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a GK Technologies subsidiary

Engineering Bulletin

2110D

SECOND PRINTING

Type 186P and 196P

Subminiature VITAMIN Q[®] Metal-Clad Paper Capacitors for 125C Operation

SUBMINIATURE metal-clad Type 186P and 196P paper capacitors have been the "work horses" of paper capacitors in industrial and military applications since Sprague first introduced them to the industry in 1949.

The impregnant used in VITAMIN Q capacitors is an inert synthetic polymer used with outstanding success in paper capacitors for many years. When used in combination with the paper dielectric, this exclusive Sprague impregnant results in a capacitor with exceptional performance characteristics.

125 C Operation

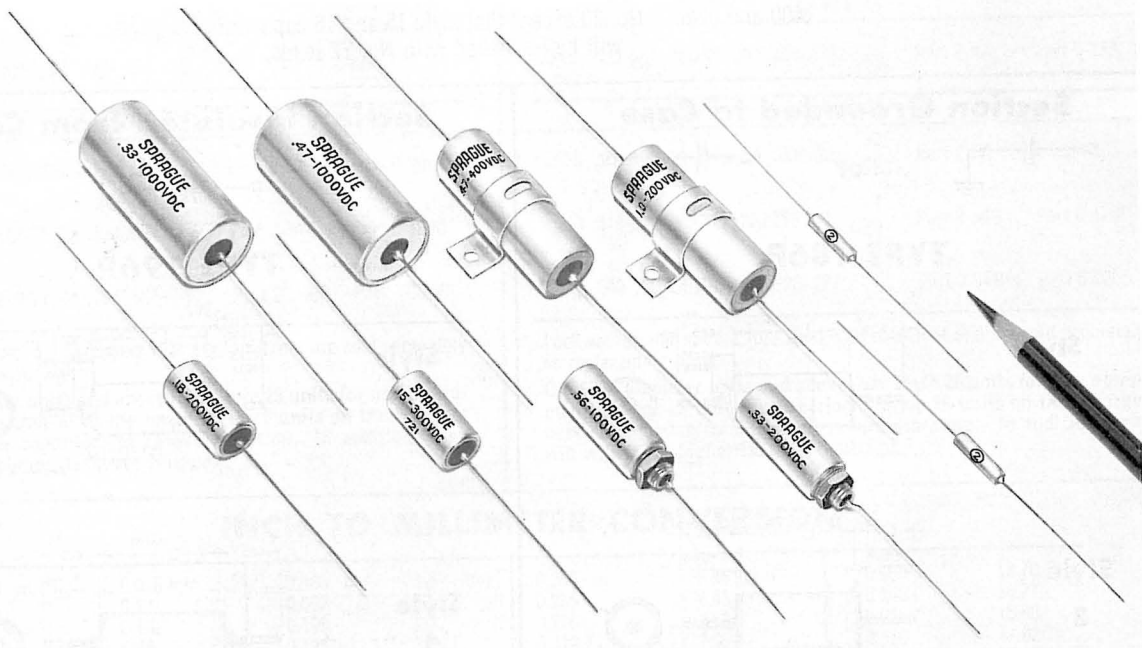
Type 186P and 196P VITAMIN Q capacitors are highly recommended for use in applications requiring

reliable operation within the operating temperature range of -55 C to $+125\text{ C}$ at rated working voltages of 100 to 1000 volts d-c.

Throughout the operating temperature range, these capacitors display excellent insulation resistance and capacitance-change-with-temperature characteristics as shown in the typical curves on page 11.

True Hermetic Seal

Electrically and mechanically, these capacitors are designed to meet stringent operating requirements. Positive hermetic closure of the metal cases is assured by glass-to-metal solder-seal terminals.

