground, therefore, depends entirely upon the supplementary insulation provided.

Current—Maximum continuous 0.1 amperes R.M.S. provided wattage rating met.

Resistance—Maximum or total resistance values from 100 ohms to 5.0 megohms inclusive. Lowest minimum specification "15 ohms or less".

Standard Total Resistance Values

100 Ohms	5,000 Ohms	0.25 Megohm
250 Ohms	10,000 Ohms	0.5 Megohm
500 Ohms	25,000 Ohms	1.0 Megohm
1,000 Ohms	50,000 Ohms	2.5 Megohms
2,500 Ohms	0.1 Megohm	5.0 Megohms

Tapers or Curves—Standard "U" linear taper available in all standard total resistance values from 100 ohms to 5.0 megohms inclusive.

Standard "A" clockwise modified logarithmic taper available in all standard total resistance values from 500 ohms to 2.5 megohms.

Standard "B" counter-clockwise modified logarithmic taper available in all standard total resistance values from 500 ohms to 2.5 megohms.

Special resistance values and tapers can be supplied.

Resistance Tolerances — Standard tolerances —on total resistance value, plus or minus 10% or plus or minus 20% up to and including 0.5 megohm. Higher values plus or minus 20% only. Mid-point resistance—actuator 145 degrees, plus or minus 10 degrees, from most clockwise position, nominal resistance value plus or minus 20%.

Special tolerance—total resistance values above 0.5 megohm to and including 2.5 megohms can be supplied on a special basis with tolerance of plus or minus 10%.

Plain Type Bushing—⅜" diameter #10-32 NF2 thread .166" long. Maximum mounting panel thickness .075" when used with standard A-B lockwasher and mounting nut.

Shaft-lock Type Bushing—⅜" diameter #10-32 NF2 thread .375" long, randomly slotted. Maximum mounting panel thickness .075" when used with standard A-B lockwasher mounting nut and lock nut. After locknut has been tightened with torque of 6 inch pounds maximum, actuator will not turn with torques up to 6 inch ounces.

Shafts—Type T controls are not supplied for shaft operation and shaft lengths therefore are always .250" max. for plain controls and .445" max. for shaft lock controls measured from mounting face to end of shaft. These dimensions result in shaft extensions beyond bushings just long enough to permit anchoring of shafts in bushings by means of C washers. See Dimensional Drawing No. 5290D.

Enclosure — As type T controls are supplied for direct operation by rotating the actuator, they are not completely enclosed and are therefore not dust-tight nor splashproof.

Turning Torque — Torque required to rotate shaft 2 inch ounces maximum (+ 25 degrees C. ambient), 4 inch ounces maximum (— 55 degrees C. ambient).

Stop Torque Rating — Mechanical stops at extreme rotation positions will withstand without damage actuator rotation torque of 4 inch pounds.

Rotation — Total rotation 290 degrees plus or minus 3 degrees.

Backlash—Maximum 3 degrees.

Terminals — The lead wire terminals of Type T controls are hot solder dipped. Bushings are electro-tin plated.

Taps—Type T controls because of their small size cannot be supplied with electrical taps.

Operation — Actuator with knurled exterior for hand operation or screwdriver slot in line with movable contact. See Dimensional Drawing No. 5290D.

Hardware—All Type T controls are normally supplied without hardware. If specified, plain controls can be supplied with one mounting nut M-4134 and one internal lock washer M-4377. If specified, lock type controls can be supplied with one mounting nut M-4134, one internal lock washer M-4377, and one lock nut M-4383. See Dimensional Drawing No. 5290D.

All hardware made of non-magnetic materials which will pass 200 hour salt spray corrosion tests. (See Federal Specification QQ-M-151).

All hardware shipped loose — not assembled — unless otherwise specified.

(Continued on Page 4)

General Specifications

(Continued from Page 3)

Marking—The Allen-Bradley octagon trademark is molded into the actuators of all Type T controls. In addition, unless otherwise specified, Type T controls carry standard eight character marking interpreted as follows:

Character	Marking	Explanation
First	T	Type of Control
Second	either K	Knurled actuator
	or S	Screwdriver slot actuator
Third	either R	Plain bushing
	or L	Slotted shaft lock bushing
Fourth	either U	Linear taper
	or A	Clockwise modified log-taper
	or B	Counter-clockwise modified log-taper

Next three characters denote total resistance value in ohms.

Fifth	A single digit	First figure of total resistance value.
Sixth	A single digit	Second figure of total resistance value.
Seventh	A single digit	Number of zeros following second figure.
Eighth	either 1	±10% Tolerance on total resistance.
	or 2	± 20% Tolerance on total resistance.

Example: Marking TKRU5042 indicates a Type T control with knurled actuator, a plain bushing, a "U" linear taper with a resistance value of 0.5 megohm plus or minus 20 per cent.

Special marking can be supplied, space permitting a maximum of 8 characters approximately 1/16" high.

Marking data is sufficient for reordering provided, in the case of special marking, the name of the originator is also supplied. Customers commercial specifications are not available to others without the originating customers approval.

Performance Specifications

Load Life—Less than 10% permanent change of resistance after 1000 hours at the recommended continuous working voltage (0.5 watt maximum) with ambient temperature of + 70 degrees C., the entire element in circuit, phenolic panel mounting, linear taper.

Humidity Characteristic—Temporary changes of resistance less than 5% after 100 hours at + 40 degrees C. 95% relative humidity.

Voltage Coefficient—Low values negligible—high values less than 0.005 per cent per volt.

Noise—Transient resistance changes with shaft rotation are small initially and become less with use which is contrary to the performance of most conventional variable resistors.

Temperature Cycling—After five cycles from minus 55 degrees C. to plus 85 degrees C. less than 2% permanent resistance change.

Temperature Characteristic—The temporary changes of resistance with respect to ambient temperature are as indicated below when compared with plus 25° values.

Vibration—Simple harmonic motion with amplitude of 0.03 inches over frequency range 10 to 55 cycles per second for five hours with movable contact at mid position, no mechanical damage and resistance change between any two terminals comparing initial and final readings less than 1½%.

Soldering—After lead wires immersed in + 350 degrees C. solder pot within 1/8" of element for three seconds, temporary change of resistance is less than 2%.

Operational Life—In excess of 50,000 cycles of operation with less than 10% change of resistance.

Corrosion Resistance—Type T controls and hardware are made of corrosion resistant materials which pass 200 hour salt spray tests. (See Federal Specification QQ-M-151).

Non-Magnetic—Type T variable resistors and hardware are made of non-magnetic materials.

Specifications—The PERFORMANCE of Type T controls exceeds the highest requirement of RETMA, JAN-R-94 and MIL-R-94A specifications.

Temperature Characteristic
"U" Linear Taper Type T Variable Resistors

Nominal Resistance	Maximum Percent Temporary Resistance Change From +25° C. Value (Terminals #1 and #3)						
	−55° C.	−25° C.	0° C.	+25° C.	+55° C.	+85° C.	+120° C.
100 Ohms	+ 4.5	+2.5	+1.5	0	±1.0	±1.5	+3.5
1,000 Ohms	+ 5.5	+3.0	+1.5	0	±1.0	±2.0	+4.5
10,000 Ohms	+ 7.0	+3.5	+2.0	0	±1.0	±2.5	+5.5
100,000 Ohms	+ 8.0	+4.0	+2.0	0	±1.5	±3.0	+6.0
1 Megohm	+10.0	+5.0	+2.5	0	±1.5	±3.5	+7.5

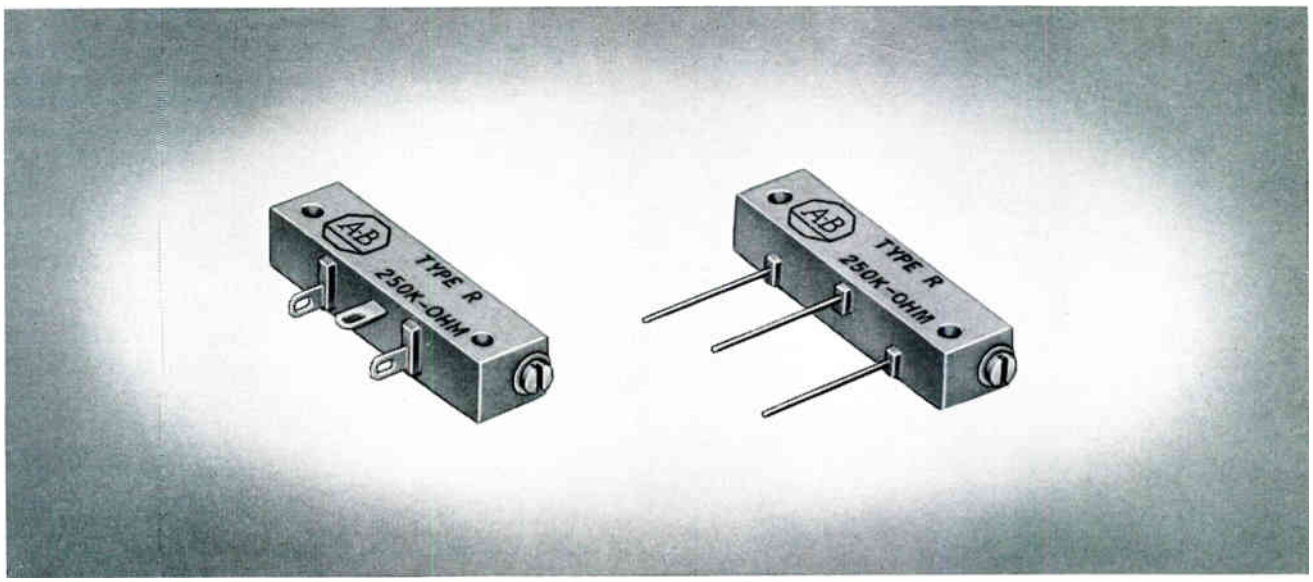
For "A" and "B" tapers multiply percentage figures shown above by 1.25.

Printed in U. S. A.

Composition Variable Resistors
Type R • ¼ Watt

March 11, 1959

Technical Bulletin 5205



Type R rectilinear "variable" resistors are here referred to as continuously adjustable "fixed" resistors to emphasize their outstanding performance from that point of view. They are intended specifically for use in compact equipments for adjustment or balancing of circuits. Unexcelled with respect to stability of setting under shock and vibration, they do not require readjustment except to compensate for change or drift of other components. Type R resistors are therefore supplied for screwdriver operation only. Their continuous, stepless control of resistance makes possible easy, precise adjustment. Since they have low distributed capacitance, and are relatively non-inductive regardless of resistance value, Allen-Bradley Type R resistors can be used in applications where the ordinary wire-wound types are entirely unsatisfactory.

Type R resistors incorporate the same basic design features which have been responsible for the superior performance characteristics of the Type J, Type G and other Allen-Bradley resistors. They include a resistor element made by the exclusive Allen-Bradley hot molding process, which combines high resistance material, low resistance commutator material, mineral filled insulation material and metal pin or lug terminals into a single, solid, integral structure. The use of a carbon, self-locking, movable contact brush eliminates all metal sliding contacts and contact lubrication. Three terminals enable either rheostat or potentiometer application.

Allen-Bradley Type R composition resistors are watertight and dust-tight, and each complete unit can be potted.

Outstanding Features

Reliability—When used in accordance with Allen-Bradley published ratings and recommendations, Type R resistors will not open or short circuit, nor will they exhibit erratic changes of resistance value. The combination of a rugged, solid, hot molded, dual track resistor element with a cooperating molded carbon contact brush and high contact pressure provides superior reliability. Substantial terminals are integrally molded. There are no fine wires or delicate electrical connections to corrode or break, nor are there any metallic sliding contacts or contact lubrication to cause erratic action.

Enclosure—The sealed, molded, insulating enclosure with "O" ring-equipped adjustment screw provides reliable watertight and dust-tight performance. The entire unit can be potted.

Insulation Resistance—The unique design exhibits an unusually high insulation resistance substantially exceeding 1,000 megohms.

Stable Setting—Type R resistors are unexcelled with respect to stability of setting under shock and vibration.

Stepless, Continuous Resistance Control—Resistors incorporating conventional wirewound resistor elements are step type devices because the resistance changes abruptly as the movable contact moves from one turn of resistance wire to the next adjacent turn. Such resistors introduce transients when operated, and it is impossible to set them at intermediate resistance values between turns. **Type R resistors are continuously adjustable and can be set to any resistance value within the particular design limits.**

Long Operational Life—The proven, low friction construction results in long life as compared to wirewound types, in which the movable contact rides and wears directly on fine resistance wires.

Standoff Mounting—Type R resistors are provided with insulation landing pads around pin or lug terminals at the resistor body to maintain physical separation between resistor and printed wiring board. When the resistors are so mounted, the pads prevent moisture from collecting between the terminals due to capillary action.

New Information

General Specifications

Power and Voltage Ratings—Maximum continuous power rating—¼ watt with maximum of 350 volts rms, entire resistor element in circuit, +70°C ambient temperature, sea level. Derate linearily to zero power at +120°C.

Resistance—Standard total resistance values from 100 ohms to 2.5 megohms with resistance tolerance of ±10% or ±20%. Resistance change directly proportional, nominally, to adjustment screw rotation.

Standard Total Resistance Values and Nominal Resistance Working Range

Total Resistance	Nominal Resistance Working Range
100 Ohms	20 Ohms to 80 Ohms
250 Ohms	20 Ohms to 230 Ohms
500 Ohms	25 Ohms to 470 Ohms
1,000 Ohms	50 Ohms to 950 Ohms
2,500 Ohms	100 Ohms to 2,400 Ohms
5,000 Ohms	200 Ohms to 4,800 Ohms
10,000 Ohms	400 Ohms to 9,600 Ohms
25,000 Ohms	1,000 Ohms to 24,000 Ohms
50,000 Ohms	2,000 Ohms to 48,000 Ohms
0.1 Megohms	4,000 Ohms to 96,000 Ohms
0.25 Megohms	10,000 Ohms to 0.24 Megohms
0.5 Megohms	20,000 Ohms to 0.48 Megohms
1.0 Megohms	40,000 Ohms to 0.96 Megohms
2.5 Megohms	0.1 Megohms to 2.4 Megohms

Marking—Allen-Bradley octagon trademark plus "Type R". Space available for maximum of eight characters on each of two lines for customer's part number or other identification, all on left-hand side looking at screw actuator with terminals down.

Adjustment Screw—Corrosion resistant. Turning torque—from two to eight inch-ounces. Continuous resistance change provided over approximately 25 complete turns, with mechanical release at end positions in place of fixed stops. Screwdriver operating slot nominally 0.031" by 0.031".

Ambient Temperatures—Mechanically and electrically suitable for continuous use throughout temperature range of −55°C to +120°C.

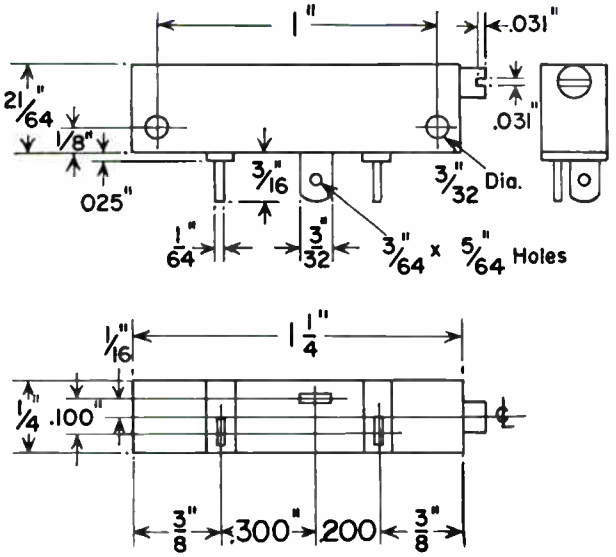
Temperature Characteristics—Similar and of the same order as for Type J variable resistors. See Technical Bulletin 5200.

