

SPRAGUE
THE MARK OF RELIABILITY

a GK Technologies subsidiary

Engineering Bulletin

2211E

Supersedes No. 2211D

Type 118P Subminiature "Metal-Clad"

125 C DIFILM[®] Metallized Capacitors

DIFILM METALLIZED Capacitors find their widest application in military electronics and in allied industrial applications where both reliability of service and economy of space are all-important considerations.

They are unmatched for reliability in high temperature operation by any other type of metallized paper capacitors presently available.

125 C Operation Without Derating

Type 118P DIFILM Metallized Capacitors are rated for operation at 125 C *without voltage derating!* And their insulation resistance is higher than that of any other metallized paper capacitors!

Unexcelled Performance Characteristics

These capacitors will withstand the same life test as that of standard paper capacitors - 140% of rated voltage for 250 hours at full rated temperature - instead of the conventional metallized paper capacitor life test of only 125% of full rated voltage at maximum operating temperature. They are also subject to the same voltage test as standard paper capacitors - *twice rated voltage* instead of the less severe tests to which conventional metallized paper capacitors are customarily subjected.

The unique dielectric consists of a dual combination of metallized paper and of polyester film impregnated with a special high-temperature mineral wax. The capacitor sections are effectively of non-inductive construction. This construction, as made and processed by Sprague, results in capacitors unmatched in performance quality by any other metallized capacitors presently available.

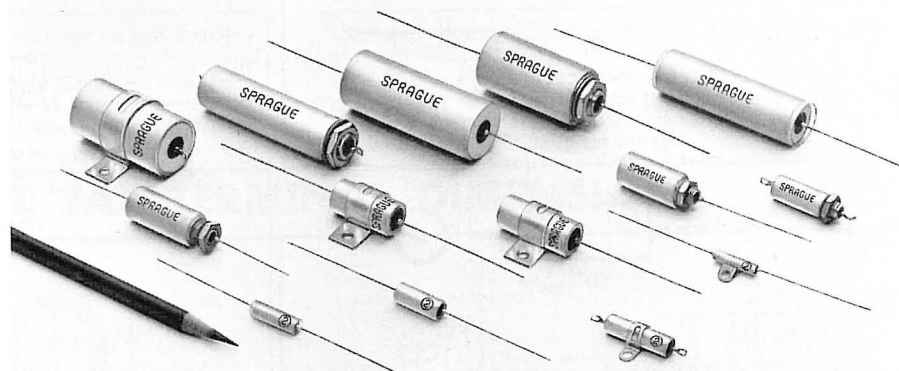
Type 118P Capacitors may be used at extremely low voltages where metallized paper construction has previously been unsatisfactory. Typical Type 118P Capacitors

have been operated up to 5000 hours with only 2 volts applied without the non-clearable short circuits which have been typical of earlier designs. Likewise, they have shown remarkable performance with regard to self-generated noise. They can be used safely in most low-noise level circuits. Typically these capacitors, when operated at rated voltage and 125 C, exhibit only an occasional clearing in which the voltage across the capacitor drops more than $\frac{1}{2}$ volt!

Features of Construction

Other features of Type 118P Capacitors are the self-healing characteristics, in the rare event of capacitor dielectric breakdown, and the complete hermetic sealing. All units have glass-to-metal solder-seal terminals. Both standard wire leads and solder tabs are available in a wide variety of mounting styles. All cases are of corrosion-resistant materials.

Type 118P capacitors will meet all the applicable requirements of Military Specification MIL-C-39022 for metallized capacitors.



SPRAGUE ELECTRIC COMPANY

SPRAGUE
ENGINEERING
BULLETIN
2211E

Catalog Numbering System

ALWAYS SPECIFY BY COMPLETE CATALOG NUMBER, SUCH AS:

118P 103 0 2 S 1

STYLE NUMBER. THIS DESIGNATES CERTAIN MECHANICAL VARIATIONS IN THE CAPACITOR CASES AND ELECTRICAL CIRCUIT. SEE PAGES 6 and 7.

TERMINAL. S = WIRE LEADS, T = SOLDERING TAB* (.235" Dia. Cans and UP)
*Capacitors with one end grounded (Styles T1 and T3) are supplied with one terminal on the insulated cover end and a ground lead supplied on the opposite end.

D-C VOLTAGE RATING. THIS IS EXPRESSED IN HUNDREDS OF VOLTS.

CAPACITANCE TOLERANCE. 0 = $\pm 20\%$; 9 = $\pm 10\%$; 5 = $\pm 5\%$

CAPACITANCE. THIS IS EXPRESSED IN PICO FARADS. THE FIRST TWO DIGITS ARE THE SIGNIFICANT FIGURES, THE THIRD IS THE NUMBER OF ZEROS. VALUES MUST CONFORM TO DECADE RATING FOR THE TOLERANCE SPECIFIED.

SPRAGUE TYPE NUMBER. THIS IDENTIFIES THE BASIC CAPACITOR AS TO CONSTRUCTION, IMPREGNANT, AND OPERATING TEMPERATURE RANGE.