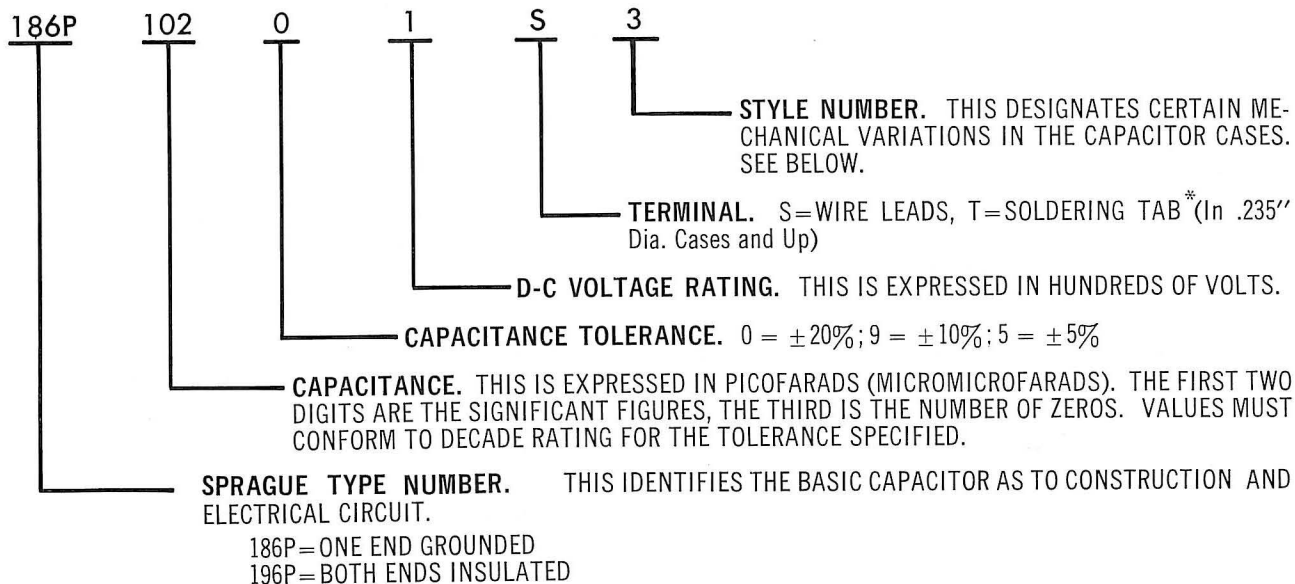


SPRAGUE ELECTRIC COMPANY

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ENGINEERING
BULLETIN
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Catalog Numbering System

ALWAYS SPECIFY BY COMPLETE CATALOG NUMBER, SUCH AS:

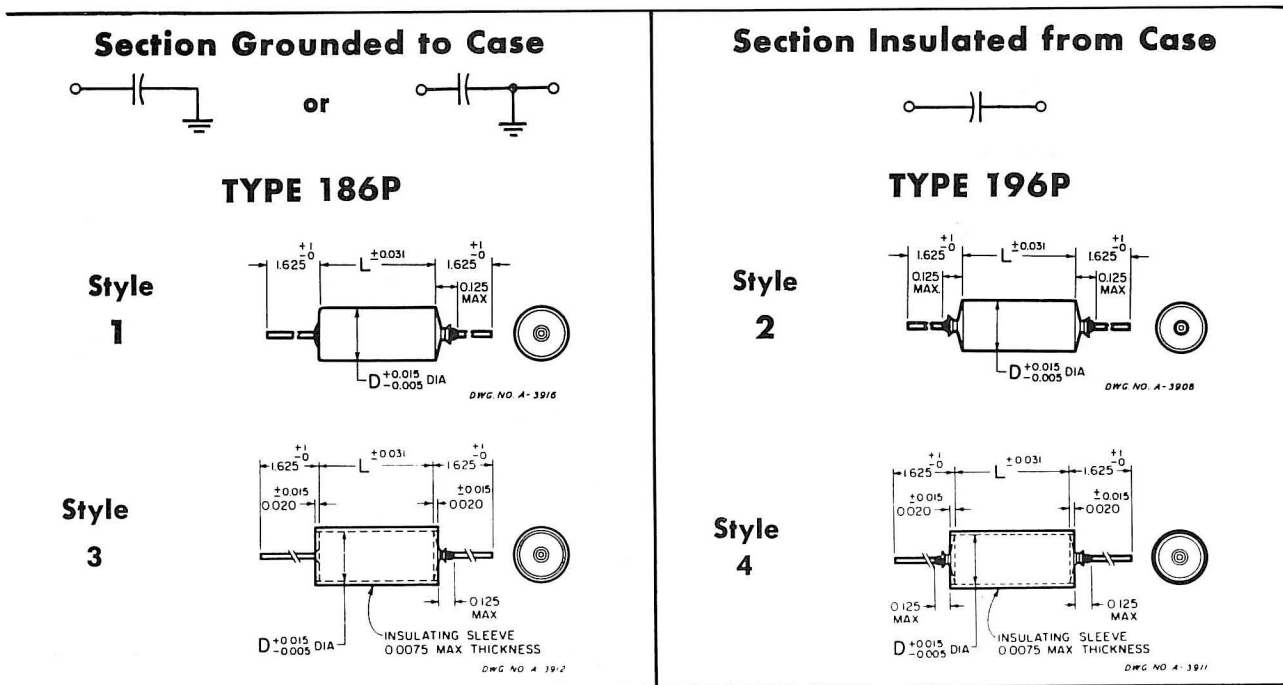


*Capacitors with one end grounded (Styles T1 and T3) are supplied with one terminal on the insulated cover end and a ground lead supplied on the opposite end.