Terminals—Gold plated, either pin or lug types, for easy soldering, spaced on 0.1 inch grid system for printed wiring boards.

Enclosure—The sealed, molded, insulating enclosure with "O" ring-equipped adjustment screw provides reliable dust-tight and watertight performance. The entire unit can be potted.

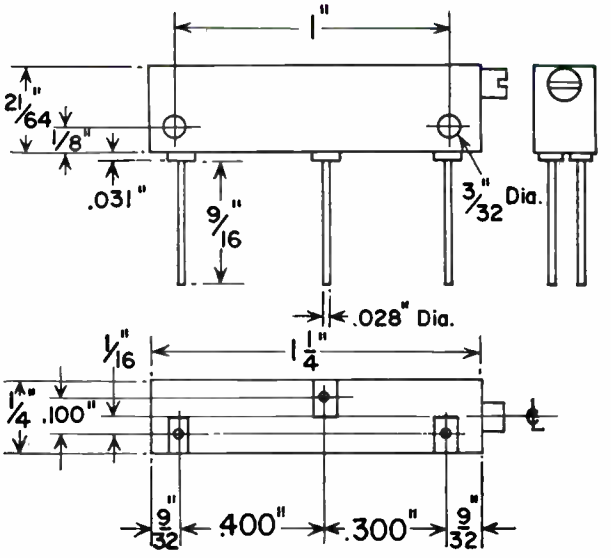
Insulation—Maximum continuous potential between current carrying parts and adjustable screw—350 volts rms. Hi pot test—700 volts rms for one second at sea level. The insulation resistance exceeds 1,000 megohms.

Dimensions



Type R

With Lug Type Terminals

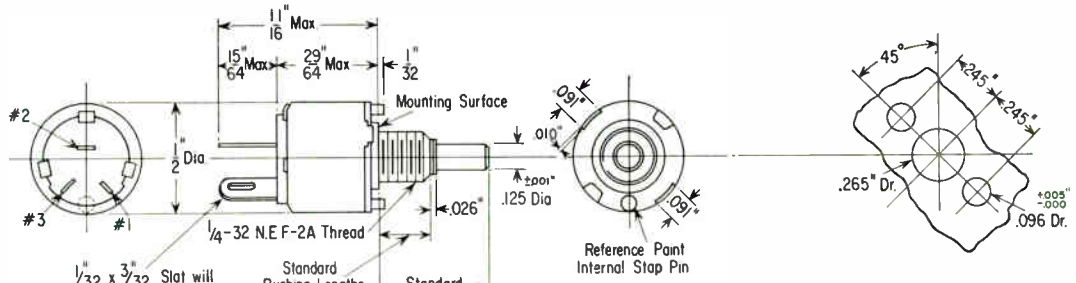


Type R

With Pin Type Terminals

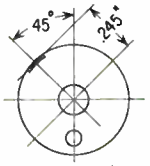
Composition Variable Resistor
Type G — 1/2 Watt

January 3, 1956 **Dimension Drawing 5290B**

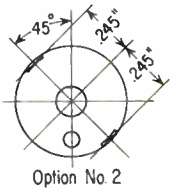


Allowances
Fractional Dimensions ± 1/64
Decimal Dimensions ±.005"
Except as Specified

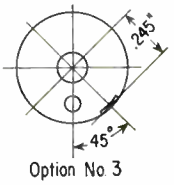
Locating Lug Options



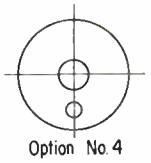
Option No. 1



Option No. 2
Standard and Used Unless Otherwise Specified

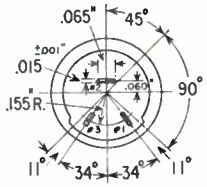


Option No. 3



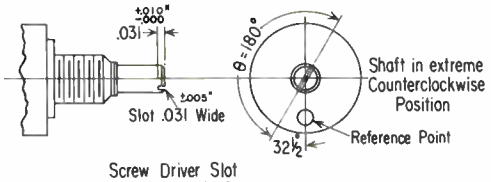
Option No. 4

Terminal Locations

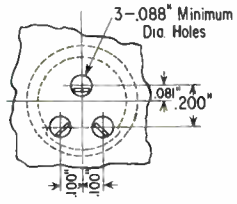


Terminal location Dimensions are at Molded Surface

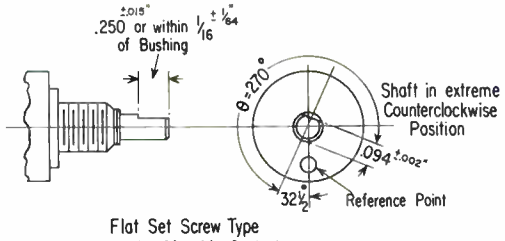
Standard Shaft Endings



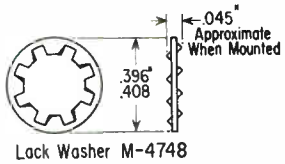
Screw Driver Slot in line with Movable Contact



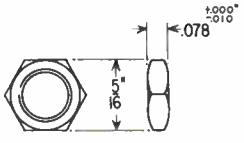
Relation of Terminals to .100 Printed Circuit Spacing



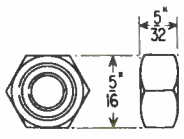
Flat Set Screw Type opposite Movable Contact



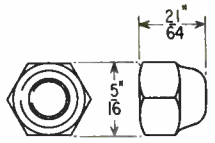
Lock Washer M-4748



Maunting Nut M-4721



Lock Nut M-4761



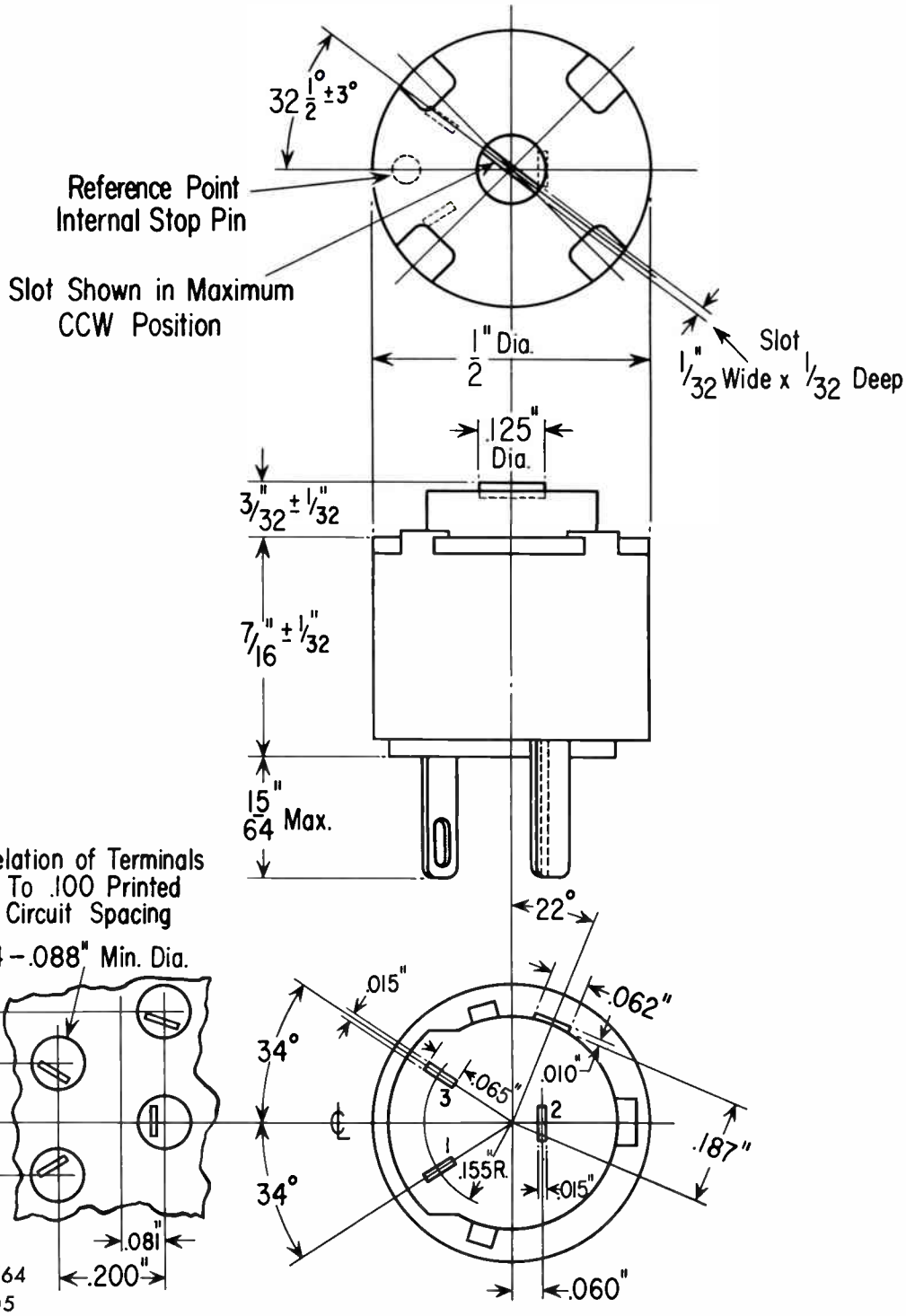
Acorn Lock Nut M-4768
Can be used in place of Lock Nut M-4761 provided shaft extension beyond the bushing does not exceed 1/16"

Supersedes Form 5201-500 dated Sept. 15, 1954
Printed in U. S. A.

Composition Variable Resistors

Type F — 1/4 Watt

December 15, 1955 • • • Dimension Drawing **5290C**



Allowances

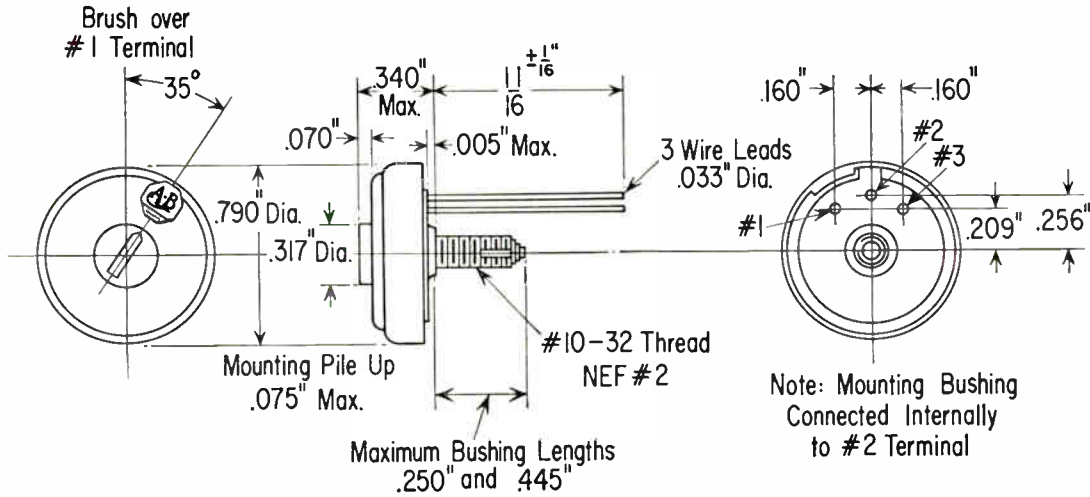
Fractional Dimensions ± 1/64
Decimal Dimensions ± .005
Except as specified

Printed in U.S.A.

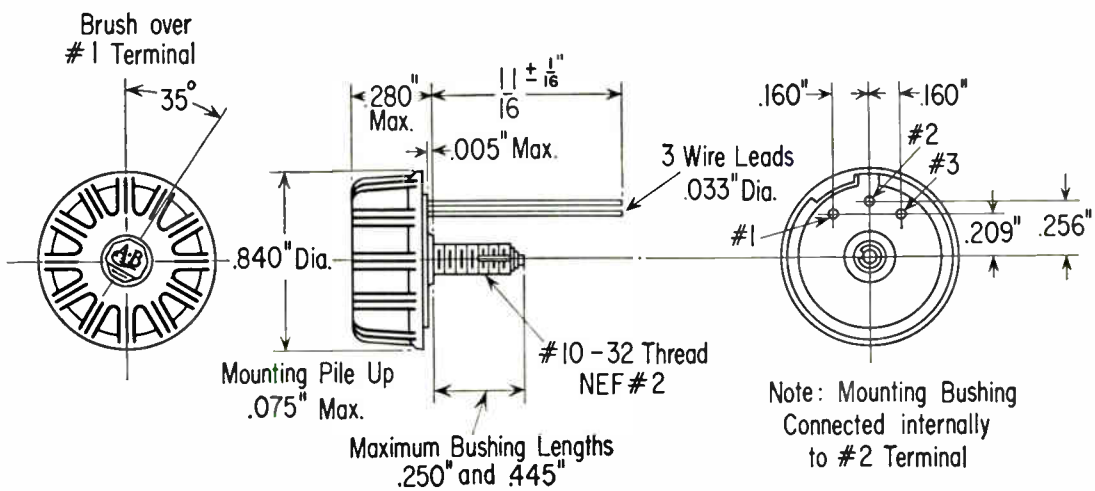
Composition Variable Resistors

Type T — 1/2 Watt

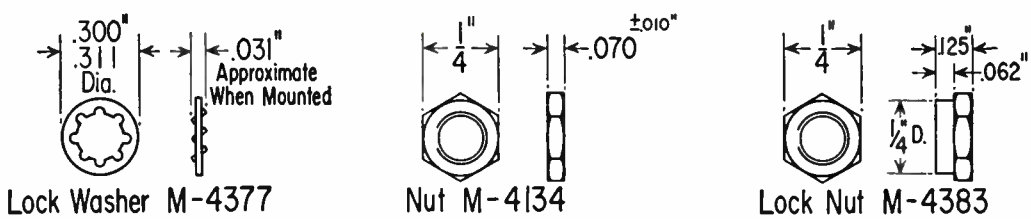
October 12, 1956 • • • Dimension Drawing **5290D**



Type TSR (Standard Bushing — .25″)
Type TSL (Lock Type Bushing — .445″)



Type TKR (Standard Bushing — .25″)
Type TKL (Lock Type Bushing — .445″)

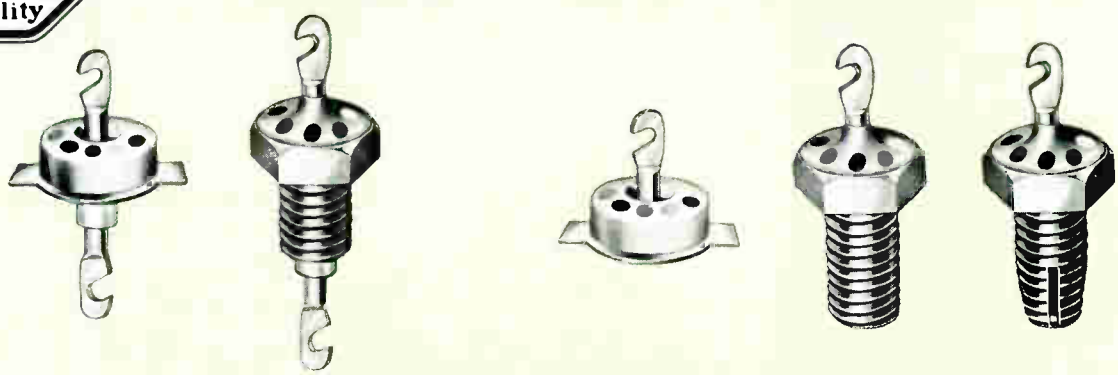


Note: Hardware Shipped Loose

New Information
Printed in U.S.A.