TYPE 118P CASE STYLES

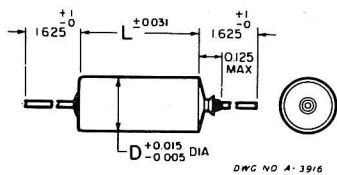
Leads are bare solid finned wire. Lead wire sizes are:

Can Dia.	Lead AWG
.175 and .195	No. 24
.235 and .312	No. 22
.400 and over	No. 20 except that Style 15 and 16 capacitors will be furnished with No. 22 leads.

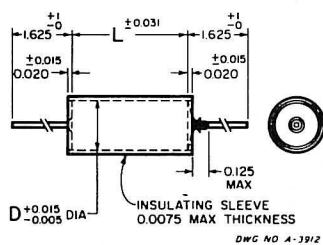
Section Grounded to Case



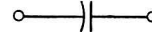
Style 1



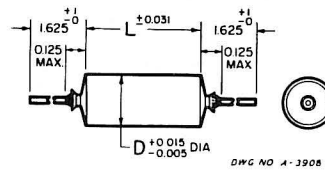
Style 3



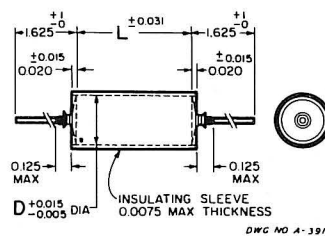
Section Insulated from Case



Style 2

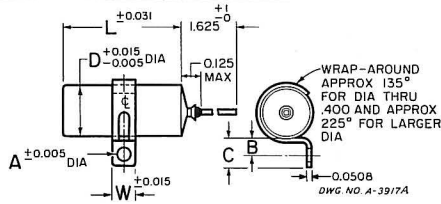


Style 4



Grounded Case - continued

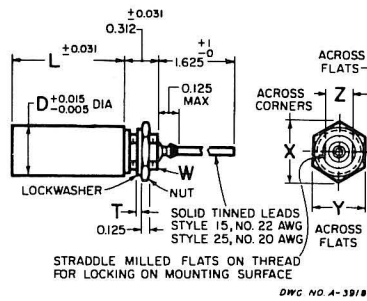
Style 12



Bracket located = 1/32" of center line

D	W	A	B	C
.175	.250	.144	.187	.312
.195	.250	.144	.187	.312
.235	.250	.144	.187	.312
.312	.250	.144	.187	.312
.400	.250	.144	.187	.312
} = .015				
.562	.500	.156	.250	.437
.670	.500	.156	.250	.437
.750	.500	.156	.250	.437
1.000	.500	.156	.250	.437
} = .062				

Styles 15 and 25



MOUNTING HARDWARE FURNISHED UNASSEMBLED

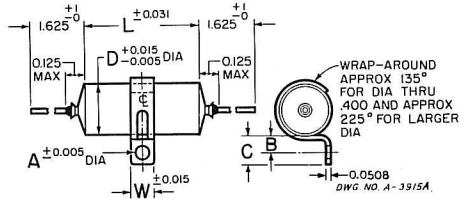
D	T	W	X	Y	Z	Lockwasher	Nut
STYLE 15							
.400	thru	.022 5/16"	24UNF-2A	.484	.437	.250	Part 2-47
1.000					.255		Part 6-113
STYLE 25							
.670	.035	1/16"	28UNEF-2A	.718	.625	.375	Part 2-6A
						.380	Part 6-208
.750	.040	1/2"	28UNEF-2A	.796	.687	.437	Part 2-54B
						.442	Part 6-120C
1.000	.040	1/2"	28UNEF-2A	.796	.687	.437	Part 2-54B
						.442	Part 6-120C

Lockwasher and nut are furnished with each unit and are sold separately as replacement parts.

On .670" diameter units and above, use Style 25 units for new equipment designs as they are superior to Style 15 units on these larger case sizes under conditions of severe vibration. In addition, they will withstand higher flashover voltage.

Insulated Case - continued

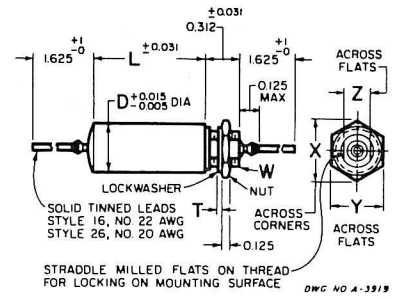
Style 13



Bracket located = 1/32" of center line

D	W	A	B	C
.175	.250	.144	.187	.312
.195	.250	.144	.187	.312
.235	.250	.144	.187	.312
.312	.250	.144	.187	.312
.400	.250	.144	.187	.312
} = .015				
.562	.500	.156	.250	.437
.670	.500	.156	.250	.437
.750	.500	.156	.250	.437
1.000	.500	.156	.250	.437
} = .062				