CASE STYLES

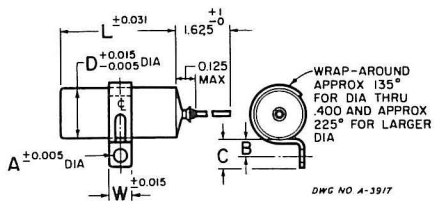
Leads are bare solid tinned wire. Lead wire sizes are:

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



Grounded Case - continued

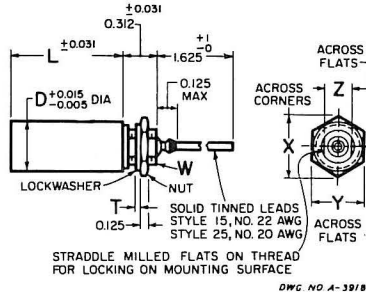
Style 12



Bracket located $\pm \frac{1}{32}$ " 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
} $\pm .015$				
.562	.500	.156	.250	.437
.670	.500	.156	.250	.437
.750	.500	.156	.250	.437
1.000	.500	.156	.250	.437
} $\pm .031$				

Styles 15 and 25



Hardware supplied unassembled

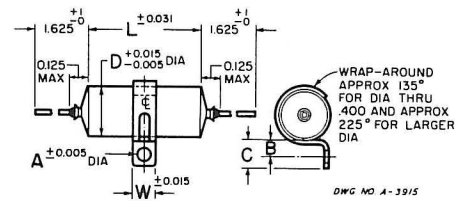
D	T	W	X	Y	Z	Lockwasher	Nut
STYLE 15							
.400	thru	.022	$\frac{3}{16}$ "	-24UNF-2A	.484	.437	.250
1.000							.255
						Part 2-47	Part 6-113
STYLE 25							
.670	.035	$\frac{7}{16}$ "	-28UNEF-2A	.718	.625	.375	.380
						Part 2-6A	Part 6-208
.750	.040	$\frac{1}{2}$ "	-28UNEF-2A	.796	.687	.437	.442
						Part 2-54B	Part 6-120C
1.000	.040	$\frac{1}{2}$ "	-28UNEF-2A	.796	.687	.437	.442
						Part 2-54B	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

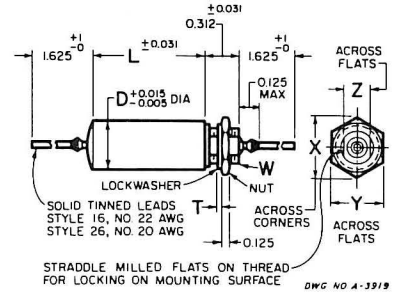
Style 13



Bracket located $\pm \frac{1}{32}$ " 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
} $\pm .015$				
.562	.500	.156	.250	.437
.670	.500	.156	.250	.437
.750	.500	.156	.250	.437
1.000	.500	.156	.250	.437
} $\pm .031$				

Styles 16 and 26



Hardware supplied unassembled

D	T	W	X	Y	Z	Lockwasher	Nut
STYLE 16							
.400	thru	.022	$\frac{3}{16}$ "	-24UNF-2A	.484	.437	.250
1.000							.255
						Part 2-47	Part 6-113
STYLE 26							
.670	.035	$\frac{7}{16}$ "	-28UNEF-2A	.718	.625	.375	.380
						Part 2-6A	Part 6-208
.750	.040	$\frac{1}{2}$ "	-28UNEF-2A	.796	.687	.437	.442
						Part 2-54B	Part 6-120C
1.000	.040	$\frac{1}{2}$ "	-28UNEF-2A	.796	.687	.437	.442
						Part 2-54B	Part 6-120C

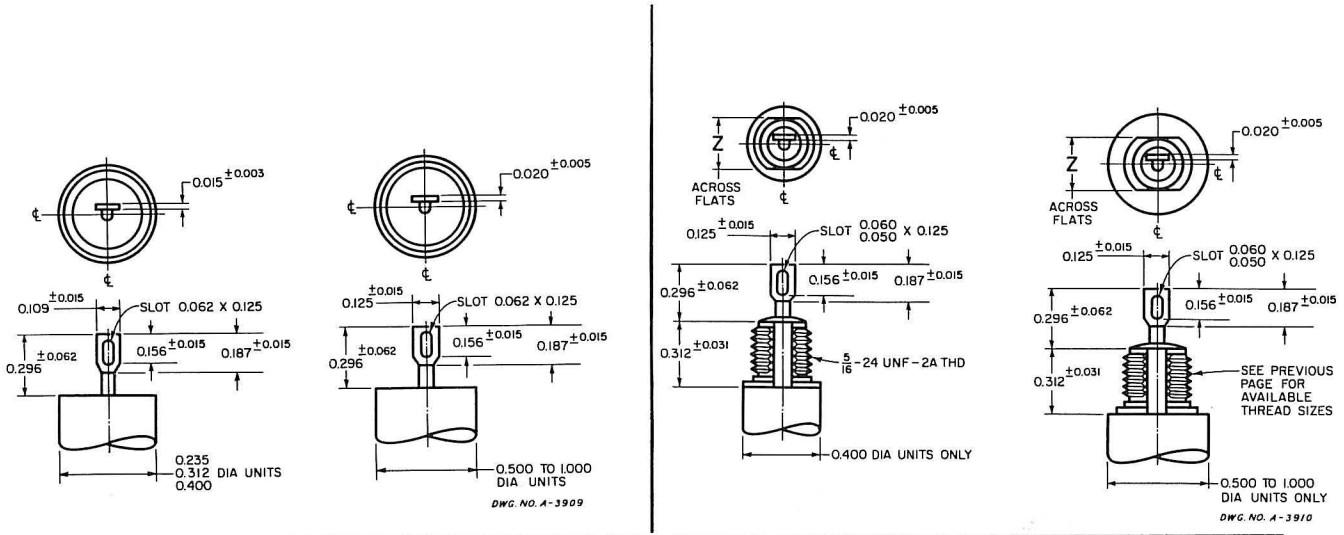
Lockwasher and nut are furnished with each unit and are sold separately as replacement parts.