Type FT Feed-Thru Capacitors • Type SO Stand-Off Capacitors

March 16, 1955 • • • Technical Bulletin **5420**



Feed-Thru Capacitors — Stand-Off Capacitors

Allen-Bradley unique Type FT feed-thru and Type SO stand-off discoidal capacitors combine high capacitance values, free from parallel resonance, with small size. The Type FT feed-thru capacitors are recommended for use in series with lead wires at the points where they pass through metal shields. When so used, they provide insulation between the lead wires and the metal shields with respect to direct current, audio and other low frequencies but due to their very low impedance to frequencies in the VHF and UHF television bands they effectively contain such frequencies within the shielded space thus preventing spurious radiation which might otherwise occur from the external lead wires.

Actual Size

Type SO stand-off capacitors are recommended for VHF and UHF television applications where direct efficient by-pass to the metal chassis is desired. They have low uniform series inductance. The Type SO stand-off capacitors can be used to provide physical support for other circuit elements.

Outstanding Features

Unique Design • • •

These capacitors incorporate a thin ceramic disc made of a high dielectric constant material with both sides silvered to serve as the electrodes of the capacitor. In the feed-thru capacitors which are 3 terminal devices, the feed-thru free conductor is electrically connected to one electrode and passes through a hole in the center of the ceramic dielectric disc. The other electrode of the capacitor is electrically connected to the metal mounting base. In stand-off capacitors which are 2 terminal devices, there is no hole in the dielectric disc. The free conductor is electrically connected to one electrode and the other electrode of the capacitor is electrically connected to the metal mounting base.

No Parallel Resonance Points • • •

Allen-Bradley capacitors are superior for filter applications in the VHF and UHF television bands because the absence of parallel resonance effects results in consistent performance throughout these bands. The large values of capacitance which can be used without these effects, results in improvements in filtering of 20db or more.

Low Series Inductance • • •

These Allen-Bradley capacitors are superior for by-pass applications because their compact discoidal design results in very low, uniform inherent series inductance.

High Insulation Resistance • • •

Allen-Bradley capacitors are superior for blocking applications for isolation of direct current because of their uniformly high insulation resistance.

Aging • • •

Allen-Bradley capacitors when applied in accordance with published ratings and recommendations, do not deteriorate with respect to time.

Rugged Construction • • •

Allen-Bradley discoidal capacitors are mechanically strong and will withstand the rough treatment generally associated with assembly line operations. The ceramic insulation is sturdy enough to withstand the physical impact of soldering irons and the thermal shock incurred in soldering due to uneven temperature distribution. They can be used to support other components by their lead wires where electrical interconnection is indicated.

Marking • • •

Bright color coding is applied to white ceramic insulators, consequently, colors are clear and distinct.

Insulation and Seal • • •

Type FT feed-thru and Type SO stand-off capacitors are insulated and sealed to protect them from moisture.

Performance Characteristics

Resonance Characteristics—These capacitors do not exhibit parallel resonance at any frequency up to and including 1000 megacycles in the temperature range from plus 10°C to plus 85°C. This applies to all listed nominal values.

Nominal Capacitance Values—Available in standard nominal values from 4.7 MMF to 1000 MMF as listed in Price Sheet 5480.

Tolerances—Available in ± 10%, ± 20%, and GMV tolerances depending upon nominal value. See Price Sheet 5480.

Initial Dissipation Factor—Initial dissipation factor less than 2.0%.

Initial "Q"—Initial "Q" more than 50.

Initial Insulation Resistance—Measured between terminals of capacitors after two minutes at 500 volts DC through protective resistor of 1 megohm, initial insulation resistance greater than 10,000 megohms.

Maximum Continuous Voltage Rating—Rated maximum continuous working voltage 500 volts D.C. at 85°C ambient temperature.

Life Test—After a life test consisting of 250 hours at 1000 volts D.C. at an ambient temperature of 85°C ± 3°C, the insulation resistance measured between the terminals of the capacitors after two minutes at 500 volts D.C. through a protective resistor of one megohm, not less than 1000 megohms, dissipation factor less than 5.0% "Q" not less than 20.

Dielectric Test—All capacitors will pass without failure a flash or "hi-pot" test of 1250 volts D.C. for a minimum of one second at normal atmospheric pressure and an ambient temperature of 25°C ± 5°C when charging current is limited to 0.05 ampere.

Maximum Ambient Temperature—These capacitors are designed for continuous operation at full rating with a maximum ambient temperature of 85°C.

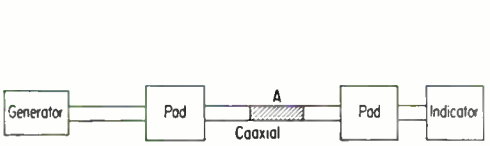
Temperature Cycling—Thermal Shock—Temperature cycling is conducted before the humidity test in accordance with the following schedule.

Step #	From	To	Hold Time
1	Room Temperature	− 30°C.	Fifteen Minutes
2	− 30°C.	Room Temperature	Ten Minutes
3	Room Temperature	+ 85°C.	Fifteen Minutes
4	+ 85°C.	Room Temperature	Ten Minutes

The capacitors are changed from one ambient to another abruptly and are subjected to a total of 5 of the above cycles.

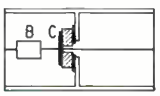
Humidity Test—After exposure to a relative humidity of 95% ± 2% at 40°C ± 1°C for 100 hours, dissipation factor less than 3.0% "Q" not less than 33 and insulation resistance not less than 1000 megohms when measured not more than 30 minutes after removal from the humidity chamber.

Standard Conditions—Unless otherwise specified, all measurements are understood to be made under the following standard conditions: Normal atmospheric pressure; a relative humidity of 50% ± 2%; an ambient temperature of 25°C ± 1°C; a frequency of 1 KC; and an RMS voltage between 0.5 and 5.0 volts.



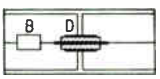
B
50 ohm Resistor

A
Section for
Discoidal

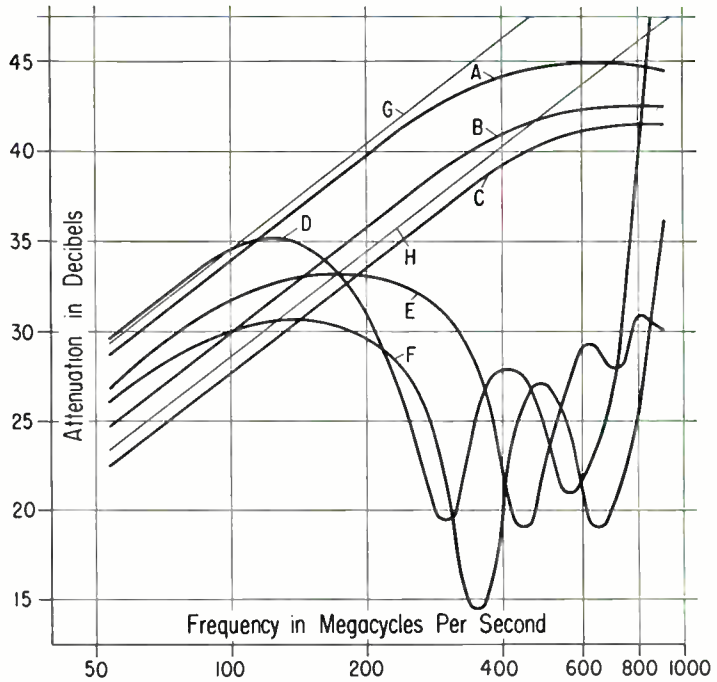


C
Discoidal
Feed-Thru
Capacitor

A
Section for
Tubular



D
Tubular
Feed-Thru
Capacitor



Discoidal Versus Tubular Feed-Thru Capacitors

Spurious Radiation—Television receivers which are poorly shielded produce electromagnetic radiations which seriously interfere with proper reception by other television receivers located in the vicinity. Even with complete shielding, spurious electromagnetic radiations can take place if the lead wires which pass in and out of the shielded spaces are not adequately filtered at the points where they pass through the metal shields. Where shielding is properly done, Allen-Bradley discoidal feed-thru capacitors are particularly effective because they efficiently contain the high frequencies involved within the shielded spaces, thus preventing undesired spurious radiation from the external lead wires.

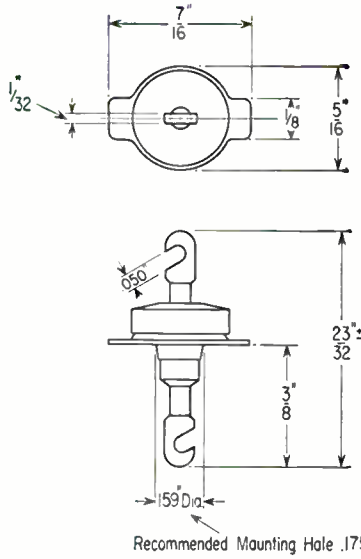
Performance of Discoidal Capacitors—The superior performance of Allen-Bradley discoidal feed-thru capacitors is illustrated by curves A, B and C in the above graph. The attenuation in decibels for various capacitors as measured in a 50 ohm transmission line circuit has been plotted against frequency from approximately 50 megacycles to 1000 megacycles. The attenuation vs frequency for 1800 mmf, 1150 mmf, and 800 mmf Allen-Bradley feed-thru capacitors is plotted at A, B, and C respectively. They closely match the attenuation of theoretically ideal capacitors of 2000 mmf and 1000 mmf capacitance values as plotted at G and H.

Performance of Tubular Capacitors—The attenuation of tubular feed-thru capacitors vs frequency is indicated by curves D, E, and F respectively 2000 mmf, 1500 mmf and 1400 mmf capacitance values. Parallel resonance causes the attenuation to drop radically from the ideal characteristic, thus resulting in poor filtering of the frequencies in the regions where these parallel resonances occur. Because of these resonance points it has been necessary to reduce capacitance values of tubular feed-thru capacitors in an effort to shift the resonance points outside the frequency range involved. This has definite disadvantages. Reducing the nominal capacitance value reduces the filtering action for the frequencies where parallel resonance is not a factor. It may make it necessary to stock a number of tubular capacitors of different nominal capacitance values if different frequencies are to be filtered at various circuit locations. Tubular capacitors which exhibit parallel resonance in the frequency range where they are used are frequency selective and may therefore relatively attenuate various harmonics or frequencies quite differently than discoidal, or theoretically, ideal capacitors.

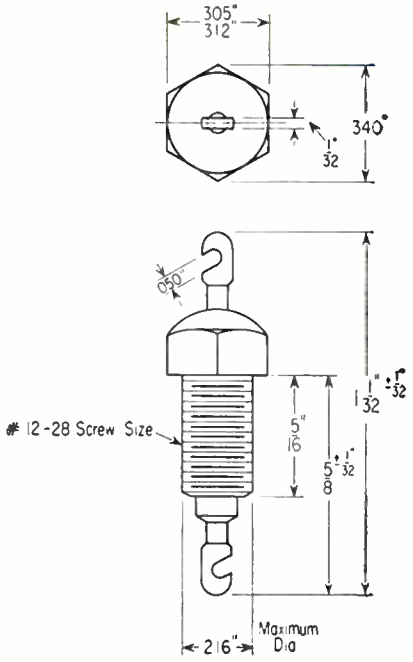
Advantages of Discoidal Capacitors—Because Allen-Bradley discoidal feed-thru capacitors have no parallel resonance points below 1000 megacycles, a single item can replace several different units resulting in a reduction in purchasing, handling, and stocking costs.

For additional information refer to article entitled "Discoidal vs Tubular Feed-through Capacitors" appearing in the February 1955 issue of "Proceeding of I. R. E."

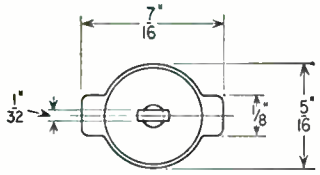
Dimensions

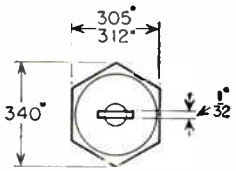


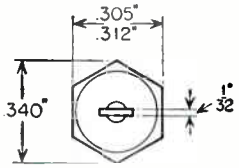
Type FTS
Feed-Thru Capacitor
Solder Mounting



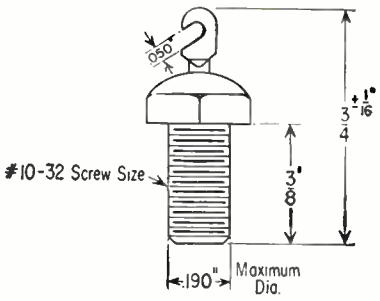
Type FTB
Feed-Thru Capacitor
Bolt Mounting



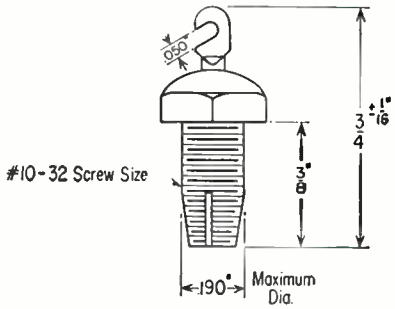




Type SOS
Stand-Off Capacitor
Solder Mounting



Type SOB
Stand-Off Capacitor
Bolt Mounting



Type SOST
Stand-Off Capacitor
Self-Tapping Screw Mounting

Printed in U.S.A.

NOMENCLATURE USED IN CONNECTION WITH CAPACITORS

Symbol	Units Abbreviations & Dimensions	Name	Descriptive Definition
C	Farad (F) $C = q/V$ Coulomb per Volt or One Ampere Flowing for one second per applied one volt.	CAPACITANCE (Sometimes conventionally, but less desirably, referred to as a "Capacity").	Electrostatic capacitance exists wherever an insulator (i.e., a dielectric) separates two conductors between which a difference of potential can exist. A CAPACITOR (sometimes conventionally termed a "condenser") has an electrostatic capacitance of one farad when one coulomb of electricity can be added to it and stored up in it upon the application of one volt across the plates.
C	Microfarad (μF)	One millionth of a farad.	The "farad" is an unwieldily large unit and is generally subdivided into the "microfarad" or the
C	Micromicrofarad ($\mu\mu$F) OR Picafarad (pF)	One millionth of a millionth of a farad.	"Micromicrofarad" OR "Picafarad"
X_c	Ohms (ω) $X_c = \frac{1}{2\pi fC}$ where "f" is freq. in cycles/sec. "C" is capac. in Farads	CAPACITIVE REACTANCE.	This is one of the "impedances" to electricity and is measured in the same units as are resistors. It is a specific type of impedance called "capacitive reactance" and, in a "good" capacitor, is substantially wattless — i.e., consumes negligible power yet acts to limit the flow of alternating current in inverse proportion to the capacitance value, and to the frequency.
K or ϵ	Numeric, A Ratio $\frac{C_x}{C_a}$	RELATIVE DIELECTRIC CONSTANT.	The capacitance of a unit depends to a large extent on the type of dielectric material separating (lying between) the metallic electrodes. The "Dielectric Constant" is that property of the dielectric material itself which determines the electrostatic energy stored in the capacitor per unit of volume and per unit of voltage gradient. It is the ratio of the actual capacitance, using a given dielectric material, to that of an equivalent capacitor in all respects except that a vacuum (or normal air) is used as the dielectric. The latter two dielectrics are substantially equal and are arbitrarily assigned dielectric constants of unity. Most other dielectrics have constants greater than unity and "multiply" the resultant capacitance — some "high K" ceramics by more than 6000 times that of an equivalent air capacitor.
ϵ'	Numeric	The REAL part of a complex Dielectric Constant.	For very high frequencies the Relative Dielectric Constant can be considered to have two components; one real, the other imaginary.