Styles 16 and 26

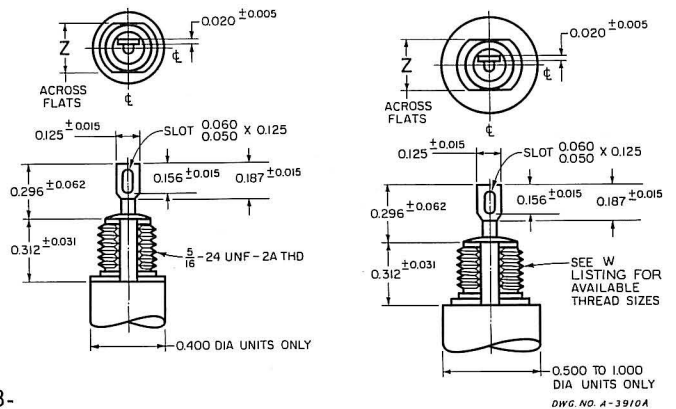
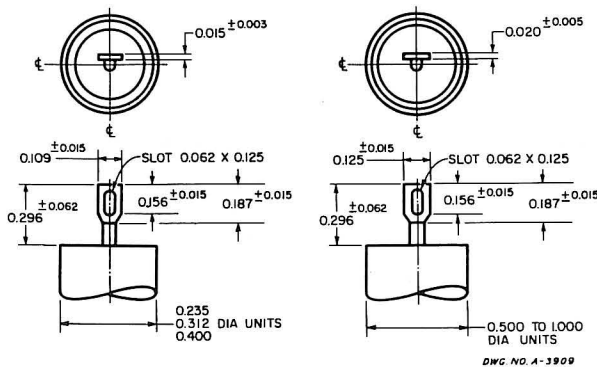


D	T	W	X	Y	Z	Lockwasher	Nut
STYLE 16							
.400	thru	.022 5/16"	24UNF-2A	.484	.437	.250	Part 2-47
1.000					.255		Part 6-113
STYLE 26							
.670	.035	1/16"	28UNEF-2A	.718	.625	.375	Part 2-6A
						.380	Part 6-208
.750	.040	1/2"	28UNEF-2A	.796	.687	.437	Part 2-54B
						.442	Part 6-120C
1.000	.040	1/2"	28UNEF-2A	.796	.687	.437	Part 2-54B
						.442	Part 6-120C

Lockwasher and nut are furnished with each unit and are sold separately as replacement parts.

On .670" diameter units and above, use Style 26 units for new equipment designs as they are superior to Style 16 units on these larger case sizes under conditions of severe vibration. In addition, they will withstand higher flashover voltage.

TYPICAL TAB TERMINAL DIMENSIONS



INCH TO MILLIMETER CONVERSION

In.	mm.	In.	mm.	In.	mm.	In.	mm.
0.003	0.08	0.125	3.17	0.400	10.16	1.062	26.97
0.005	0.13	0.144	3.66	0.437	11.10	1.312	33.32
0.0075	0.19	0.156	3.96	0.500	12.70	1.562	39.67
0.015	0.38	0.175	4.44	0.508	12.90	1.812	46.02
0.020	0.51	0.187	4.75	0.562	14.27	2.062	52.37
0.031	0.79	0.195	4.95	0.670	17.02	2.312	58.72
0.050	1.27	0.235	5.97	0.687	17.45	2.562	65.07
0.060	1.52	0.250	6.35	0.750	19.05		
0.062	1.57	0.296	7.52	0.812	20.62		
		0.312	7.92	1.000	25.40		

Table of Dimensions
TYPE 118P

For a complete catalog number, the capacitance code numbers listed in the following table must be prefixed with the designation 118P, to indicate the construction type desired, and must be followed by a style number selected from the available styles shown on pages 2 and 3. For example, 118P10302S3.

The tolerances allowed on the dimensions tabulated below are shown in the line drawings on pages 2 and 3, which illustrate the available case styles.

It should be noted that, for Styles 15 and 16, the minimum can diameter in which the units are available is 0.400 inch. Any combination of capacitance and voltage rating, for which the diameter shown in the table is smaller, will be furnished in these styles in a can 0.400 inch in diameter. Styles 15 and 16 capacitors are not available in ratings higher than 600 volts. Where 1000 volt screwneck units are required, please order Styles 25 and 26 capacitors. The minimum lengths of Styles 15 and 16 capacitors are 0.687" and 0.750", respectively.

Note: For units larger than 0.562 by 1.812 mounting by means of the lead wires is not recommended.

If the capacitance rating you need is not shown under the working voltage your circuit requirements would indicate, please consult the table for the next higher working voltage. Failing that, consult the table for the next voltage still higher. In order to minimize the number of units which must be stocked both by Sprague and by our customers, as well as the Armed Services, a capacitance rating is usually listed only in the highest voltage rating which will fit into a particular case size.

μF	Size		Capacitance Code		μF	Size		Capacitance Code	
	D	L*	±20% Tol.	±10% Tol.		D	L*	±20% Tol.	±10% Tol.
200 VOLTS D-C					200 VOLTS D-C (Cont.)				
.001	.175	.687	10202	10292	.01	.175	.687	10302	10392
.0012	.175	.687		12292	.012	.195	.687		12392
.0015	.175	.687	15202	15292	.015	.195	.687	15302	15392
.0018	.175	.687		18292	.018	.235	.687		18392
.0022	.175	.687	22202	22292	.022	.235	.687	22302	22392
.0027	.175	.687		27292	.027	.235	.687		27392
.0033	.175	.687	33202	33292	.033	.235	.687	33302	33392
.0039	.175	.687		39292	.039	.312	.812		39392
.0047	.175	.687	47202	47292	.047	.312	.812	47302	47392
.0056	.175	.687		56292	.056	.312	.812		56392
.0068	.175	.687	68202	68292	.068	.312	.812	68302	68392
.0082	.175	.687		82292	.082	.312	.812		82392
					.1	.312	.812	10402	10492
					.12	.312	1.062		12492

*Add 0.062" to Listed "L" Dimension for Length of Styles with Both Terminals Insulated from Case. (Styles 2, 4, 13, 16 and 26.)