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.

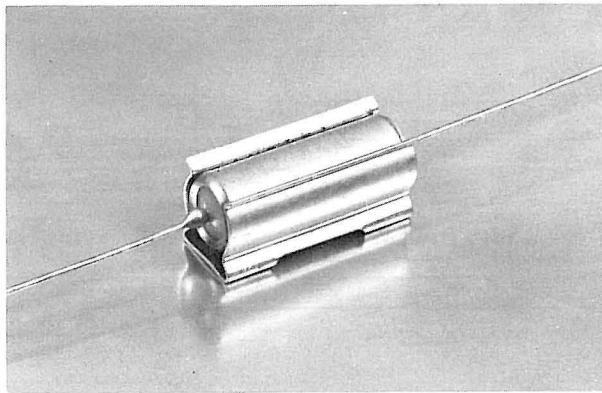
INCH TO MILLIMETER CONVERSION

0.003 in.	0.076 mm	0.060 in.	1.52 mm	0.250 in.	6.35 mm	0.500 in.	12.70 mm
0.005	0.13	0.062	1.57	0.255	6.48	0.562	14.27
0.0075	0.19	0.109	2.77	0.296	7.52	0.625	15.88
0.015	0.38	0.125	3.18	0.312	7.92	0.670	17.02
0.020	0.51	0.144	3.66	0.375	9.53	0.687	17.45
0.022	0.56	0.156	3.96	0.380	9.65	0.718	18.24
0.031	0.79	0.175	4.45	0.400	10.16	0.750	19.05
0.035	0.89	0.187	4.75	0.437	11.10	0.796	20.22
0.040	1.02	0.195	4.95	0.442	11.23	1.000	25.40
0.050	1.27	0.235	5.97	0.484	12.29	1.625	41.28

TYPICAL TAB TERMINAL DIMENSIONS



Application Notes

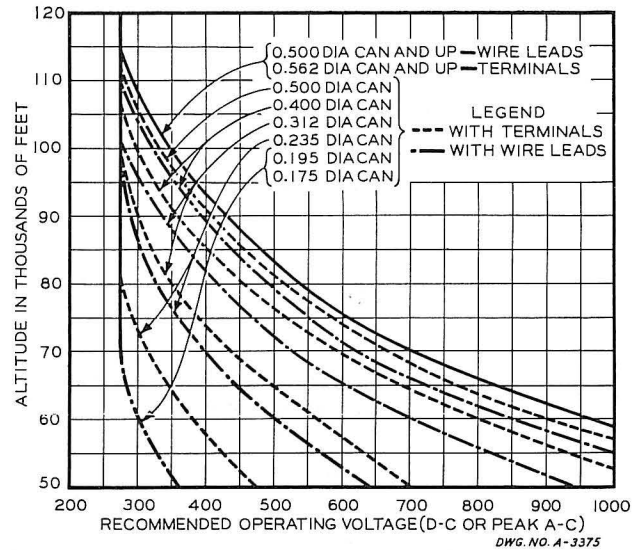


Mounting. Tubular capacitors should be mounted such that the leads are not required to withstand forces arising from the mass of the capacitor body where shock or high frequency vibration is likely to be encountered. The necessity for exercising great care in the use of a strap or clamp is emphasized. 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 voltage limitations across the compression glass-to-metal seals should be

taken into consideration when designing circuits for use in guided missiles and similar high altitude applications. The curves below give the recommended operating voltages which should be taken into consid-



eration when using Subminiature Paper 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.

TYPE 186P and 196P*

— Extended Foil Construction

Table of Dimensions

For a complete catalog number, the capacitance code numbers listed in the following table must be prefixed with the designation 186P or 196P 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, 186P10201S3.

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 .400 inch. Any combination of capacitance and voltage rating for which the diameter shown in the table is smaller, will be furnished in Styles 15 and 16 in a can .400 inch in diameter. Style 15 and 16 capacitors are not available in ratings higher than 600 volts. Where 1000 volt screwneck units are required, please order Style 25 or 26 capacitors. The minimum lengths of Style 15 and 16 capacitors is 0.687 and 0.750 inch, respectively.

NOTE: For units larger than .562 by 1.812" mounting by means of the lead wires is not recommended.