Symbol	Units Abbreviations & Dimensions	Name	Descriptive Definition
ϵ''	Numeric	The IMAGINARY part of a complex Diel. Constant.	The "real" and "imaginary" components are particularly useful in dealing with quasi-optical frequencies. For d-c and most orders of r-f currents, the "Relative" and "Real" Dielectric Constants are synonymous.
θ	Degrees or radians	DIELECTRIC PHASE ANGLE.	The "dielectric phase angle" is the angular difference in phase between the sinusoidal voltage applied to the dielectric and the component of the resulting current having the same frequency. The sinusoidal current in a capacitor rises and falls approximately 90 electrical degrees ahead of the corresponding sinusoidal fluctuations of the driving potential applied.
$\propto$	Degrees or radians	DIELECTRIC LOSS ANGLE.	The "dielectric loss angle" is the complement of the dielectric phase angle. In other words it is the difference between 90 electrical degrees and the dielectric phase angle. If the above difference is greater than zero, the capacitor is "lossy" and some of the applied energy is dissipated.
D	Numeric, or, if multiplied by 100, "%". $D = \cot\theta = \tan\propto = \frac{1}{\omega C_p R_p} = \omega C_s R_s$	DIELECTRIC DISSIPATION FACTOR. Where $\omega = 2nf$ & Where C_p & C_s are respective capacitances in farads & R_p or R_s is respective effective parallel or series ohmic resistances.	This factor is the cotangent of the above dielectric phase angle; or the tangent of the above dielectric loss angle of the material. It is a measure of the relative lossiness of a dielectric for normally "good" capacitors and is a convenient term easily integrated by "bridge" measurements. (SEE NOTE BELOW)
δ	Numeric, or, if multiplied by 100, "%" $\delta = \cos\theta = \sin\propto$	DIELECTRIC POWER FACTOR.	This factor is the cosine of the above dielectric phase angle and the sine of the above dielectric loss angle. It is a DIRECT measure of capacitor LOSSES for all magnitudes of capacitor lossiness. (SEE NOTE BELOW)
d	Numeric $d = KD$	DIELECTRIC LOSS FACTOR.	This factor is a product of the DIELECTRIC CONSTANT and the DISSIPATION FACTOR for a given material and operating conditions.
FM	Micromicrofarads $FM = D \times C\mu\mu F = 2\pi f R_s C^2 \mu\mu F$ Where R_s is as given below & other factors are as previously listed	FIGURE OF MERIT.	A convenient factor expressing the relative quality of variable capacitors in particular because the resulting product of a varying DISSIPATION FACTOR and a varying CAPACITANCE is reasonably constant over a wide range of the capacitance setting.

NOTE: When the cotangent of the phase angle ("D" above) is smaller than 0.1 (10%), the cosine and the cotangent differ by less than 0.0005 and then the dissipation factor "D" may be considered to be identical with the power factar. This is the normal "good" condition for ceramic capacitors of the TEMPERATURE COMPENSATING and BYPASS types.

Symbol	Units Abbreviations & Dimensions	Name	Descriptive Definition
R_s	Ohms $R_s = \frac{D}{2\pi f c_s}$	EFFECTIVE SERIES RESISTANCE.	A dropping resistance considered to be in series with the assumed pure capacitance value "C_s". It represents the metallic resistance in the leads, stack supports and electrode material and is ordinarily of little significance except at frequencies high enough to produce nearly 100% "skin effect." The above and other losses can be mathematically juggled into an "equivalent" series resistance which is convenient for study but which is constant only for the set conditions and which is dependent on all factors.
R_p	Ohms $R_p = \frac{1}{2\pi f c_p D}$	EFFECTIVE PARALLEL RESISTANCE.	A resistance leakage considered to be in parallel with the "pure" dielectric. In a normally "good" ceramic capacitor, the ohmic value is fairly high. It is representative of the d-c leakage resistance loss and the ohmic leakage losses at the specific a-c frequency considered. The d-c leakage is negligible above a few cycles but the a-c dielectric losses increase with frequency and with capacitance. This and the above "series" & dissipation factor losses can be mathematically juggled into an "equivalent" parallel resistance which is convenient for study and meaningful only if the set conditions are maintained.
G	mhos $G = DWC = 2\pi fDC = \frac{1}{R_p}$	CONDUCTANCE.	This is the reciprocal of the EFFECTIVE PARALLEL RESISTANCE referred to above.
Q	Numeric $Q = \frac{X_c}{R_s} = \frac{1}{2\pi f c R_s} = \frac{1}{D} = \frac{100}{D\%}$	"Q" — FACTOR OR QUALITY FACTOR.	The larger the "Q" the better the capacitor. It is the reciprocal of the DISS. FACTOR expressed numerically. It is decreased by increased ohmic losses and frequency; increased by higher ohmic reactance — other factors being equal.
R	OHMS $R = \frac{E_{d-c}}{I_T}$	Total Insulation Resistance.	The insulation resistance between two electrodes which are in contact with, or imbedded in, an insulator, is the ratio of the direct current voltage applied across the electrodes to the total current between them. It is dependent on both the resistance *through* the volume and *across* the surface of the specimen. In very good dielectrics in which the leakage currents are very low (i.e., having high insulation resistance), both of the above component resistances are complicated in that each, in turn, is apt to be made up of two components. One component arises from the generation of "ion" currents; the other, from the generation of "electron" currents under the influence of the applied d-c voltage. The applied d-c voltage also tends to warp the internal dimensions of some of the individual molecules of the dielectric — producing a 90° out-of-phase type of direct current which decreases slowly over a time period of application of the applied potential. This is sometimes called "Polarization." Thus strong variations and sudden changes of resistance value can often be read — superimposed on a progressively increasing value with time on voltage. Thus, again, comparative measurements are often difficult to make, even with standardization of the equipment, voltage and time of application. Normal ceramic capacitors of conventional range of values can have total insulation resistances varying from a few thousand million ohms to more than 100 million, million ohms (100,000,000,000,000 Ohms).

Symbol	Units Abbreviations & Dimensions	Name	Descriptive Definition
R_v	OHMS $R_v = \frac{E_{d-c}}{I_v}$	VOLUME RESISTANCE.	The volume resistance between two electrodes which are in contact with, or embedded in a specimen, is the ratio of the d-c voltage applied to the electrodes, to that portion of the current between them that is distributed through the volume of the specimen.
R_s	Ohms $R_s = \frac{E_{d-c}}{I_s}$	SURFACE RESISTANCE.	The surface resistance between two electrodes which are on the surface of a specimen is the ratio of the d-c voltage applied to the electrodes to that portion of the current between them which is in a thin layer of moisture or other semi-conducting material that may be native to, or deposited on, the surface.
p	Ohms $p = \frac{A}{t} R_v$	VOLUME RESISTIVITY. Where R_v is volume resistance as defined above; t = average thickness of the specimen. A = effective area of the guarded electrode.	The volume resistivity of a material is the ratio of the potential gradient parallel to the current in the material, to the current density. In the metric system volume resistivity of a material is numerically equal to the above volume resistance when measured between two electrodes which cover opposite faces of a centimeter cube of the material.
σ	Ohms $\sigma = \frac{P}{g} R_s$	SURFACE RESISTIVITY. Where R_s is the above surface resistance; g = distance between the electrodes; P = effective circumference of the guarded electrode.	The surface resistivity of a material is the ratio of the potential gradient parallel to the surface current, to the current per unit width of surface.
None or E_u	Volts/mil $E_u = \frac{E_f}{t}$	DIELECTRIC STRENGTH. Where E_f is the potential at which rupture of the specimen occurs; t is the thickness in mils.	The dielectric strength of a material having the properties of an insulator is the maximum potential gradient that the material can withstand without rupture. In general, the dielectric strength of insulating materials decreases with time of exposure to the electrical stress and usually has considerably higher "volts per mil" values for the thinner cross-sections.
TC	$\Delta C/C_T/\Delta T$ $\mu\mu F/\mu\mu F/^{\circ}C$ sometimes the above multiplied by one million to express the change in C in parts per million	TEMPERATURE COEFFICIENT OF CAPACITANCE. Where ΔT = the change in temperature from initial T_1 to the final T_2, expressed in degrees centigrade; and ΔC = the corresponding change from initial to final capacitance. C_T is the total initial Capacitance.	The temperature coefficient of capacitance of capacitors can sometimes be one of the most tricky of all of the measurements which are made on capacitors. In particular, wherein determinations must be made on how "zero" is zero "TC" change on these types of temperature compensating capacitors of the precision type, it is extremely difficult to get equipment and techniques that are sensitive enough and, at the same time, stable enough to integrate very small changes in "C" on small values of capacitance. Equipment and measurement techniques must have reproducible accuracies of better than plus or minus three parts per million for some of the specifications now extant.

Ceramic Dsic Capacitors
General Purpose Type

September 24, 1956 • • • Price Sheet 5480A

The listed prices apply to single disc type general purpose capacitors having the following standard features.

1. Coating material may extend down lead wires ⅛" from tangent line (Bottom edge of disc).
2. Lead wires are #20 or #22 awg.
3. Marking may include either color coding or stamping at option of supplier. Stamping will include capacitance, tolerance (other than GMV), TC designation and supplier identification (may be omitted on ¼" disc).

For any deviations from above specifications (except for the special features listed on the other side), obtain individual quotations from the Sales Department at Milwaukee.

The quantity to be used in determining the price must consist of identical capacitors. Various capacitance values cannot be combined to determine the quantity price.

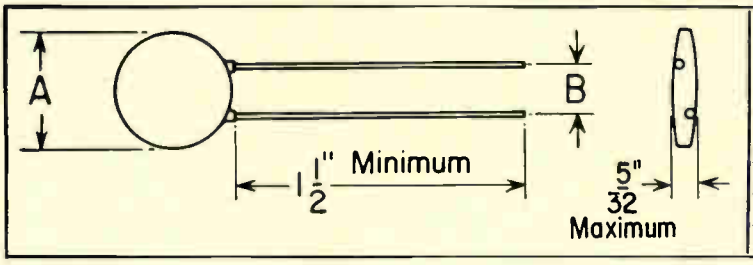
Part shipments specified by the purchaser will be billed on the basis of the quantity requested for each individual shipment. Part shipments made at the seller's convenience will be billed on the basis of the quantity per item ordered for "one time" shipment.

Where simultaneous shipments are specified for several destinations, add **$2.50** net per order for each destination beyond one.

Minimum billing charge **$10.00**.

Terms are 1% 10th and 25th, 30 days net, F.O.B. Milwaukee, Wisconsin, with lowest cost transportation prepaid and absorbed by us to any recognized freight station within the continental United States, provided method and routing of shipment are left to our discretion. Title passes upon delivery to carrier.

All prices, terms and conditions subject to change without notice.



Type	Dimension A		Dimension B ± 1/16"
	Nominal	Actual	
16	¼"	.250/.310	3/16"
24	⅜"	.315/.385	¼"
36	9/16"	.510/.590	⅜"
40	⅝"	.630/.690	⅜"
48	¾"	.770/.820	⅜"

MMF	Tolerance	Part No.	Price per Thousand					
			1-49	50-99	100-249	250-499	500-999	1000 or More
10	GMV	16-100W	$300.00	$250.00	$200.00	$47.25	$44.25	$29.50
10	± 20%	16-1002	300.00	250.00	200.00	47.25	44.25	29.50
10	± 10%	16-1001	300.00	250.00	200.00	49.50	46.50	31.00
12	± 10%	16-1201	300.00	250.00	200.00	49.50	46.50	31.00
15	GMV	16-150W	300.00	250.00	200.00	47.25	44.25	29.50
15	± 20%	16-1502	300.00	250.00	200.00	47.25	44.25	29.50
15	± 10%	16-1501	300.00	250.00	200.00	49.50	46.50	31.00
18	± 10%	16-1801	300.00	250.00	200.00	49.50	46.50	31.00
22	GMV	16-220W	300.00	250.00	200.00	47.25	44.25	29.50
22	± 20%	16-2202	300.00	250.00	200.00	47.25	44.25	29.50
22	± 10%	16-2201	300.00	250.00	200.00	49.50	46.50	31.00
27	± 10%	16-2701	300.00	250.00	200.00	49.50	46.50	31.00
33	GMV	16-330W	300.00	250.00	200.00	47.25	44.25	29.50
33	± 20%	16-3302	300.00	250.00	200.00	47.25	44.25	29.50
33	± 10%	16-3301	300.00	250.00	200.00	49.50	46.50	31.00
39	± 10%	16-3901	300.00	250.00	200.00	49.50	46.50	31.00
47	GMV	16-470W	300.00	250.00	200.00	47.25	44.25	29.50
47	± 20%	16-4702	300.00	250.00	200.00	47.25	44.25	29.50
47	± 10%	16-4701	300.00	250.00	200.00	49.50	46.50	31.00
56	± 10%	16-5601	300.00	250.00	200.00	49.50	46.50	31.00
68	GMV	16-680W	300.00	250.00	200.00	47.25	44.25	29.50
68	± 20%	16-6802	300.00	250.00	200.00	47.25	44.25	29.50
68	± 10%	16-6801	300.00	250.00	200.00	49.50	46.50	31.00
82	± 10%	16-8201	300.00	250.00	200.00	49.50	46.50	31.00