Type 118 - continued

μF	Size		Capacitance Code		μF	Size		Capacitance Code	
	D	L*	±20% Tol.	±10% Tol.		D	L*	±20% Tol.	±10% Tol.
200 VOLTS D-C (Cont.)					400 VOLTS D-C (Cont.)				
.15	.312	1.062	15402	15492	1.0	.750	1.812	10504	10594
.18	.400	.812		18492	1.5	1.000	1.812	15504	15594
.22	.400	.812	22402	22492	2.0	1.000	1.812	20504	20594
.27	.400	1.062		27492	3.0	1.000	2.562	30504	30594
.33	.400	1.062	33402	33492	600 VOLTS D-C				
.39	.500	1.062		39492	.001	.235	.687	10206	10296
.47	.500	1.062	47402	47492	.0012	.235	.687		12296
.56	.500	1.062		56492	.0015	.235	.687	15206	15296
.68	.500	1.062	68402	68492	.0018	.235	.687		18296
.82	.562	1.062		82492	.0022	.235	.687	22206	22296
1.0	.562	1.062	10502	10592	.0027	.235	.687		27296
1.5	.562	1.562	15502	15592	.0033	.235	.687	33206	33296
2.0	.670	1.562	20502	20592	.0039	.312	.812		39296
3.0	.670	1.812	30502	30592	.0047	.312	.812	47206	47296
4.0	.750	1.812	40502	40592	.0056	.312	.812		56296
5.0	1.000	1.812	50502	50592	.0068	.312	.812	68206	68296
6.0	1.000	1.812	60502	60592	.0082	.312	.812		82296
8.0	1.000	1.812	80502	80592	.01	.312	.812	10306	10396
10.0	1.000	2.312	10602	10692	.012	.312	.812		12396
12.0	1.000	2.562	12602	12692	.015	.312	.812	15306	15396
400 VOLTS D-C					.018	.312	1.062		18396
.01	.312	.812	10304	10394	.022	.312	1.062	22306	22396
.012	.312	.812		12394	.027	.312	1.062		27396
.015	.312	.812	15304	15394	.033	.312	1.062	33306	33396
.018	.312	.812		18394	.039	.400	1.062		39396
.022	.312	.812	22304	22394	.047	.400	1.062	47306	47396
.027	.312	1.062		27394	.056	.400	1.062		56396
.033	.312	1.062	33304	33394	.068	.400	1.062	68306	68396
.039	.400	1.062		39394	.082	.500	1.062		82396
.047	.400	1.062	47304	47394	.1	.500	1.062	10406	10496
.056	.400	1.062		56394	.12	.562	1.062		12496
.068	.400	1.062	68304	68394	.15	.562	1.062	15406	15496
.082	.500	1.062		82394	.18	.562	1.312		18496
.1	.500	1.062	10404	10494	.22	.562	1.312	22406	22496
.12	.500	1.062		12494	.27	.562	1.562		27496
.15	.500	1.062	15404	15494	.33	.562	1.562	33406	33496
.18	.562	1.312		18494	.39	.670	1.562		39496
.22	.562	1.312	22404	22494	.47	.670	1.562	47406	47496
.27	.562	1.562		27494	.56	.670	1.812		56496
.33	.562	1.562	33404	33494	.68	.670	1.812	68406	68496
.39	.670	1.562		39494	.82	1.000	1.812		82496
.47	.670	1.562	47404	47494	1.0	1.000	1.812	10506	10596
.56	.670	1.812		56494	1.5	1.000	1.812	15506	15596
.68	.670	1.812	68404	68494	2.0	1.000	2.062	20506	20596
.82	.750	1.812		82494	2.5	1.000	2.562	25506	25596

*Add 0.062" to Listed "L" Dimensions for Length of Styles with Both Terminals Insulated from Case. (Styles 2, 4, 13, 16 and 26.)

Type 118P - continued

μF	Size		Capacitance Code		μF	Size		Capacitance Code	
	D	L*	±20% Tol.	±10% Tol.		D	L*	±20% Tol.	±10% Tol.
1000 VOLTS D-C					1000 VOLTS D-C (Cont.)				
.001	.400	.687	102010	102910	.047	.500	1.062	473010	473910
.0012	.400	.687		122910	.056	.500	1.062		563910
.0015	.400	.687	152010	152910	.068	.500	1.062	683010	683910
.0018	.400	.687		182910	.082	.562	1.062		823910
.0022	.400	.687	222010	222910	.1	.562	1.062	104010	104910
.0027	.400	.687		272910	.12	.562	1.562		124910
.0033	.400	.687	332010	332910	.15	.562	1.562	154010	154910
.0039	.400	.687		392910	.18	.670	1.562		184910
.0047	.400	.687	472010	472910	.22	.670	1.562	224010	224910
.0056	.400	.687		562910	.27	.670	1.812		274910
.0068	.400	.687	682010	682910	.33	.670	1.812	334010	334910
.0082	.400	.812		822910	.39	.750	1.812		394910
.01	.400	.812	103010	103910	.47	.750	1.812	474010	474910
.012	.400	.812		123910	.56	1.000	1.812		564910
.015	.400	.812	153010	153910	.68	1.000	1.812	684010	684910
.018	.400	1.062		183910	.82	1.000	2.062		824910
.022	.400	1.062	223010	223910	1.0	1.000	2.062	105010	105910
.027	.400	1.062		273910	1.5	1.000	2.562	155010	155910
.033	.400	1.062	333010	333910					
.039	.500	1.062		393910					