100 VOLTS D-C					200 VOLTS D-C					300 VOLTS D-C				
μF	Size		Capacitance Code		μF	Size		Capacitance Code		μF	Size		Capacitance Code	
	D	L*	±20% Tol.	±10% Tol.		D	L*	±20% Tol.	±10% Tol.		D	L*	±20% Tol.	±10% Tol.
.001	.175	0.687	10201	10291	.001	.235	0.687	10202	10292	.001	.235	0.687	10203	10293
.0012	.175	0.687		12291	.0012	.235	0.687		12292	.0012	.235	0.687		12293
.0015	.175	0.687	15201	15291	.0015	.235	0.687	15202	15292	.0015	.235	0.687	15203	15293
.0018	.175	0.687		18291	.0018	.235	0.687		18292	.0018	.235	0.687		18293
.0022	.175	0.687	22201	22291	.0022	.235	0.687	22202	22292	.0022	.235	0.687	22203	22293
.0027	.175	0.687		27291	.0027	.235	0.687		27292	.0027	.235	0.687		27293
.0033	.175	0.687	33201	33291	.0033	.235	0.687	33202	33292	.0033	.235	0.687	33203	33293
.0039	.175	0.687		39291	.0039	.235	0.687		39292	.0039	.235	0.687		39293
.0047	.175	0.687	47201	47291	.0047	.235	0.687	47202	47292	.0047	.235	0.687	47203	47293
.0056	.195	0.687		56291	.0056	.235	0.687		56292	.0056	.312	0.812		56293
.0068	.195	0.687	68201	68291	.0068	.235	0.687	68202	68292	.0068	.312	0.812	68203	68293
.0082	.235	0.687		82291	.0082	.312	0.812		82292	.0082	.312	0.812		82293
.01	.235	0.687	10301	10391	.01	.312	0.812	10302	10392	.01	.312	0.812	10303	10393
.012	.235	0.687		12391	.012	.312	0.812		12392	.012	.312	0.812		12393
.015	.235	0.687	15301	15391	.015	.312	0.812	15302	15392	.015	.312	0.812	15303	15393
.018	.312	0.812		18391	.018	.312	0.812		18392	.018	.312	0.812		18393
.022	.312	0.812	22301	22391	.022	.312	0.812	22302	22392	.022	.312	0.812	22303	22393
.027	.312	0.812		27391	.027	.312	0.812		27392	.027	.400	0.812		27393
.033	.312	0.812	33301	33391	.033	.312	0.812	33302	33392	.033	.400	0.812	33303	33393
.039	.312	0.812		39391	.039	.400	0.812		39392	.039	.400	0.812		39393
.047	.312	0.812	47301	47391	.047	.400	0.812	47302	47392	.047	.400	0.812	47303	47393
.056	.400	0.812		56391	.056	.400	0.812		56392	.056	.400	1.062		56393
.068	.400	0.812	68301	68391	.068	.400	0.812	68302	68392	.068	.400	1.062	68303	68393
.082	.400	0.812		82391	.082	.400	1.062		82392	.082	.400	1.312		82393
.1	.400	0.812	10401	10491	.1	.400	1.062	10402	10492	.1	.400	1.312	10403	10493
.12	.400	1.062		12491	.12	.400	1.312		12492	.12	.562	1.062		12493
.15	.400	1.062	15401	15491	.15	.400	1.312	15402	15492	.15	.562	1.062	15403	15493
.18	.400	1.312		18491	.18	.562	1.062		18492	.18	.562	1.312		18493
.22	.400	1.312	22401	22491	.22	.562	1.062	22402	22492	.22	.562	1.312	22403	22493
.27	.562	1.062		27491	.27	.562	1.312		27492	.27	.562	1.562		27493
.33	.562	1.062	33401	33491	.33	.562	1.312	33402	33492	.33	.562	1.562	33403	33493
.39	.562	1.312		39491	.39	.562	1.562		39492	.39	.670	1.562		39493
.47	.562	1.312	47401	47491	.47	.562	1.562	47402	47492	.47	.670	1.562	47403	47493
.56	.562	1.562		56491	.56	.670	1.562		56492	.56	.750	2.062		56493
.68	.562	1.562	68401	68491	.68	.670	1.562	68402	68492	.68	.750	2.062	68403	68493
.82	.670	1.562		82491	.82	.750	2.062		82492	.82	.750	2.062		82493
1.00	.670	1.562	10501	10591	1.0	.750	2.062	10502	10592	1.0	.750	2.062	10503	10593

*The dimensions tabulated above are for Type 186P units. The corresponding Type 196P unit for each capacitance and voltage rating is 0.062" longer than shown.