Ceramic Disc Capacitors
General Purpose Type

MMF	Tolerance	Part No.	Price per Thousand					
			1–49	50–99	100–249	250–499	500–999	1000 or More
100	GMV	16-101W	300.00	250.00	200.00	47.25	44.25	29.50
100	± 20%	16-1012	300.00	250.00	200.00	47.25	44.25	29.50
100	± 10%	16-1011	300.00	250.00	200.00	49.50	46.50	31.00
120	± 10%	16-1211	300.00	250.00	200.00	49.50	46.50	31.00
150	GMV	16-151W	150.00	125.00	100.00	51.25	48.00	32.00
150	± 20%	16-1512	150.00	125.00	100.00	56.00	52.50	35.00
150	± 10%	16-1511	170.00	140.00	115.00	62.50	58.50	39.00
180	± 10%	16-1811	170.00	140.00	115.00	62.50	58.50	39.00
220	GMV	16-221W	150.00	125.00	100.00	51.25	48.00	32.00
220	± 20%	16-2212	150.00	125.00	100.00	56.00	52.50	35.00
220	± 10%	16-2211	170.00	140.00	115.00	62.50	58.50	39.00
270	± 10%	16-2711	170.00	140.00	115.00	62.50	58.50	39.00
330	GMV	16-331W	150.00	125.00	100.00	51.25	48.00	32.00
330	± 20%	16-3312	150.00	125.00	100.00	56.00	52.50	35.00
330	± 10%	16-3311	170.00	140.00	115.00	62.50	58.50	39.00
390	± 10%	16-3911	170.00	140.00	115.00	62.50	58.50	39.00
470	GMV	16-471W	150.00	125.00	100.00	45.50	42.75	28.50
470	± 20%	16-4712	150.00	125.00	100.00	50.50	47.25	31.50
470	± 10%	16-4711	170.00	140.00	115.00	70.50	66.00	44.00
560	± 10%	16-5611	170.00	140.00	115.00	70.50	66.00	44.00
680	GMV	16-681W	150.00	125.00	100.00	45.50	42.75	28.50
680	± 20%	16-6812	150.00	125.00	100.00	50.50	47.25	31.50
1000	GMV	16-102W	150.00	125.00	100.00	45.50	42.75	28.50
1000	± 20%	16-1022	150.00	125.00	100.00	56.00	52.50	35.00
1000	GMV	24-102W	150.00	125.00	100.00	45.50	42.75	28.50
1000	± 20%	24-1022	150.00	125.00	100.00	56.00	52.50	35.00
1500	GMV	24-152W	150.00	125.00	100.00	45.50	42.75	28.50
1500	± 20%	24-1522	150.00	125.00	100.00	56.00	52.50	35.00
2000	GMV	24-202W	150.00	125.00	100.00	45.50	42.75	28.50
2200	GMV	24-222W	150.00	125.00	100.00	45.50	42.75	28.50
2200	± 20%	24-2222	150.00	125.00	100.00	56.00	52.50	35.00
3300	GMV	36-332W	155.00	130.00	105.00	53.50	50.25	33.50
3300	± 20%	36-3322	155.00	130.00	105.00	64.00	60.00	40.00
4700	GMV	36-472W	150.00	125.00	100.00	46.50	43.50	29.00
4700	± 20%	36-4722	150.00	125.00	100.00	58.50	54.75	36.50
5000	GMV	36-502W	150.00	125.00	100.00	46.50	43.50	29.00
5000	± 20%	36-5022	150.00	125.00	100.00	58.50	54.75	36.50
6800	GMV	36-682W	155.00	130.00	105.00	54.50	51.00	34.00
6800	± 20%	36-6822	155.00	130.00	105.00	64.75	60.75	40.50
10000	GMV	36-103W	150.00	125.00	100.00	54.50	51.00	34.00
10000	± 20%	36-1032	150.00	125.00	100.00	66.50	62.25	41.50
10000	GMV	40-103W	150.00	125.00	100.00	54.50	51.00	34.00
10000	± 20%	40-1032	150.00	125.00	100.00	66.50	62.25	41.50
20000	GMV	48-203W	150.00	125.00	100.00	87.25	81.75	54.50

• • • Price Additions for Special Features • • •

1. Coating closer than 1/8" allowing no exposed disc..... $ **5.00** per 1000
2. Leads cut shorter than standard to 3/64" total deviation..... **2.50** per 1000
3. Leads cut shorter than standard to less than 3/64" total deviation..... **10.00** per 1000
4. On standard cut leads (pin-type) tolerance closer than ± .035" at end of leads..... **5.00** per 1000
5. Markings, other than standard..... **5.00** per 1000
6. For reference to Government Specifications.....add **25.00** per 1000

Printed in U.S.A.

Ceramic Capacitors
Stable Type

September 24, 1956 • • • **Price Sheet 5480B**

The listed prices apply to single disc type capacitors having the following standard features.

1. Coating material may extend down lead wires ⅛" from tangent line (Bottom edge of disc).
2. Lead wires are #20 or #22 awg.
3. Marking may include either color coding or stamping at option of supplier. Stamping will include capacitance, tolerance and supplier identification (may be omitted on ¼" disc).

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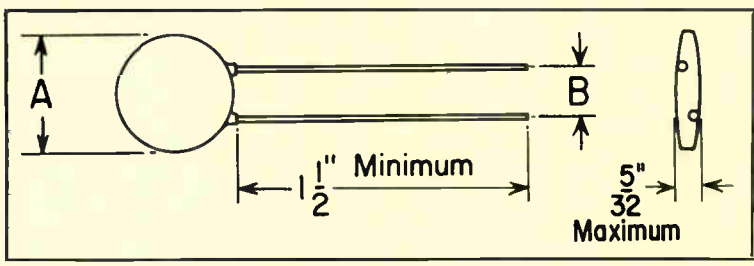
Where simultaneous shipments are specified for several destinations, add **$2.50** net per order for each destination beyond one.

Minimum billing charge **$10.00**.

Terms are 1% 10th and 25th, 30 days net, F.O.B. Milwaukee, Wisconsin, with lowest cost transportation prepaid and absorbed by us to any recognized freight station within the continental United States, provided method and routing of shipment are left to our discretion. Title passes upon delivery to carrier.

All prices, terms and conditions subject to change without notice.



Type	Dimension A		Dimension B ± 1/16"
	Nominal	Actual	
S16	¼"	.250/.310	3/16"
S24	⅜"	.315/.385	¼"
S36	9/16"	.510/.590	⅜"
S40	⅝"	.630/.690	⅜"
S48	¾"	.770/.820	⅜"

MMF	Tolerance	Part No.	Price per Thousand					
			1-49	50-99	100-249	250-499	500-999	1000 or More
91	± 5%	S16-9105	$300.00	$250.00	$200.00	$56.00	$52.50	$35.00
100	± 5%	S16-1015	300.00	250.00	200.00	56.00	52.50	35.00
100	± 10%	S16-1011	300.00	250.00	200.00	49.50	46.50	31.00
100	± 20%	S16-1012	300.00	250.00	200.00	47.25	44.25	29.50
110	± 5%	S16-1115	300.00	250.00	200.00	56.00	52.50	35.00
120	± 5%	S16-1215	300.00	250.00	200.00	56.00	52.50	35.00
120	± 10%	S16-1211	300.00	250.00	200.00	49.50	46.50	31.00
130	± 5%	S16-1315	300.00	250.00	200.00	56.00	52.50	35.00
150	± 5%	S16-1515	210.00	175.00	140.00	76.75	72.00	48.00
150	± 10%	S16-1511	170.00	140.00	115.00	62.50	58.50	39.00
150	± 20%	S16-1512	150.00	125.00	100.00	56.00	52.50	35.00
160	± 5%	S16-1615	210.00	175.00	140.00	76.75	72.00	48.00
180	± 5%	S16-1815	210.00	175.00	140.00	76.75	72.00	48.00
180	± 10%	S16-1811	170.00	140.00	115.00	62.50	58.50	39.00
200	± 5%	S16-2015	210.00	175.00	140.00	76.75	72.00	48.00
220	± 5%	S16-2215	210.00	175.00	140.00	76.75	72.00	48.00
220	± 10%	S16-2211	170.00	140.00	115.00	62.50	58.50	39.00
220	± 20%	S16-2212	150.00	125.00	100.00	56.00	52.50	35.00
240	± 5%	S16-2415	210.00	175.00	140.00	76.75	72.00	48.00
270	± 5%	S16-2715	210.00	175.00	140.00	76.75	72.00	48.00
270	± 10%	S16-2711	170.00	140.00	115.00	62.50	58.50	39.00
300	± 5%	S16-3015	210.00	175.00	140.00	76.75	72.00	48.00

Ceramic Capacitors
Stable Type

MMF	Tolerance	Part No.	Price per Thousand					
			1-49	50-99	100-249	250-499	500-999	1000 or More
330	± 5%	S16-3315	$210.00	$175.00	$140.00	$76.75	$72.00	$48.00
330	± 10%	S16-3311	170.00	140.00	115.00	62.50	58.50	39.00
330	± 20%	S16-3312	150.00	125.00	100.00	56.00	52.50	35.00
360	± 5%	S16-3615	210.00	175.00	140.00	76.75	72.00	48.00
390	± 5%	S16-3915	210.00	175.00	140.00	76.75	72.00	48.00
390	± 10%	S16-3911	170.00	140.00	115.00	62.50	58.50	39.00
430	± 5%	S16-4315	210.00	175.00	140.00	84.75	79.50	53.00
470	± 5%	S16-4715	210.00	175.00	140.00	84.75	79.50	53.00
470	± 10%	S16-4711	170.00	140.00	115.00	70.50	66.00	44.00
470	± 20%	S16-4712	150.00	125.00	100.00	60.75	57.00	38.00
560	± 10%	S16-5611	170.00	140.00	115.00	70.50	66.00	44.00
680	± 10%	S24-6811	170.00	140.00	115.00	70.50	66.00	44.00
680	± 20%	S24-6812	150.00	125.00	100.00	60.75	57.00	38.00
820	± 10%	S24-8211	170.00	140.00	115.00	70.50	66.00	44.00
1000	± 10%	S24-1021	170.00	140.00	115.00	70.50	66.00	44.00
1000	± 20%	S24-1022	150.00	125.00	100.00	60.75	57.00	38.00
1200	± 10%	S24-1221	170.00	140.00	115.00	72.00	67.50	45.00
1500	± 10%	S28-1521	170.00	140.00	115.00	72.00	67.50	45.00
1500	± 20%	S28-1522	150.00	125.00	100.00	64.00	60.00	40.00
1800	± 10%	S28-1821	170.00	140.00	115.00	76.00	71.25	47.50
2200	± 10%	S36-2221	170.00	140.00	115.00	76.00	71.25	47.50
2200	± 20%	S36-2222	150.00	125.00	100.00	68.00	63.75	42.50
2700	± 10%	S36-2721	170.00	140.00	115.00	80.00	75.00	50.00
3300	± 10%	S36-3321	170.00	140.00	115.00	80.00	75.00	50.00
3300	± 20%	S36-3322	150.00	125.00	100.00	70.50	66.00	44.00
3900	± 10%	S40-3921	170.00	140.00	115.00	80.00	75.00	50.00
4700	± 10%	S40-4721	170.00	140.00	115.00	80.00	75.00	50.00
4700	± 20%	S40-4722	150.00	125.00	100.00	70.50	66.00	44.00
5600	± 10%	S48-5621	170.00	140.00	115.00	88.00	82.50	55.00
6800	± 10%	S48-6821	170.00	140.00	115.00	88.00	82.50	55.00
6800	± 20%	S48-6822	150.00	125.00	100.00	78.50	73.50	49.00

• • • Price Additions for Special Features • • •

1. Coating closer than 1/8" allowing no exposed disc..... **$ 5.00** per 1000
2. Leads cut shorter than standard to 3/64" total deviation..... **2.50** per 1000
3. Leads cut shorter than standard to less than 3/64" total deviation..... **10.00** per 1000
4. On standard cut leads (pin-type) tolerance closer than ± .035" at end of leads..... **5.00** per 1000
5. Markings, other than standard..... **5.00** per 1000
6. For reference to Government Specifications.....add **25.00** per 1000

Printed in U. S. A.

Ceramic Capacitors
Temperature Compensating Type

September 24, 1956 • • • **Price Sheet 5480C**

The listed prices apply to single disc type capacitors having the following standard features.

1. Coating material may extend down lead wires ⅛" from tangent line (Bottom edge of disc).
2. Lead wires are #20 or #22 awg.
3. Marking may include either color coding or stamping at option of supplier. Stamping will include capacitance, tolerance, TC designation and supplier identification (maybe omitted on ¼" disc).

For any deviations from above specifications (except for the special features listed below), obtain individual quotations from the Sales Department at Milwaukee.

The quantity to be used in determining the price must consist of identical capacitors. Various capacitance values cannot be combined to determine the quantity price.

Part shipments specified by the purchaser will be billed on the basis of the quantity requested for each individual shipment. Part shipments made at the seller's convenience will be billed on the basis of the quantity per item ordered for "one time" shipment.

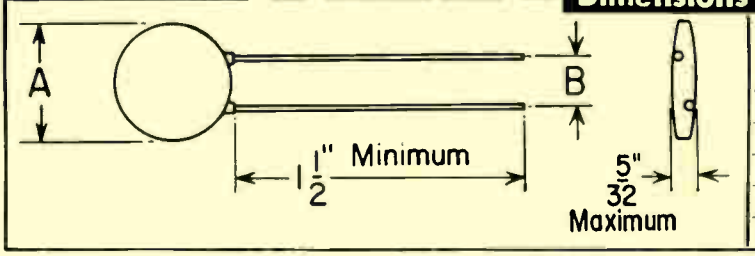
Where simultaneous shipments are specified for several destinations, add **$2.50** net per order for each destination beyond one.

Minimum billing charge **$10.00**.

Terms are 1% 10th and 25th, 30 days net, F.O.B. Milwaukee, Wisconsin, with lowest cost transportation prepaid and absorbed by us to any recognized freight station within the continental United States, provided method and routing of shipment are left to our discretion. Title passes upon delivery to carrier.

All prices, terms and conditions subject to change without notice.

Dimensions



Type	Dimension A		Dimension B ± 1/16"
	Nominal	Actual	
16	¼"	.250/.310	3/16"
24	⅜"	.315/.385	¼"
36	9/16"	.510/.590	⅜"
40	⅝"	.630/.690	⅜"
48	¾"	.770/.820	⅜"

Prices

Type	Tolerance	Price Per Thousand					
		1-49	50-99	100-249	250-499	500-999	1000 or More
16	5% 10% 20%	$300.00 300.00 300.00	$250.00 250.00 250.00	$200.00 200.00 200.00	$56.00 49.50 47.25	$52.50 46.50 44.25	$35.00 31.00 29.50
24	5% 10% 20%	300.00 300.00 300.00	250.00 250.00 250.00	200.00 200.00 200.00	56.00 49.50 47.25	52.50 46.50 44.25	35.00 31.00 29.50
28	5% 10% 20%	300.00 300.00 300.00	250.00 250.00 250.00	200.00 200.00 200.00	57.50 52.75 50.50	54.00 49.50 47.25	36.00 33.00 31.50
36	5% 10% 20%	300.00 300.00 300.00	250.00 250.00 250.00	200.00 200.00 200.00	57.50 52.75 50.50	54.00 49.50 47.25	36.00 33.00 31.50
40	5% 10% 20%	300.00 300.00 300.00	250.00 250.00 250.00	200.00 200.00 200.00	57.50 52.75 50.50	54.00 49.50 47.25	36.00 33.00 31.50
48	5% 10% 20%	300.00 300.00 300.00	250.00 250.00 250.00	200.00 200.00 200.00	80.00 70.50 64.00	75.00 66.00 60.00	50.00 44.00 40.00

• • • Price Additions for Special Features • • •

1. Coating closer than ⅛" allowing no exposed disc..... **$5.00** per 1000
2. Leads cut shorter than standard to 3/64" total deviation..... **2.50** per 1000
3. Leads cut shorter than standard to less than 3/64" total deviation..... **10.00** per 1000
4. On standard cut leads (pin-type) tolerance closer than ± .035" at end of leads..... **5.00** per 1000
5. Markings, other than standard..... **5.00** per 1000
6. For reference to Government Specifications..... add **25.00** per 1000