*Add 0.062" to Listed "L" Dimension for Length of Styles with Both Terminals Insulated from Case. (Styles 2, 4, 13, 16 and 26.)



5% TOLERANCE UNITS AVAILABLE

For special circuit applications requiring very close tolerances on the nominal capacitance ratings, ±5% units may be obtained. These can be made in any of the microfarad ratings in which 10% units are available, as well as in intermediate ratings falling between the regular ±10% decade values.

The entire list of standard ±5% decade values can be constructed by using the following table. Each pair of two digits in this table represents the significant figures of the capacitance rating.

10	16	27	43	68
11	18	30	47	75
12	20	33	51	82
13	22	36	56	91
15	24	39	62	10

Five per cent units are available in the same range of capacitance and voltage ratings which are available for ±10% and ±20% units.

The first ±5% value after a ±20% decade value is, with few exceptions, available in the same size as the ±20% unit. For the ±10% decade value after a ±20% value, the case size will usually be that of the next higher ±20% value. For a ±5% decade value preceding a ±20% value, the case size will be that of the ±20% value it precedes. Thus, a .91 μF, 200 volt capacitor of a given type would be the same size as a 1.00 μF 200 volt capacitor.

PERFORMANCE CHARACTERISTICS

1. Physical Characteristics. Standard sizes are as specified in the accompanying tables.

2. D-C Voltage Rating. Type 118P Capacitors are available with standard continuous voltage ratings of 200, 400, 600, and 1000 volts d-c.

3. Operating Temperature Range. These capacitors are designed to operate over a temperature range of -55 C to $+125\text{ C}$.

4. Insulation Resistance.

4.1 At 25 C. The minimum product of insulation resistance and capacitance shall be 2,000 megohm-microfarads.

4.1.1 However, in no case need the insulation resistance exceed 12,000 megohms.

4.1.2 Where the case is not a terminal, the insulation resistance between the case and either terminal shall be at least 10,000 megohms.

4.2 At 125 C. The minimum product of insulation resistance and capacitance shall be 10 megohm-microfarads for 200 VDC capacitors or 40 megohm-microfarads for 400, 600, and 1000 VDC capacitors.

4.2.1 However, in no case need the insulation resistance exceed 150 megohms for 200 VDC capacitors or 600 megohms for 400, 600, and 1000 VDC capacitors.

4.3 Measurements shall be made after a two minute charge at rated voltage or 500 volts d-c, whichever is less.

5. Capacitance and Tolerance. The capacitance of all capacitors shall be within the specified tolerance limits of the nominal rating.

5.1 Capacitors of $1\ \mu\text{F}$ or less in capacitance shall be measured at a frequency of 1000 Hz at 25 C, or else referred to measurements made at that frequency and temperature.

5.2 Capacitors greater than $1\ \mu\text{F}$ in capacitance shall be measured at a frequency of 60 Hz at 25 C, or else referred to measurements made at that frequency and temperature.

6. Power Factor. The maximum power factor of all capacitors shall be 1% at 25 C.

6.1 Capacitors of $1\ \mu\text{F}$ or less in capacitance shall be measured at a frequency of 1000 Hz, or else referred to measurements made at that frequency.

6.2 Capacitors greater than $1\ \mu\text{F}$ in capacitance shall be measured at a frequency of 60 Hz, or else referred to measurements made at that frequency.

7. Voltage Test.

7.1 Capacitors shall withstand a d-c potential of twice the rated voltage applied between the terminals, or between terminals and case if the case is not a terminal, for two minutes maximum without permanent breakdown.

7.2 The test voltage must be applied and discharged through a resistor of one ohm per volt.

8. Life Test. Capacitors shall withstand a test potential of 140% of rated voltage between terminals, or between terminals and case, if the case is a terminal, for a period of 250 hours at 125 C.

8.1 The life test voltage must be applied and discharged through a resistor of one ohm per volt.

8.2 Not more than one failure shall be permitted in 25 units tested. Failure shall be considered to be any one of the following:

8.2.1 Terminal to Terminal.

(a) A permanent short or open circuit.

(b) A drop in capacitance to less than 90% of capacitance before life test.

(c) A change in insulation resistance times capacitance product to less than 1200 megohm-microfarads at 25 C.

(d) A drop in insulation resistance to less than 7200 megohms when the requirements of section 4.1.1 originally applied.

8.2.2 Terminal to Case

(a) When the case is not a terminal, a drop in insulation resistance between case and either terminal to less than 5000 megohms at 25 C.