TYPE 186P and 196P* – continued

400 VOLTS D-C					600 VOLTS D-C					1000 VOLTS D-C				
μF	Size		Capacitance Code		μF	Size		Capacitance Code		μF	Size		Capacitance Code	
	D	L*	±20% Tol.	±10% Tol.		D	L*	±20% Tol.	±10% Tol.		D	L*	±20% Tol.	±10% Tol.
.001	.235	0.687	10204	10294	.001	.235	0.687	10206	10296	.001	.400	0.812	102010	102910
.0012	.235	0.687		12294	.0012	.235	0.687		12296	.0012	.400	0.812		122910
.0015	.235	0.687	15204	15294	.0015	.235	0.687	15206	15296	.0015	.400	0.812	152010	152910
.0018	.235	0.687		18294	.0018	.235	0.687		18296	.0018	.400	0.812		182910
.0022	.235	0.687	22204	22294	.0022	.235	0.687	22206	22296	.0022	.400	0.812	222010	222910
.0027	.235	0.687		27294	.0027	.312	0.812		27296	.0027	.400	0.812		272910
.0033	.235	0.687	33204	33294	.0033	.312	0.812	33206	33296	.0033	.400	0.812	332010	332910
.0039	.312	0.812		39294	.0039	.312	0.812		39296	.0039	.400	0.812		392910
.0047	.312	0.812	47204	47294	.0047	.312	0.812	47206	47296	.0047	.400	0.812	472010	472910
.0056	.312	0.812		56294	.0056	.312	0.812		56296	.0056	.400	0.812		562910
.0068	.312	0.812	68204	68294	.0068	.312	0.812	68206	68296	.0068	.400	0.812	682010	682910
.0082	.312	0.812		82294	.0082	.312	0.812		82296	.0082	.400	0.812		822910
.01	.312	0.812	10304	10394	.01	.312	0.812	10306	10396	.01	.400	0.812	103010	103910
.012	.312	0.812		12394	.012	.400	0.812		12396	.012	.400	1.062		123910
.015	.312	0.812	15304	15394	.015	.400	0.812	15306	15396	.015	.400	1.062	153010	153910
.018	.400	0.812		18394	.018	.400	0.812		18396	.018	.400	1.312		183910
.022	.400	0.812	22304	22394	.022	.400	0.812	22306	22396	.022	.400	1.312	223010	223910
.027	.400	0.812		27394	.027	.400	1.062		27396	.027	.562	1.062		273910
.033	.400	0.812	33304	33394	.033	.400	1.062	33306	33396	.033	.562	1.062	333010	333910
.039	.400	1.062		39394	.039	.400	1.312		39396	.039	.562	1.312		393910
.047	.400	1.062	47304	47394	.047	.400	1.312	47306	47396	.047	.562	1.312	473010	473910
.056	.400	1.312		56394	.056	.562	1.062		56396	.056	.562	1.562		563910
.068	.400	1.312	68304	68394	.068	.562	1.062	68306	68396	.068	.562	1.562	683010	683910
.082	.562	1.062		82394	.082	.562	1.312		82396	.082	.670	1.562		823910
.1	.562	1.062	10404	10494	.1	.562	1.312	10406	10496	.1	.670	1.562	104010	104910
.12	.562	1.312		12494	.12	.562	1.562		12496	.12	.670	1.812		124910
.15	.562	1.312	15404	15494	.15	.562	1.562	15406	15496	.15	.670	1.812	154010	154910
.18	.562	1.562		18494	.18	.670	1.562		18496	.18	.750	2.062		184910
.22	.562	1.562	22404	22494	.22	.670	1.562	22406	22496	.22	.750	2.062	224010	224910
.27	.670	1.562		27494	.27	.750	2.062		27496	.27	1.000	2.062		274910
.33	.670	1.562	33404	33494	.33	.750	2.062	33406	33496	.33	1.000	2.062	334010	334910
.39	.750	2.062		39494	.39	.750	2.312		39496	.39	1.000	2.312		394910
.47	.750	2.062	47404	47494	.47	.750	2.312	47406	47496	.47	1.000	2.312	474010	474910

*The dimensions tabulated above are for Type 186P units. The corresponding Type 196P unit for each capacitance and voltage rating is 0.062" longer than shown.