MMF	Tolerance	Temperature Characteristics										
		P100	P33	NP0	N33	N80	N150	N220	N330	N470	N750	N1500
2.0	± 5%	16-2095-P100										
2.2	± 5%	16-2295-P100										
2.2	±10%	16-2291-P100										
2.2	±20%	16-2292-P100										
2.4	± 5%	16-2495-P100										
2.7	± 5%	16-2795-P100										
2.7	±10%	16-2791-P100										
3.0	± 5%	16-3095-P100	16-3095-P33	16-3095-NP0	16-3095-N33	16-3095-N80	16-3095-N150					
3.3	± 5%	16-3395-P100	16-3395-P33	16-3395-NP0	16-3395-N33	16-3395-N80	16-3395-N150					
3.3	±10%	16-3391-P100	16-3391-P33	16-3391-NP0	16-3391-N33	16-3391-N80	16-3391-N150					
3.3	±20%	16-3392-P100	16-3392-P33	16-3392-NP0	16-3392-N33	16-3392-N80	16-3392-N150					
3.6	± 5%	16-3695-P100	16-3695-P33	16-3695-NP0	16-3695-N33	16-3695-N80	16-3695-N150					
3.9	± 5%	16-3995-P100	16-3995-P33	16-3995-NP0	16-3995-N33	16-3995-N80	16-3995-N150					
3.9	±10%	16-3991-P100	16-3991-P33	16-3991-NP0	16-3991-N33	16-3991-N80	16-3991-N150					
4.3	± 5%	16-4395-P100	16-4395-P33	16-4395-NP0	16-4395-N33	16-4395-N80	16-4395-N150	16-4395-N220	16-4395-N330			
4.7	± 5%	16-4795-P100	16-4795-P33	16-4795-NP0	16-4795-N33	16-4795-N80	16-4795-N150	16-4795-N220	16-4795-N330			
4.7	±10%	16-4791-P100	16-4791-P33	16-4791-NP0	16-4791-N33	16-4791-N80	16-4791-N150	16-4791-N220	16-4791-N330			
4.7	±20%	16-4792-P100	16-4792-P33	16-4792-NP0	16-4792-N33	16-4792-N80	16-4792-N150	16-4792-N220	16-4792-N330			
5.1	± 5%	16-5195-P100	16-5195-P33	16-5195-NP0	16-5195-N33	16-5195-N80	16-5195-N150	16-5195-N220	16-5195-N330	16-5195-N470		
5.6	± 5%	16-5695-P100	16-5695-P33	16-5695-NP0	16-5695-N33	16-5695-N80	16-5695-N150	16-5695-N220	16-5695-N330	16-5695-N470		
5.6	±10%	16-5691-P100	16-5691-P33	16-5691-NP0	16-5691-N33	16-5691-N80	16-5691-N150	16-5691-N220	16-5691-N330	16-5691-N470		
6.2	± 5%	16-6295-P100	16-6295-P33	16-6295-NP0	16-6295-N33	16-6295-N80	16-6295-N150	16-6295-N220	16-6295-N330	16-6295-N470		
6.8	± 5%	16-6895-P100	16-6895-P33	16-6895-NP0	16-6895-N33	16-6895-N80	16-6895-N150	16-6895-N220	16-6895-N330	16-6895-N470		
6.8	±10%	16-6891-P100	16-6891-P33	16-6891-NP0	16-6891-N33	16-6891-N80	16-6891-N150	16-6891-N220	16-6891-N330	16-6891-N470		
6.8	±20%	16-6892-P100	16-6892-P33	16-6892-NP0	16-6892-N33	16-6892-N80	16-6892-N150	16-6892-N220	16-6892-N330	16-6892-N470		
7.5	± 5%	16-7595-P100	16-7595-P33	16-7595-NP0	16-7595-N33	16-7595-N80	16-7595-N150	16-7595-N220	16-7595-N330	16-7595-N470		
8.2	± 5%	16-8295-P100	16-8295-P33	16-8295-NP0	16-8295-N33	16-8295-N80	16-8295-N150	16-8295-N220	16-8295-N330	16-8295-N470		
8.2	±10%	16-8291-P100	16-8291-P33	16-8291-NP0	16-8291-N33	16-8291-N80	16-8291-N150	16-8291-N220	16-8291-N330	16-8291-N470		
9.1	± 5%	16-9195-P100	16-9195-P33	16-9195-NP0	16-9195-N33	16-9195-N80	16-9195-N150	16-9195-N220	16-9195-N330	16-9195-N470		
10	± 5%	24-1005-P100	16-1005-P33	16-1005-NP0	16-1005-N33	16-1005-N80	16-1005-N150	16-1005-N220	16-1005-N330	16-1005-N470	16-1005-N750	
10	±10%	24-1001-P100	16-1001-P33	16-1001-NP0	16-1001-N33	16-1001-N80	16-1001-N150	16-1001-N220	16-1001-N330	16-1001-N470	16-1001-N750	
10	±20%	24-1002-P100	16-1002-P33	16-1002-NP0	16-1002-N33	16-1002-N80	16-1002-N150	16-1002-N220	16-1002-N330	16-1002-N470	16-1002-N750	
11	± 5%	24-1105-P100	16-1105-P33	16-1105-NP0	16-1105-N33	16-1105-N80	16-1105-N150	16-1105-N220	16-1105-N330	16-1105-N470	16-1105-N750	
12	± 5%	24-1205-P100	16-1205-P33	16-1205-NP0	16-1205-N33	16-1205-N80	16-1205-N150	16-1205-N220	16-1205-N330	16-1205-N470	16-1205-N750	
12	±10%	24-1201-P100	16-1201-P33	16-1201-NP0	16-1201-N33	16-1201-N80	16-1201-N150	16-1201-N220	16-1201-N330	16-1201-N470	16-1201-N750	

13	± 5%	24-1305-P100	24-1305-P33	24-1305-NP0	24-1305-N33	24-1305-N80	16-1305-N150	16-1305-N220	16-1305-N330	16-1305-N470	16-1305-N750		
15	± 5%	24-1505-P100	24-1505-P33	24-1505-NP0	24-1505-N33	24-1505-N80	24-1505-N150	16-1505-N220	16-1505-N330	16-1505-N470	16-1505-N750	16-1505-N1500	
15	±10%	24-1501-P100	24-1501-P33	24-1501-NP0	24-1501-N33	24-1501-N80	24-1501-N150	16-1501-N220	16-1501-N330	16-1501-N470	16-1501-N750	16-1501-N1500	
15	±20%	24-1502-P100	24-1502-P33	24-1502-NP0	24-1502-N33	24-1502-N80	24-1502-N150	16-1502-N220	16-1502-N330	16-1502-N470	16-1502-N750	16-1502-N1500	
16	± 5%	24-1605-P100	24-1605-P33	24-1605-NP0	24-1605-N33	24-1605-N80	24-1605-N150	24-1605-N220	16-1605-N330	16-1605-N470	16-1605-N750	16-1605-N1500	
18	± 5%	24-1805-P100	24-1805-P33	24-1805-NP0	24-1805-N33	24-1805-N80	24-1805-N150	24-1805-N220	16-1805-N330	16-1805-N470	16-1805-N750	16-1805-N1500	
18	±10%	24-1801-P100	24-1801-P33	24-1801-NP0	24-1801-N33	24-1801-N80	24-1801-N150	24-1801-N220	16-1801-N330	16-1801-N470	16-1801-N750	16-1801-N1500	
20	± 5%	24-2005-P100	24-2005-P33	24-2005-NP0	24-2005-N33	24-2005-N80	24-2005-N150	24-2005-N220	24-2005-N330	16-2005-N470	16-2005-N750	16-2005-N1500	
22	± 5%	28-2205-P100	24-2205-P33	24-2205-NP0	24-2205-N33	24-2205-N80	24-2205-N150	24-2205-N220	24-2205-N330	24-2205-N470	16-2205-N750	16-2205-N1500	
22	±10%	28-2201-P100	24-2201-P33	24-2201-NP0	24-2201-N33	24-2201-N80	24-2201-N150	24-2201-N220	24-2201-N330	24-2201-N470	16-2201-N750	16-2201-N1500	
22	±20%	28-2202-P100	24-2202-P33	24-2202-NP0	24-2202-N33	24-2202-N80	24-2202-N150	24-2202-N220	24-2202-N330	24-2202-N470	16-2202-N750	16-2202-N1500	
24	± 5%	28-2405-P100	24-2405-P33	24-2405-NP0	24-2405-N33	24-2405-N80	24-2405-N150	24-2405-N220	24-2405-N330	24-2405-N470	16-2405-N750	16-2405-N1500	
27	± 5%	28-2705-P100	28-2705-P33	28-2705-NP0	28-2705-N33	24-2705-N80	24-2705-N150	24-2705-N220	24-2705-N330	24-2705-N470	16-2705-N750	16-2705-N1500	
27	±10%	28-2701-P100	28-2701-P33	28-2701-NP0	28-2701-N33	24-2701-N80	24-2701-N150	24-2701-N220	24-2701-N330	24-2701-N470	16-2701-N750	16-2701-N1500	
30	± 5%	28-3005-P100	28-3005-P33	28-3005-NP0	28-3005-N33	28-3005-N80	24-3005-N150	24-3005-N220	24-3005-N330	24-3005-N470	16-3005-N750	16-3005-N1500	
33	± 5%	36-3305-P100	28-3305-P33	28-3305-NP0	28-3305-N33	28-3305-N80	28-3305-N150	24-3305-N220	24-3305-N330	24-3305-N470	16-3305-N750	16-3305-N1500	
33	±10%	36-3301-P100	28-3301-P33	28-3301-NP0	28-3301-N33	28-3301-N80	28-3301-N150	24-3301-N220	24-3301-N330	24-3301-N470	16-3301-N750	16-3301-N1500	
33	±20%	36-3302-P100	28-3302-P33	28-3302-NP0	28-3302-N33	28-3302-N80	28-3302-N150	24-3302-N220	24-3302-N330	24-3302-N470	16-3302-N750	16-3302-N1500	
36	± 5%	36-3605-P100	36-3605-P33	28-3605-NP0	28-3605-N33	28-3605-N80	28-3605-N150	28-3605-N220	24-3605-N330	24-3605-N470	16-3605-N750	16-3605-N1500	
39	± 5%	36-3905-P100	36-3905-P33	36-3905-NP0	36-3905-N33	28-3905-N80	28-3905-N150	28-3905-N220	28-3905-N330	24-3905-N470	24-3905-N750	16-3905-N1500	
39	±10%	36-3901-P100	36-3901-P33	36-3901-NP0	36-3901-N33	28-3901-N80	28-3901-N150	28-3901-N220	28-3901-N330	24-3901-N470	24-3901-N750	16-3901-N1500	
43	± 5%	36-4305-P100	36-4305-P33	36-4305-NP0	36-4305-N33	28-4305-N80	28-4305-N150	28-4305-N220	28-4305-N330	24-4305-N470	24-4305-N750	16-4305-N1500	
47	± 5%	40-4705-P100	36-4705-P33	36-4705-NP0	36-4705-N33	36-4705-N80	28-4705-N150	28-4705-N220	28-4705-N330	24-4705-N470	24-4705-N750	16-4705-N1500	
47	±10%	40-4701-P100	36-4701-P33	36-4701-NP0	36-4701-N33	36-4701-N80	28-4701-N150	28-4701-N220	28-4701-N330	24-4701-N470	24-4701-N750	16-4701-N1500	
47	±20%	40-4702-P100	36-4702-P33	36-4702-NP0	36-4702-N33	36-4702-N80	28-4702-N150	28-4702-N220	28-4702-N330	24-4702-N470	24-4702-N750	16-4702-N1500	
51	± 5%	40-5105-P100	36-5105-P33	36-5105-NP0	36-5105-N33	36-5105-N80	36-5105-N150	28-5105-N220	28-5105-N330	28-5105-N470	24-5105-N750	16-5105-N1500	
56	± 5%	40-5605-P100	40-5605-P33	40-5605-NP0	36-5605-N33	36-5605-N80	36-5605-N150	36-5605-N220	28-5605-N330	28-5605-N470	24-5605-N750	24-5605-N1500	
56	±10%	40-5601-P100	40-5601-P33	40-5601-NP0	36-5601-N33	36-5601-N80	36-5601-N150	36-5601-N220	28-5601-N330	28-5601-N470	24-5601-N750	24-5601-N1500	
62	± 5%	40-6205-P100	40-6205-P33	40-6205-NP0	40-6205-N33	40-6205-N80	36-6205-N150	36-6205-N220	28-6205-N330	28-6205-N470	24-6205-N750	24-6205-N1500	
68	± 5%	48-6805-P100	40-6805-P33	40-6805-NP0	40-6805-N33	40-6805-N80	36-6805-N150	36-6805-N220	36-6805-N330	28-6805-N470	24-6805-N750	24-6805-N1500	
68	±10%	48-6801-P100	40-6801-P33	40-6801-NP0	40-6801-N33	40-6801-N80	36-6801-N150	36-6801-N220	36-6801-N330	28-6801-N470	24-6801-N750	24-6801-N1500	
68	±20%	48-6802-P100	40-6802-P33	40-6802-NP0	40-6802-N33	40-6802-N80	36-6802-N150	36-6802-N220	36-6802-N330	28-6802-N470	24-6802-N750	24-6802-N1500	
75	± 5%	48-7505-P100	40-7505-P33	40-7505-NP0	40-7505-N33	40-7505-N80	40-7505-N150	36-7505-N220	36-7505-N330	28-7505-N470	24-7505-N750	24-7505-N1500	
82	± 5%	48-8205-P100	48-8205-P33	48-8205-NP0	40-8205-N33	40-8205-N80	40-8205-N150	40-8205-N220	36-8205-N330	36-8205-N470	24-8205-N750	24-8205-N1500	
82	±10%	48-8201-P100	48-8201-P33	48-8201-NP0	40-8201-N33	40-8201-N80	40-8201-N150	40-8201-N220	36-8201-N330	36-8201-N470	24-8201-N750	24-8201-N1500	
91	± 5%	.....	48-9105-P33	48-9105-NP0	48-9105-N33	40-9105-N80	40-9105-N150	40-9105-N220	36-9105-N330	36-9105-N470	28-9105-N750	24-9105-N1500	
100	± 5%	.....	48-1015-P33	48-1015-NP0	48-1015-N33	40-1015-N80	40-1015-N150	40-1015-N220	40-1015-N330	36-1015-N470	28-1015-N750	24-1015-N1500	
100	±10%	.....	48-1011-P33	48-1011-NP0	48-1011-N33	40-1011-N80	40-1011-N150	40-1011-N220	40-1011-N330	36-1011-N470	28-1011-N750	24-1011-N1500	
100	±20%	.....	48-1012-P33	48-1012-NP0	48-1012-N33	40-1012-N80	40-1012-N150	40-1012-N220	40-1012-N330	36-1012-N470	28-1012-N750	24-1012-N1500	

MMF	Tolerance	Temperature Characteristics										
		P100	P33	NP0	N33	N80	N150	N220	N330	N470	N750	N1500
110	± 5%		48-1115-P33	48-1115-NP0	48-1115-N33	48-1115-N80	48-1115-N150	40-1115-N220	40-1115-N330	40-1115-N470	28-1115-N750	28-1115-N1500
120	± 5%					48-1215-N80	48-1215-N150	48-1215-N220	40-1215-N330	40-1215-N470	28-1215-N750	28-1215-N1500
120	±10%					48-1211-N80	48-1211-N150	48-1211-N220	40-1211-N330	40-1211-N470	28-1211-N750	28-1211-N1500
130	± 5%						48-1315-N150	48-1315-N220	48-1315-N330	40-1315-N470	28-1315-N750	28-1315-N1500
150	± 5%							48-1515-N220	48-1515-N330	40-1515-N470	36-1515-N750	28-1515-N1500
150	±10%							48-1511-N220	48-1511-N330	40-1511-N470	36-1511-N750	28-1511-N1500
150	±20%							48-1512-N220	48-1512-N330	40-1512-N470	36-1512-N750	28-1512-N1500
160	± 5%								48-1615-N330	48-1615-N470	36-1615-N750	28-1615-N1500
180	± 5%									48-1815-N470	36-1815-N750	36-1815-N1500
180	±10%									48-1811-N470	36-1811-N750	36-1811-N1500
200	± 5%									48-2015-N470	40-2015-N750	36-2015-N1500
220	± 5%										40-2215-N750	36-2215-N1500
220	±10%										40-2211-N750	36-2211-N1500
220	±20%										40-2212-N750	36-2212-N1500
240	± 5%										40-2415-N750	36-2415-N1500
270	± 5%										40-2715-N750	40-2715-N1500
270	±10%										40-2711-N750	40-2711-N1500
300	± 5%										48-3015-N750	40-3015-N1500
330	± 5%										48-3315-N750	40-3315-N1500
330	±10%										48-3311-N750	40-3311-N1500
330	±20%										48-3312-N750	40-3312-N1500
360	± 5%										48-3615-N750	40-3615-N1500
390	± 5%										48-3915-N750	48-3915-N1500
390	±10%										48-3911-N750	48-3911-N1500
430	± 5%											48-4315-N1500
470	± 5%											48-4715-N1500
470	±10%											48-4711-N1500
470	±20%											48-4712-N1500
510	± 5%											48-5115-N1500

Printed in U.S.A.