9. A-C Operation. Capacitors shall withstand an a-c potential of 120% of rated a-c voltage for a period of 250 hours. Rated a-c voltages are shown in the graphs on pages 7 through 11.

9.1 Superimposed A-C. In no case should the sum of the d-c and peak a-c voltages applied to a capacitor exceed the rated d-c voltage.

10. Pulse Applications. For pulse applications or special charge-discharge duty cycles, please consult the Sprague Field Engineering Department.

11. Temperature and Immersion Cycling. These capacitors shall meet the temperature and cycling tests of Military Specification MIL-C-39022.

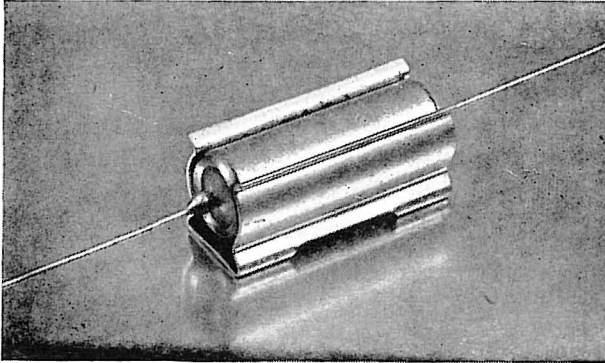
12. Moisture Resistance. These capacitors shall meet the moisture resistance tests of Military Specification MIL-C-39022.

13. Vibration. Styles 1, 2, 3, 4, 12, 13, 15, 16, 25, and 26, capacitors shall withstand the 2000 Hz vibration test at 15g in accordance with MIL-STD-202, method 204, test condition B provided supplementary mounting is used for Styles 1, 2, 3, and 4.

14. Pull Test. These capacitors shall withstand a steady pull of 5 pounds applied axially to the leads for one minute.

15. Lead Bending Test. Wire leads shall withstand without breakage bending about the point of egress from the capacitor first 90° in one direction, then back to the original position and then 90° in the opposite direction.

Application Notes

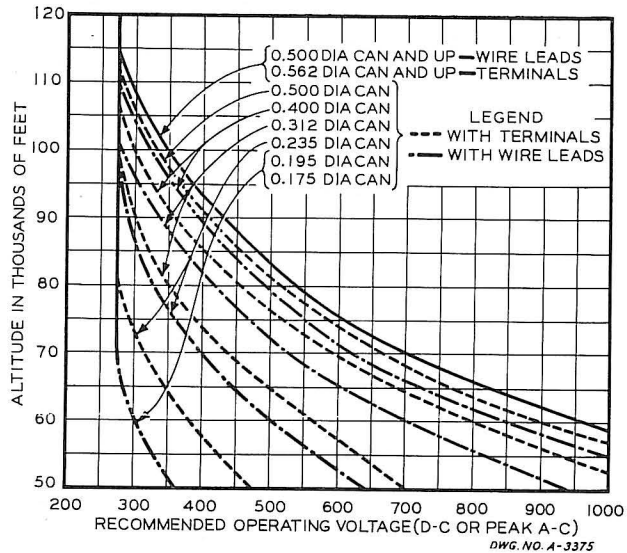


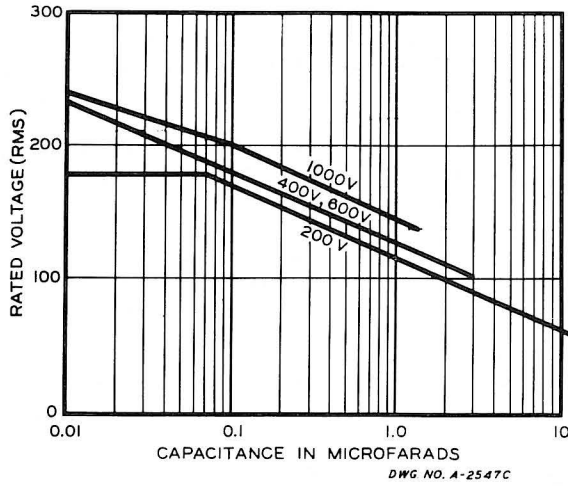
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Mounting. Tubular capacitors should be mounted such that the leads are not required to withstand forces arising from the mass of the capacitor body where shock or high frequency vibration is likely to be encountered. The necessity for exercising great care in the use of a strap or clamp is emphasized. A clamp which pinches the body too tightly may injure it, either because of the stress produced in tightening or because of the aggravation of these stresses by vibration.

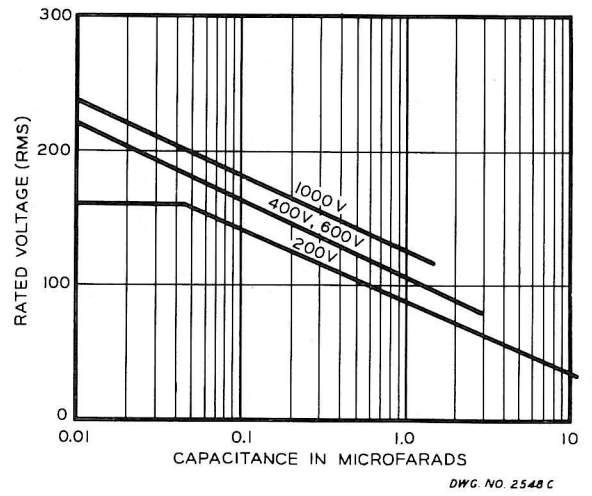
There are available, however, clamps designed to support capacitors subject to shock and vibration. Typical of these is the spring clip shown in the above photograph.