5% TOLERANCE UNITS AVAILABLE

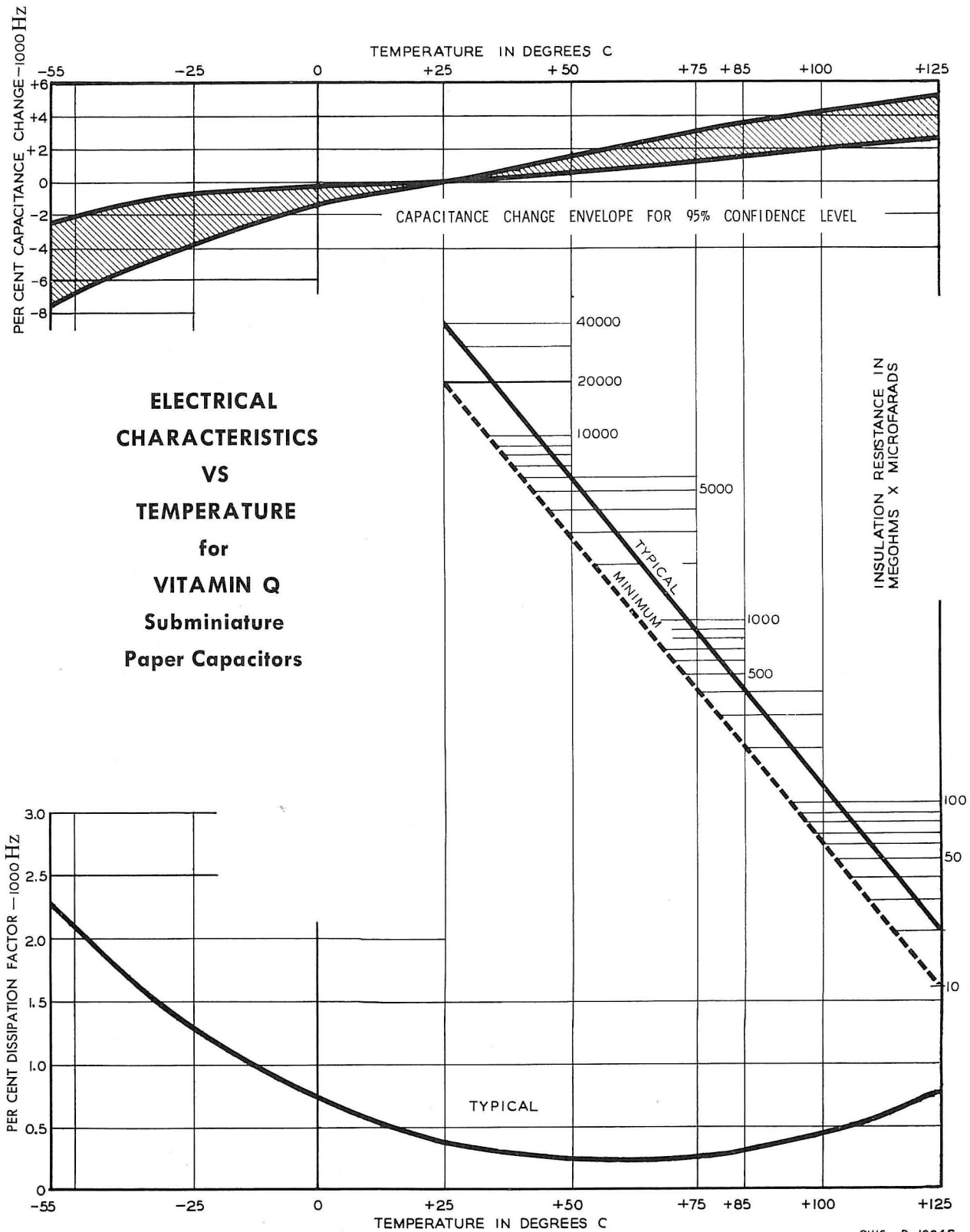
For special circuit applications requiring very close tolerances on the nominal capacitance ratings, ±5% units may be obtained. These can be made in any of the microfarad ratings in which 10% units are available, as well as in intermediate ratings falling between the regular ±10% decade values.

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 usually will 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. D-C Voltage Rating. Vitamin Q capacitors are available with ratings up to and including 1000 volts.

2. Operating Temperature Range. Type 186P and 196P Vitamin Q capacitors are designed to operate over a temperature range of -55 C to $+125\text{ C}$.

3. Insulation Resistance.

3.1 At 25 C. The minimum product of insulation resistance, expressed in megohms, and capacitance, expressed in microfarads, shall be 20,000 megohm-microfarads.

3.1.1 However, in no case need the insulation resistance exceed 30,000 megohms.

3.1.2 Where the case is not a terminal, the insulation resistance at 25 C between the case and either terminal shall be at least 3,000 megohms.

3.2 At 85 C. The minimum product of insulation resistance, expressed in megohms, and capacitance, expressed in microfarads, shall be 200 megohm-microfarads.

3.2.1 However, in no case need the insulation resistance exceed 1,000 megohms.

3.3 At 125 C. The minimum product of insulation resistance, expressed in megohms, and capacitance, expressed in microfarads, shall be 10 megohm-microfarads.

3.3.1 However, in no case need the insulation resistance exceed 150 megohms.

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

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

4.1 Capacitors shall be measured at a frequency of 1kHz at 25 C, or else referred to measurements made at that frequency.

5. Dissipation Factor.

5.1 The maximum dissipation factor of all capacitors shall be 1%.

5.2 Power factor shall be measured at a frequency of 1kHz at 25 C, or else referred to measurements made at that frequency.

6. Voltage Test.

6.1 Capacitors shall withstand a d-c potential of twice the rated voltage applied between the terminals for two minutes.

6.2 When the case is not a terminal, the capacitors shall withstand for one minute a d-c potential of twice the rated voltage applied between the case and the terminals connected together.

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

7. Life Test.

7.1 Capacitors shall withstand a test potential of 1.4 times the rated voltage between terminals, or between terminal and case, if the case is a terminal, for a period of 250 hours at 125 C for capacitors of .08 watt-seconds or less.

7.1.1 Capacitors larger than .08 watt-seconds shall withstand a test potential of 1.2 times the rated voltage for 250 hours. Units rated at 1000 volts shall be tested for a period of 500 hours at 1.2 times the rated voltage.

7.1.2 Not more than 1 failure shall be permitted in 25 units tested.

7.2 Failure shall be considered to be any one of the following:

- (a) A change in capacitance from initial value in excess of 5%
- (b) A value of insulation resistance less than 50% of the values specified in sections 3.1 and 3.1.1
- (c) Dissipation factor in excess of 1%

8. Lead Pull Test. Capacitors with wire leads shall withstand a steady pull of 5 pounds (2.27 kg) applied axially to the leads for one minute.