Ceramic Disc Capacitors
Ceramic Encased

October 15, 1956 • • • Price Sheet **5480D**

The listed prices apply to single disc type capacitors having the following standard features.

1. Lead wires are #20 awg.
2. Marking may include either color coding or stamping at option of supplier. Stamping will include capacitance, tolerance and supplier identification (may be omitted on ¼" disc).

For any deviations from above specifications (except for the special features listed), obtain individual quotations from the Sales Department at Milwaukee.

The quantity to be used in determining the price must consist of identical capacitors. Various capacitance values cannot be combined to determine the quantity price.

Part shipments specified by the purchaser will be billed on the basis of the quantity requested for each individual shipment. Part shipments made at the seller's convenience will be billed on the basis of the quantity per item ordered for "one time" shipment.

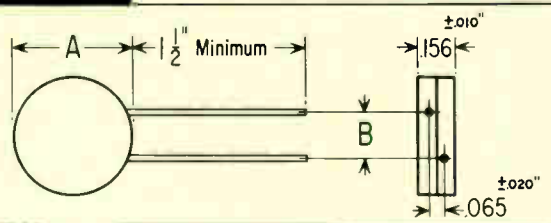
Where simultaneous shipments are specified for several destinations, add **$2.50** net per order for each destination beyond one.

Minimum billing charge **$10.00.**

Terms are 1% 10th and 25th, 30 days net, F.O.B. Milwaukee, Wisconsin, with lowest cost transportation prepaid and absorbed by us to any recognized freight station within the continental United States, provided method and routing of shipment are left to our discretion. Title passes upon delivery to carrier.

All prices, terms and conditions subject to change without notice.

Dimensions



Type	Dimension A		Dimension B ± .015" Tolerance at Body of Capacitor
	Nominal	Actual ± .010"	
C16	¼"	.312	.250
C36	9/16"	.600	.375

Prices

Tolerance	Price Per Thousand					
	1 — 49	50 — 99	100 — 249	250 — 499	500 — 999	1000 or More
± 10%	$750	$625	$500	$225	$180	$150
± 20%	700	575	450	195	155	130
± 30%	675	550	425	190	150	125

• • • Price Additions for Special Features • • •

1. Leads cut shorter than standard to 3/64" total deviation ..... $ **2.50** per 1000
2. Leads cut shorter than standard to less than 3/64" total deviation ..... **10.00** per 1000
3. On standard cut leads (pin-type) tolerance closer than ± .035" at end of leads ..... **5.00** per 1000
4. Markings, other than standard ..... **5.00** per 1000
5. For reference to Government Specifications ..... add **25.00** per 1000

New Information

Part Numbers

MMF	Part No.			MMF	Part No.			MMF	Part No.		
	± 10%	± 20%	± 30%		± 10%	± 20%	± 30%		± 10%	± 20%	± 30%
2.2	C16-2291	C16-2292	C16-2293	56	C36-5601	—	—	1500	C36-1521	C36-1522	C36-1523
2.7	C16-2791	—	—	68	C36-6801	C36-6802	C36-6803	1800	C36-1821	—	—
3.3	C16-3391	C16-3392	C16-3393	82	C36-8201	—	—	2200	C36-2221	C36-2222	C36-2223
3.9	C16-3991	—	—	100	C16-1011	C16-1012	C16-1013	2700	C36-2721	—	—
								3300	C36-3321	C36-3322	C36-3323
4.7	C16-4791	C16-4792	C16-4793	120	C16-1211	—	—				
5.6	C16-5691	—	—	150	C16-1511	C16-1512	C16-1513				
6.8	C16-6891	C16-6892	C16-6893	180	C16-1811	—	—				
8.2	C16-8291	—	—	220	C16-2211	C16-2212	C16-2213				
10	C16-1001	C16-1002	C16-1003	270	C16-2711	—	—				
12	C16-1201	—	—	330	C16-3311	C16-3312	C16-3313				
15	C16-1501	C16-1502	C16-1503	390	C16-3911	—	—				
18	C16-1801	—	—	470	C16-4711	C16-4712	C16-4713				
22	C16-2201	C16-2202	C16-2203	560	C36-5611	—	—				
27	C16-2701	—	—	680	C36-6811	C36-6812	C36-6813				
33	C16-3301	C16-3302	C16-3303	820	C36-8211	—	—				
39	C16-3901	—	—	1000	C36-1021	C36-1022	C36-1023				
47	C36-4701	C36-4702	C36-4703	1200	C36-1221	—	—				

Ceramic Disc Capacitors
Military Type—MIL-C-11015A

October 31, 1956 • • • **Price Sheet 5480F**

The listed prices apply to single disc type capacitors having the following standard features.

1. Coating material may extend down lead wires 1/8" from tangent line (Bottom edge of disc).
2. Lead wires are #22 awg.

The quantity to be used in determining the price must consist of identical capacitors. Various capacitance values cannot be combined to determine the quantity price.

Part shipments specified by purchaser will be billed on basis of quantity requested for each shipment. Part shipments made at seller's convenience will be billed on basis of the quantity per item ordered for "one time" shipment.

Where simultaneous shipments are specified for several destinations, add **$2.50** net per order for each destination beyond one.

Minimum billing charge **$10.00.**

Terms are 1% 10th and 25th, 30 days net, F.O.B. Milwaukee, Wisconsin, with lowest cost transportation prepaid and absorbed by us to any recognized freight station within the continental United States, provided method and routing of shipment are left to our discretion. Title passes upon delivery to carrier.

Prices, terms and conditions subject to change without notice.

Prices

MMF	MIL Part Number	Allen-Bradley Part Number	Price Per Thousand					
			1-49	50-99	100-249	250-499	500-999	1000 or more
470	CK60Y471Z	16-471Y	$175.00	$150.00	$125.00	$70.50	$67.75	$53.50
680	CK60Y681Z	16-681Y	175.00	150.00	125.00	70.50	67.75	53.50
820	CK60Y821Z	16-821Y	180.00	155.00	130.00	78.50	75.25	58.50
1000	CK61Y102Z	24-102Y	175.00	150.00	125.00	70.50	67.75	53.50
1500	CK61Y152Z	24-152Y	175.00	150.00	125.00	70.50	67.75	53.50
2200	CK62Y222Z	36-222Y	175.00	150.00	125.00	70.50	67.75	53.50
3300	CK62Y332Z	36-332Y	180.00	155.00	130.00	78.50	75.25	58.50
4700	CK62Y472Z	36-472Y	175.00	150.00	125.00	71.50	68.50	54.00
10000	CK63Y103Z	48-103Y	175.00	150.00	125.00	79.50	76.00	59.00

Supersedes Price Sheet dated Sept. 24, 1956

Type A Ceramic Disc Capacitors

General Purpose • Temperature Staple • Temperature Compensating

December 15, 1958 • • • **Price Sheet 5481**

The prices on this price sheet apply to the capacitors listed in Bulletin 5401.

The quantity to be used in determining the price must consist of identical capacitors. Various capacitance values cannot be combined to determine the quantity price.

Part shipments specified by the purchaser will be billed on the basis of the quantity requested for each individual shipment. Part shipments made at the seller's convenience will be billed on the basis of the quantity per item ordered for "one time" shipment.

Where simultaneous shipments are specified for several destinations, add $2.50 net per order for each destination beyond one.

Minimum item charge $10.00.

Terms are 1% 10th and 25th, 30 days net, F.O.B. Milwaukee, Wisconsin, with lowest cost transportation prepaid and absorbed by us to any recognized freight station within the continental United States, provided method and routing of shipment are left to our discretion. Title passes upon delivery to carrier.

All prices, terms and conditions subject to change without notice.

Type of Capacitor	Values	Tolerance	PRICE PER M				
			1-99	100-249	250-499	500-999	1000 or More
General Purpose See Technical Bulletin 5401 Page 6 Table II for specific values available	10 mmf thru 180 mmf	GMV	$148.00	$104.00	$67.00	$44.50	$29.50
		± 20%	148.00	104.00	67.00	44.50	29.50
		± 10%	158.00	111.00	71.00	47.50	31.50
		± 5%	175.00	123.00	79.00	52.50	35.00
	220 mmf thru 3300 mmf	GMV	118.00	83.00	53.00	35.50	26.00
		± 20%	123.00	86.00	56.00	37.00	29.50
		± 10%	158.00	111.00	71.00	47.50	31.50
	4700 mmf	GMV	123.00	86.00	56.00	37.00	26.50
		± 20%	128.00	90.00	58.00	38.50	30.00
	6800 mmf and .01 mfd	GMV	145.00	102.00	66.00	43.50	31.50
		± 20%	168.00	118.00	76.00	50.50	35.00
General Purpose Temperature Stable See Technical Bulletin 5401 Page 6, Table III for specific values available	10 mmf thru 180 mmf	± 20%	148.00	104.00	67.00	44.50	29.50
		± 10%	158.00	111.00	71.00	47.50	31.50
		± 5%	175.00	123.00	79.00	52.50	35.00
	220 mmf thru 1200 mmf	± 20%	163.00	114.00	73.00	49.00	36.50
		± 10%	188.00	132.00	85.00	56.50	40.00
	1500 mmf thru 3300 mmf	± 20%	178.00	125.00	80.00	53.50	40.00
		± 10%	198.00	139.00	89.00	59.50	45.00
Standard Temperature Compensating Characteristic NPO See Technical Bulletin 5401 Page 7, Table IV for specific values available	10 mmf thru 24 mmf	± 20%	130.00	91.00	59.00	39.00	29.50
		± 10%	140.00	98.00	63.00	42.00	31.00
		± 5%	165.00	116.00	75.00	49.00	35.00
	27 mmf thru 82 mmf	± 20%	145.00	102.00	66.00	43.50	31.50
		± 10%	150.00	105.00	68.00	45.00	33.00
		± 5%	170.00	119.00	77.00	51.00	36.00
Standard Temperature Compensating Characteristic N750 See Technical Bulletin 5401 Page 7, Table IV for specific values available	15 mmf thru 82 mmf	± 20%	130.00	91.00	59.00	39.00	29.50
		± 10%	140.00	98.00	63.00	42.00	31.00
		± 5%	165.00	116.00	75.00	49.50	35.00
	91 mmf thru 180 mmf	± 20%	145.00	102.00	66.00	43.50	31.50
		± 10%	150.00	105.00	68.00	45.00	33.00
		± 5%	170.00	119.00	77.00	51.00	36.00
Special Temperature Compensating Characteristics N150 N470 P33 N33 N220 N1500 P100 N80 N330 N2200 See Technical Bulletin 5401 Page 7, Table V for specific values available	All Values Listed	± 20%	163.00	114.00	73.00	49.00	32.50
		± 10%	168.00	118.00	76.00	50.50	33.50
		± 5%	180.00	126.00	81.00	54.00	36.00
Special Temperature Compensating Characteristics N3300 N4700 See Technical Bulletin 5401 Page 7, Table V for specific values available	All Values Listed	± 20%	178.00	125.00	80.00	53.50	35.50
		± 10%	198.00	139.00	89.00	59.50	39.50
		± 5%	233.00	165.00	106.00	70.50	47.00

(Continued an other side)

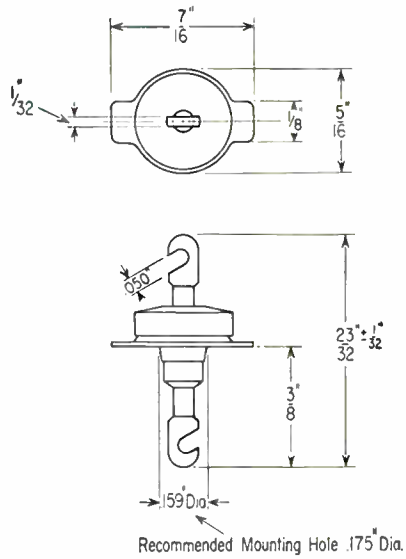
New Information

Price Additions for Special Features • • •

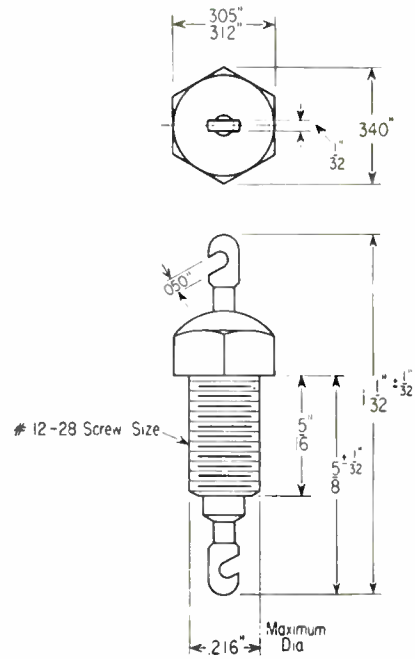
1.	Leads cut shorter than standard to less than 3/64" total deviation	$10.00 per 1000
2.	On standard cut leads (pin-type) tolerance closer than ±.035" at end of leads	5.00 per 1000
3.	Markings, other than standard	5.00 per 1000
4.	For reference to Government Specifications (Includes Source Inspection)	35.00 per 1000
5.	For Government Source Inspection to Commercial Specifications	35.00 per 1000
6.	For other values than listed add $5.00 to the next higher standard value.	

Type FT-Feed-Thru Capacitors
Type SO-Stand-Off Capacitors

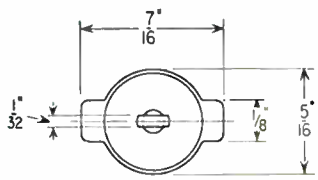
July 16, 1955 • • • Dimension Drawing **5490D**

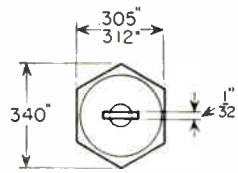


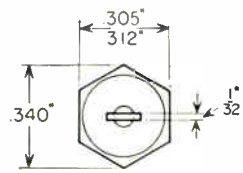
Type FTS
Feed-Thru Capacitor
Solder Mounting



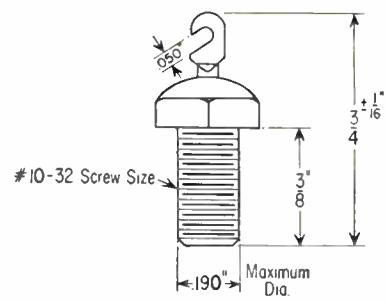
Type FTB
Feed-Thru Capacitor
Bolt Mounting



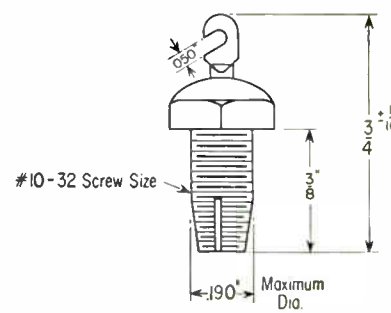




Type SOS
Stand-Off Capacitor
Solder Mounting



Type SOB
Stand-Off Capacitor
Bolt Mounting



Type SOST
Stand-Off Capacitor
Self-Tapping Screw Mounting

Supersedes Drawing Dated June 1, 1955
Printed in U. S. A.