Altitude Limitations. Flashover across the compression glass-to-metal seals voltage limitations should be taken into consideration when designing circuits for use in guided missiles and similar high altitude applications. The curves at the right give the recommended operating voltages which should be taken into consideration when using Type 118P Difilm Metallized Capacitors in electronic equipment. From the practical standpoint these curves indicate that it may sometimes be necessary to specify a higher working voltage capacitor in a larger diameter case in order to insure satisfactory operation of the finished equipment.

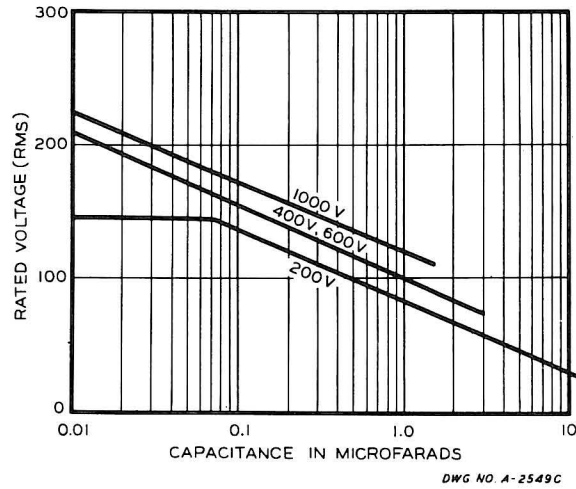




A-C VOLTAGE RATINGS AT 400 HERTZ AND 85 C AMBIENT

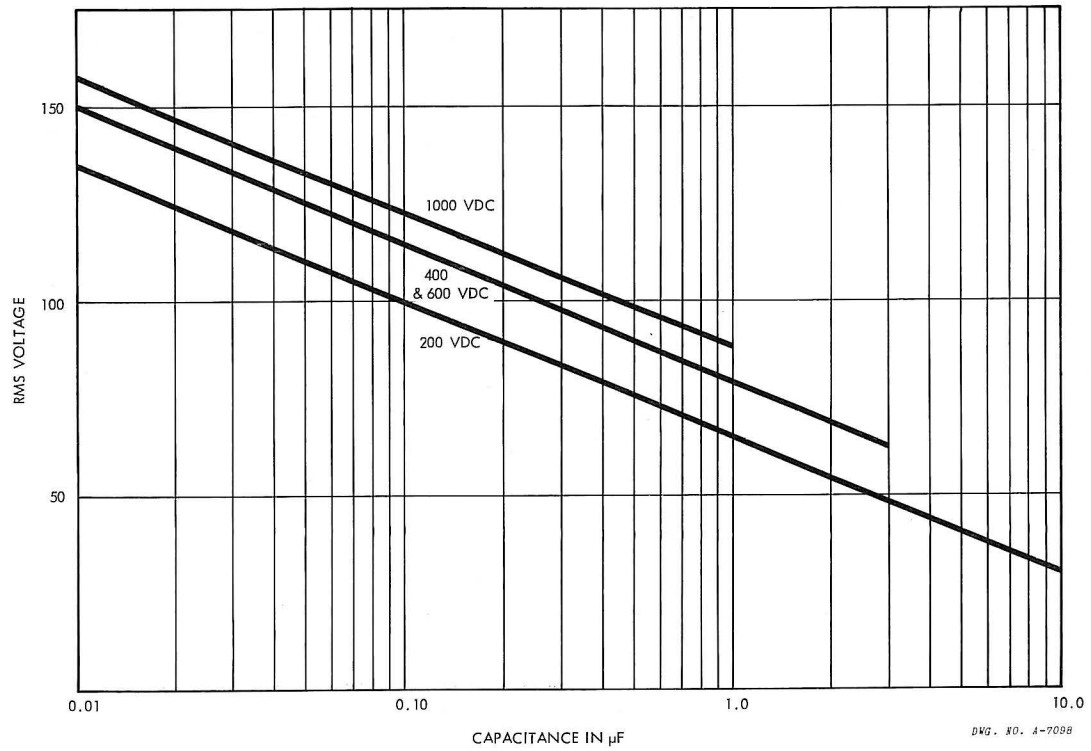


A-C VOLTAGE RATINGS AT 400 HERTZ AND 105 C AMBIENT

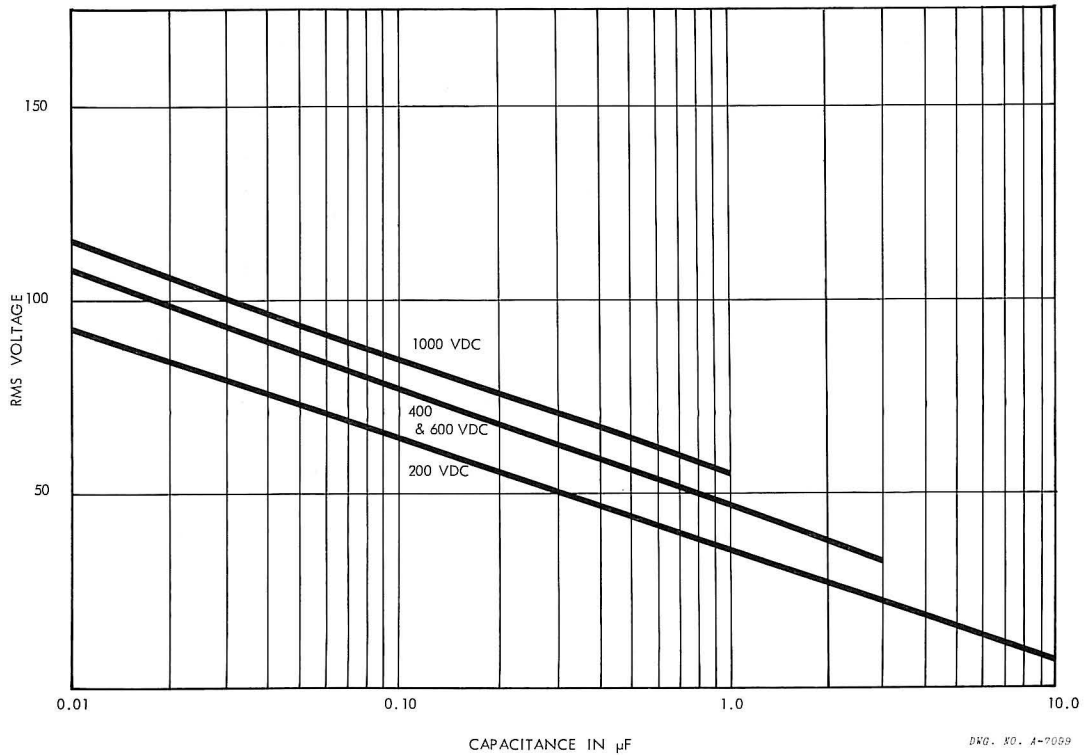


A-C VOLTAGE RATINGS AT 400 HERTZ AND 125 C AMBIENT

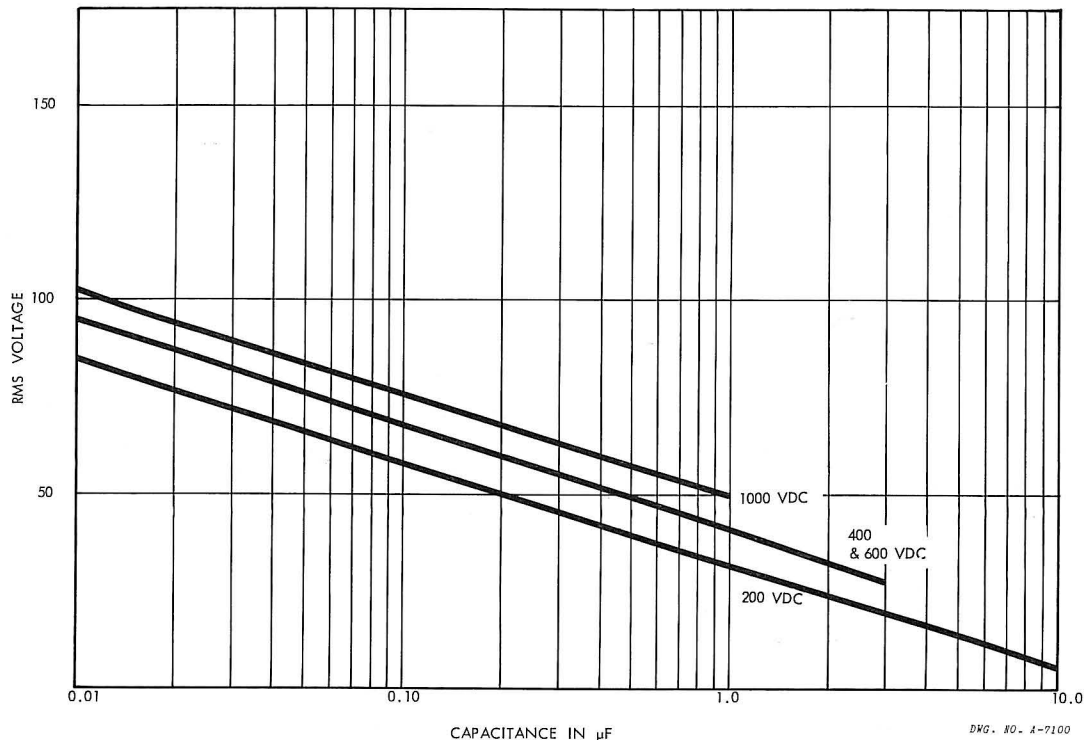
A-C Operation Type 118P capacitors are also useful for a-c applications at frequencies above 400Hz. The following curves illustrate rms voltage ratings at 85 C. For 105 C operation, derate to 80%; for 125 C operation, derate to 40%.



A-C RATINGS AT 1000 Hz



A-C RATINGS AT 2000 Hz



A-C RATINGS AT 2500 Hz