9. Lead Bending Test. 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.

10. Temperature and Immersion Cycling. These capacitors will meet the temperature and immersion cycling tests of military specification MIL-C-25D.

11. Moisture Resistance. These capacitors will meet the moisture resistance test of military specification MIL-C-25.

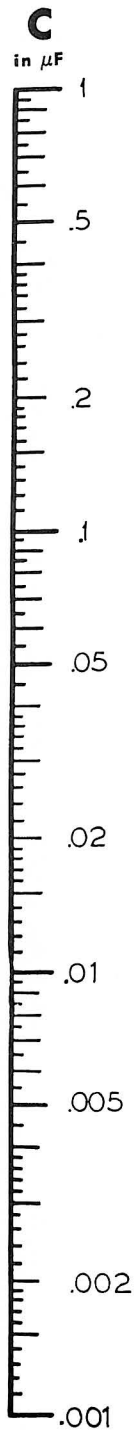
12. Vibration.

12.1 Capacitors shall withstand the 55 Hz vibration test in accordance with Military Specification MIL-C-25.

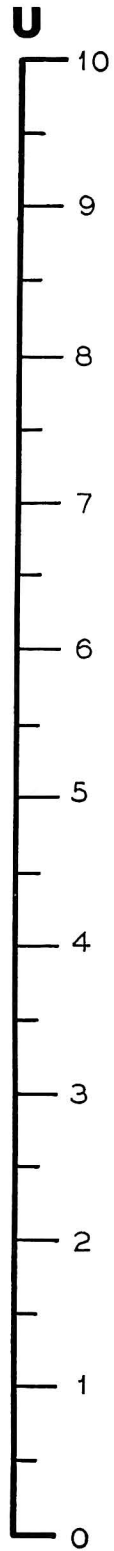
12.2 Capacitors shall withstand the 2000 Hz vibration test at 15g in accordance with MIL-STD-202D, method 204B test condition B provided supplementary mounting is used for Styles 1, 2, 3, and 4.

NOMOGRAM FOR DETERMINING A-C RATINGS OF SUBMINIATURE VITAMIN Q[®] CAPACITORS

(APPLICABLE TO TYPES 186P AND 196P)



Can Size D x L	Surface Area in Square Inches
0.175 x 0.688	.43
0.175 x 0.750	.46
0.195 x 0.688	.48
0.195 x 0.750	.52
0.235 x 0.688	.59
0.235 x 0.750	.64
0.312 x 0.813	.95
0.312 x 0.875	1.0
0.400 x 0.813	1.3
0.400 x 0.875	1.4
0.400 x 1.063	1.6
0.400 x 1.125	1.7
0.400 x 1.313	1.9
0.400 x 1.375	2.0
0.562 x 1.063	2.4
0.562 x 1.125	2.5
0.562 x 1.313	2.8
0.562 x 1.375	2.9
0.562 x 1.563	3.3
0.562 x 1.625	3.4
0.562 x 1.813	3.7
0.562 x 1.875	3.8
0.670 x 1.563	4.0
0.670 x 1.625	4.1
0.670 x 1.813	4.5
0.670 x 1.875	4.6
0.750 x 2.063	5.7
0.750 x 2.125	5.9
0.750 x 2.313	6.3
0.750 x 2.375	6.5
0.750 x 2.563	6.9
0.750 x 2.625	7.1
1.000 x 1.813	7.3
1.000 x 1.875	7.5
1.000 x 2.063	8.1
1.000 x 2.125	8.2
1.000 x 2.313	8.8
1.000 x 2.375	9.0



INSTRUCTIONS

GIVEN: Capacitance, d-c voltage rating, size, maximum operating temperature.

WANTED: A-C voltage rating

PROCEDURE:

1. From the can surface area chart, find the total can surface area.
2. Draw a straight line between the capacitance on the C scale and the can area on the A scale extending to a point on the U scale.
3. Draw a straight line vertically from ambient temperature scale to the line which corresponds to the operating frequency. From this point extend a horizontal line to the V scale obtaining a point on the V scale.
4. Draw a straight line between the point obtained on the U scale (step 2) and the point obtained on the V scale (step 3).
5. The A-C Voltage rating is found at the intersection of this line and the E scale. However, the a-c voltage rating must never exceed the limits set in Table 1.

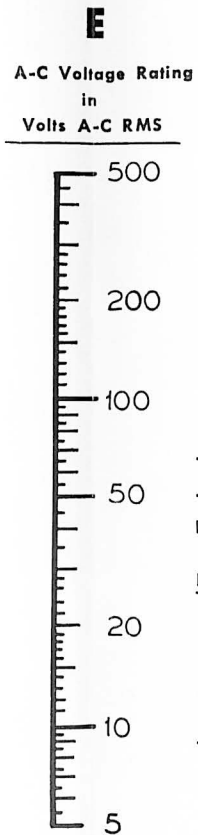


TABLE 1
THE MAXIMUM A-C VOLTAGE MUST NOT EXCEED THESE LIMITS:

D-C RATING	MAX. A-C RATING
100 VDC	70 VAC RMS
200	140
300	210
400	280
600	420
1000	500