Specifications
Type R-02 Ferrite Material

August 15, 1957 • • • Technical Bulletin 5657

Application • • •

Core Material For:

1. High frequency saturable reactors
2. Broad Band Transformers
3. Permeability tuning
4. Antennas

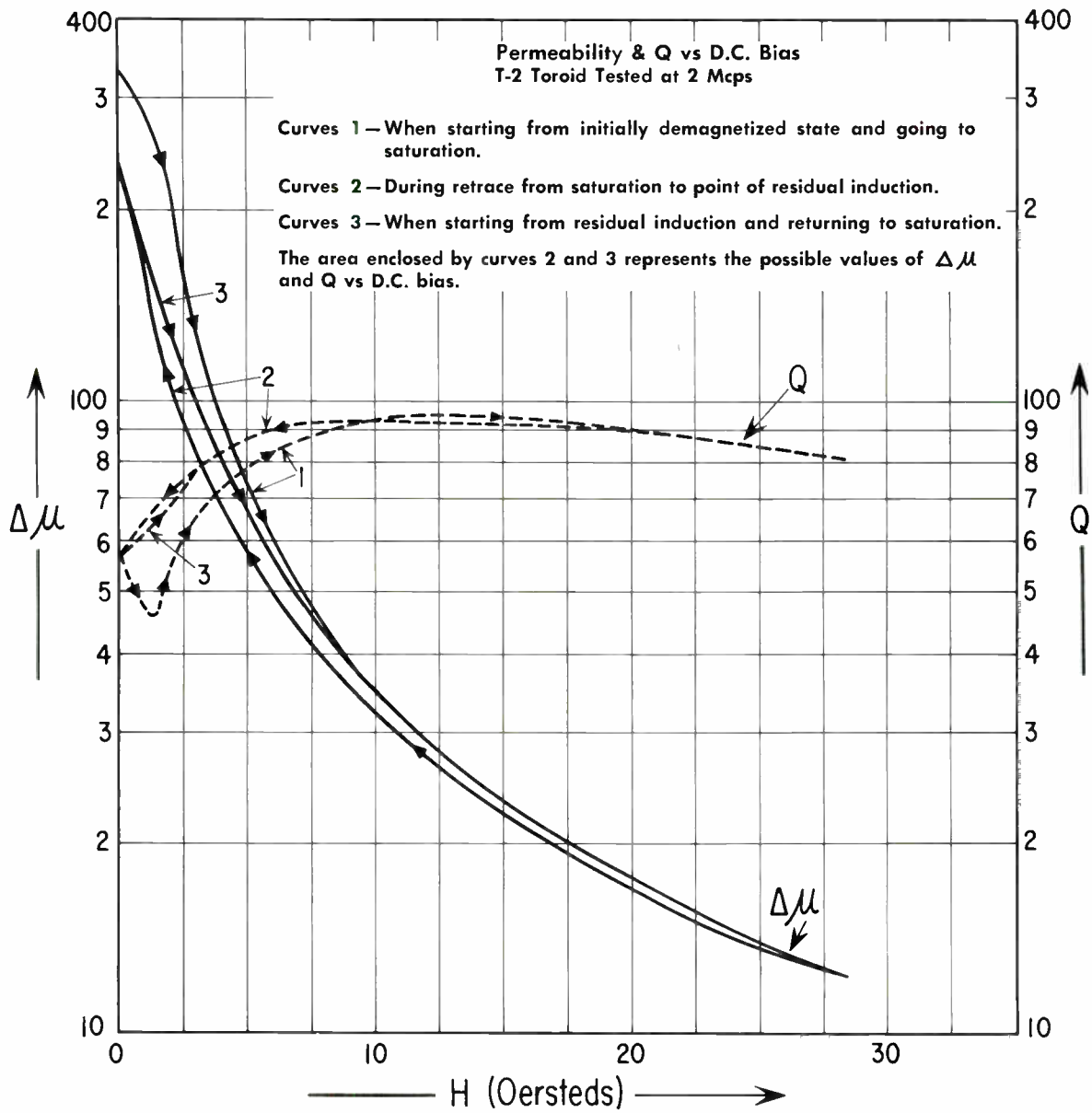
Significant Parameters

Extreme temperature stability
Low core losses

Useful frequency range—to approximately 10 Mcps

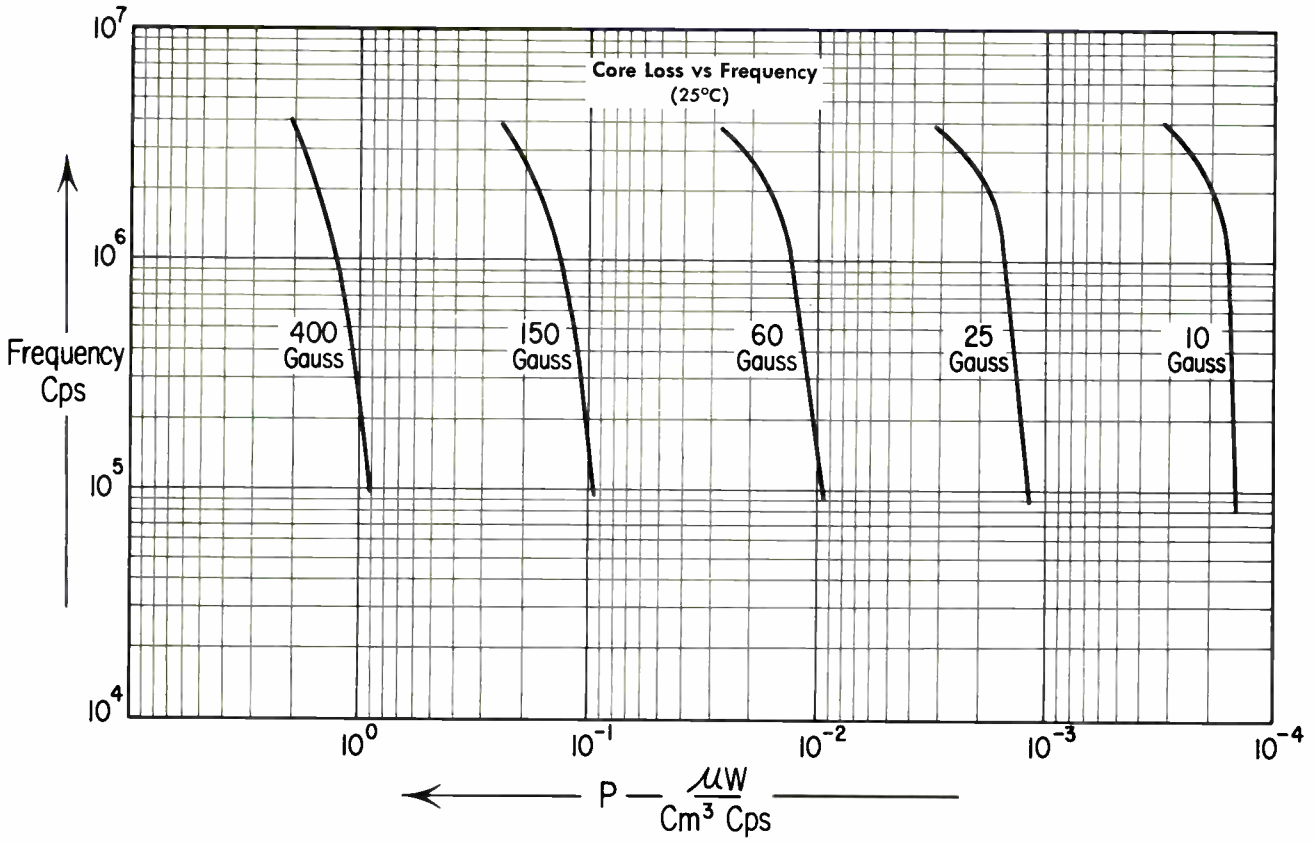
Representative Values • • •

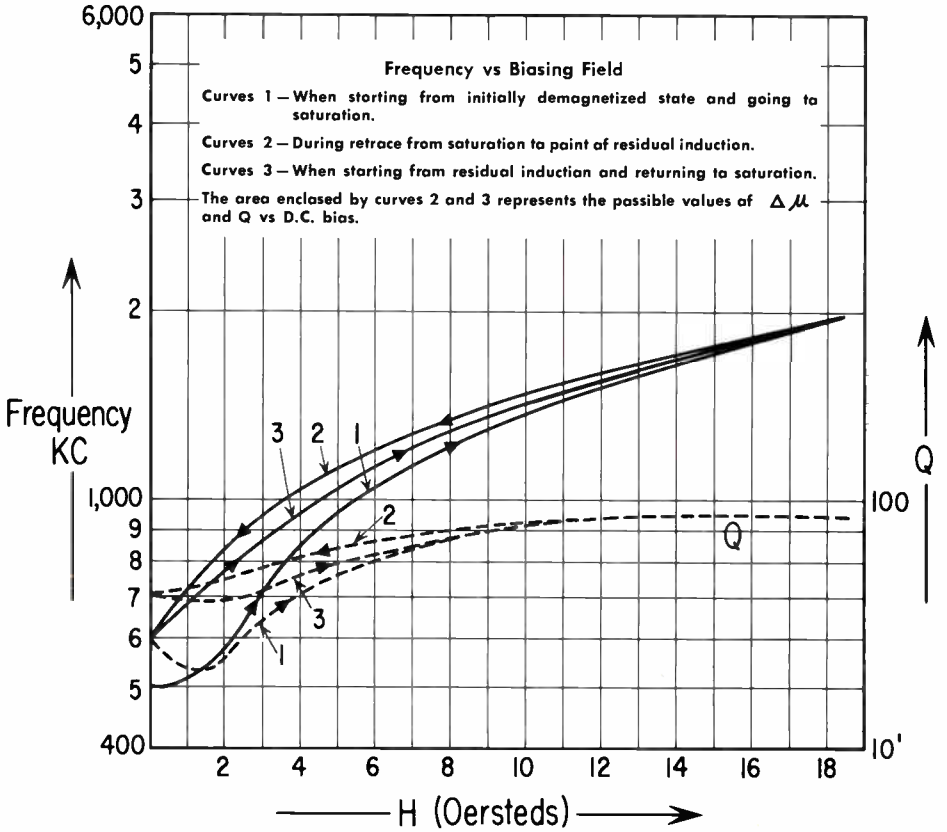
μ_o @ 25°C—2 Mcps	395
Q @ 25°C—2 Mcps	57
Temp. Coeff. of μ_o (25° C to 100° C) %/°C	.07
Dielectric Constant ϵ @ 2 Mcps	14
Volume Resistivity, (Ω cm) D.C.	1.7×10^6
Maximum Permeability, 4 Kcps, 25°C	810
B max @ 6AT/cm, 4 Kcps, 25°C (gauss)	3030



New Information

Specifications Type R-02 Ferrite Material





CHECKING LIST
ALLEN-BRADLEY ELECTRONIC COMPONENTS CATALOG

★Publication 6014 dated February, 1959
★Standard Conditions of Sale, Publication 6001, dated January 2, 1959

FIXED RESISTORS

Publication 6301 dated November 3, 1958
Technical Bulletin 5000 dated May 16, 1955
Technical Bulletin 5000A dated May 2, 1955
Technical Bulletin 5000B dated February 15, 1957
Technical Bulletin 5000C dated March 1, 1957
Technical Bulletin 5000D dated August 1, 1957
Technical Bulletin 5001 dated June 1, 1955
Technical Bulletin 5002 dated May 2, 1955
Technical Bulletin 5003 dated June 16, 1958
Technical Bulletin 5004 dated April 1, 1958
Technical Bulletin 5050 dated March 3, 1958
Technical Bulletin 5053 dated March 3, 1958
Technical Bulletin 5054 dated November 15, 1957
Price Sheet 5080 dated October 22, 1958
Price Sheet 5080A dated October 22, 1958
Price Sheet 5084 dated October 22, 1958
Dimension Drawing 5090 dated November 15, 1957

VARIABLE RESISTORS

Technical Bulletin 5200 dated March 1, 1956
Technical Bulletin 5200A dated September 3, 1957
Technical Bulletin 5201 dated July 1, 1955
Technical Data 5202 dated November 15, 1955
Technical Bulletin 5203 dated September 4, 1956
Technical Bulletin 5204 dated March 1, 1957
★Technical Bulletin 5205 dated March 11, 1959
Technical Bulletin 5250 dated September 16, 1957
Price Sheet 5280E dated July 1, 1957
Dimension Drawing 5290A, Sheet 1, dated November 15, 1956
Dimension Drawing 5290A, Sheet 2, dated November 15, 1956
Dimension Drawing 5290A, Sheet 3, dated November 15, 1956
Dimension Drawing 5290A, Sheet 4, dated November 15, 1956
Dimension Drawing 5290A, Sheet 5, dated November 15, 1956
Dimension Drawing 5290A, Sheet 6, dated November 15, 1956
Dimension Drawing 5290A, Sheet 7, dated November 15, 1956
Dimension Drawing 5290A, Sheet 8, dated November 15, 1956
Dimension Drawing 5290A, Sheet 9, dated November 15, 1956
Dimension Drawing 5290B dated January 3, 1956
Dimension Drawing 5290C dated December 15, 1955
Dimension Drawing 5290D dated October 12, 1956
Dimension Drawing 5290E, Sheet 1, dated May 31, 1957
Dimension Drawing 5290E, Sheet 2, dated May 31, 1957

CERAMIC CAPACITORS

Technical Bulletin 5400D dated June 1, 1957
Technical Bulletin 5401 dated December 1, 1958
Technical Bulletin 5409 dated October 16, 1957
Technical Bulletin 5410 dated January 16, 1958
Technical Bulletin 5440 dated May 16, 1955
Price Sheet 5480A dated May 19, 1958
Price Sheet 5480Aa dated September 16, 1957
Price Sheet 5480B dated August 15, 1957
Price Sheet 5480Ba dated September 16, 1957
Price Sheet 5480C dated August 15, 1957
Price Sheet 5480Ca dated August 15, 1957
Price Sheet 5480Cb dated September 16, 1957
Price Sheet 5480D dated August 1, 1957
Price Sheet 5480F dated August 15, 1957
★Price Sheet 5481 dated December 15, 1958
Price Sheet 5489 dated October 1, 1957
Price Sheet 54810 dated February 3, 1958
Dimension Drawing 5499 dated October 1, 1957

FERRITES

Technical Bulletin 5630 dated July 1, 1955
Technical Bulletin 5640 dated May 2, 1955
Technical Bulletin 5651 dated November 15, 1957
Technical Bulletin 5653 dated November 15, 1957
Technical Bulletin 5654 dated August 1, 1958
Technical Bulletin 5655 dated June 30, 1958
Technical Bulletin 5657 dated August 15, 1957
Technical Bulletin 5658 dated July 1, 1958
Price Sheet 5680 dated June 2, 1958

★Added or changed since previous issue.