TYPE SCM
SOLID TANTALUM ELECTROLYTIC CAPACITORS
POLAR OPERATION

TYPE SCM SOLID TANTALUM ELECTROLYTIC CAPACITORS
BULLETIN NO. DL-C 1173 NOVEMBER, 1959
REPLACES BULLETIN NO. DL-C 1127 AUGUST, 1959

Military — Industrial — Commercial Use

Long Life • Stable Operation • Low DC Leakage

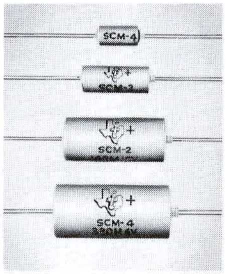
Low Dissipation Factor • Reverse Voltage Capability

6 to 35 volts • 1 to 330 µf • — 80°C to + 125°C
20% Decades • 20% Tolerance and 10% Tolerance
10% Decades • 10% Tolerance

Really Dry—No Liquids • Shock and Vibration Resistant • Long Shelf Life

Corrosion Resistant • Hermetically Sealed • Compact, Easy Mounting

For your transistorized equipments—filters; by-pass; de-coupling; coupling; RC timing, integrating, and differentiating circuits; servo systems.



ACTUAL SIZE
Sub Miniature Capacitors
MIL Standard Case Sizes

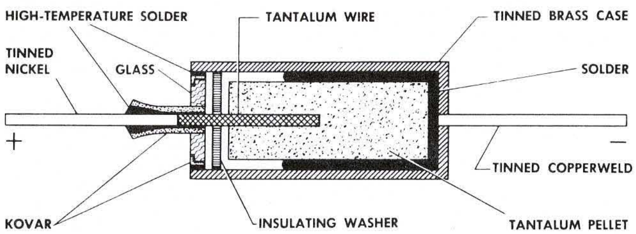


Fig. 1

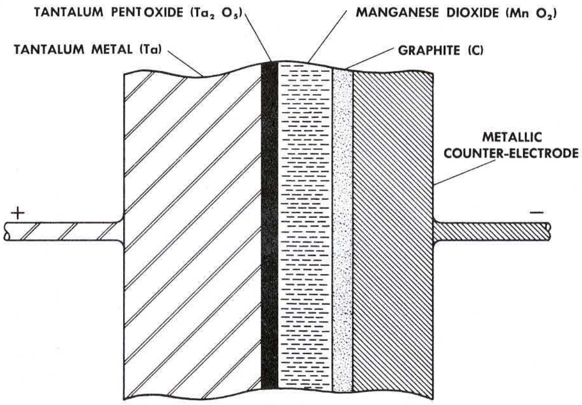


Fig. 2

The Texas Instruments *tan*-TI-*cap* capacitor, type SCM, is a solid electrolyte, porous sintered tantalum anode, electrolytic capacitor. It is an efficient, reliable, capacitor for military, industrial, and commercial applications, where long life, small size, stable electrical characteristics, and ability to withstand severe ambient conditions are of primary interest.

Figure 1 is a section of a type SCM *tan*-TI-*cap* capacitor and illustrates the sturdy precision assembly. Figure 2 is a highly magnified section from one of the thousands of individual tantalum powder grains which comprise the completed capacitor anode; the total capacitor is the sum of these "microscopic capacitors" connected in parallel within each anode by the carefully controlled sintering process. These sections illustrate the construction and design which make possible this unique, new concept for an electrolytic capacitor – one that is completely dry – no corrosive liquids to leak or dehydrate – long, trouble-free, stable operation. Electronic instead of ionic contact and conduction results in chemical, physical, and electrical stability over long periods of time and a wide temperature range previously attainable only with expensive, bulky, electrostatic capacitors.

Tantalum powder of controlled purity is carefully pressed into an anode pellet of uniform density. Pre-sintering and sintering of the anode is precisely controlled and performed in a vacuum furnace. The anode is then electrolyzed in a chemically pure bath under controlled temperature, current, and voltage conditions to form a tantalum pentoxide dielectric film of high integrity; this reduces dc leakage, increases life, and permits the highest capacity, voltage, and temperature rating of each finished capacitor.

SEMICONDUCTOR-COMPONENTS DIVISION

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
P. O. BOX 312 • 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

SPECIFICATIONS

Deposition of the manganese dioxide, semiconductor electrolyte is accomplished under controlled temperature, atmosphere, and time conditions, to assure maximum surface area and penetration, good electrical contact, and a low dissipation factor. Reform anodization and deposition to retain high film integrity is supervised by careful control of process temperatures, voltage, and time.

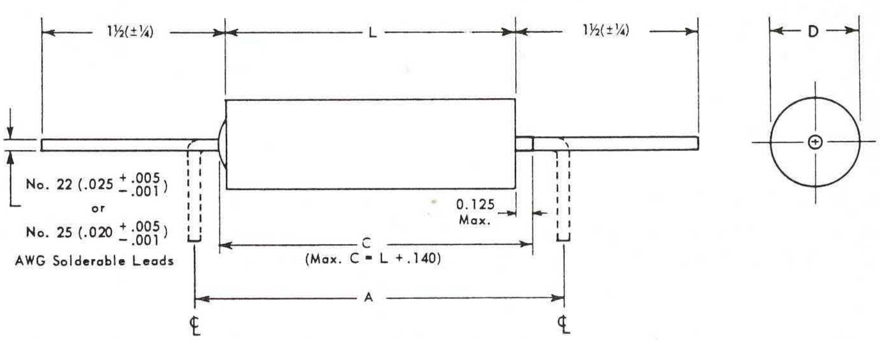
Good electrical contact to the enclosing case and cathode lead is assured by a uniform coating of chemically pure carbon deposited over the manganese dioxide electrolyte. The carbon coating is protected and electrically connected through the internal solder bed to the tinned brass enclosing case by means of a thin conducting metal jacket which surrounds the entire anode assembly except at its top. The pre-staked, tinned, copper-weld cathode lead is further secured by the molten solder bed during assembly and provides a secure, easy-to-solder electrical contact.

The pre-tinned, electronic grade nickel lead wire is securely butt-welded to the internal tantalum anode wire. The weld is carefully controlled to fall within the protective structure of the kovar gland of the glass-to-kovar anode header. This permits freedom of circuit assembly with sharp lead bends without fear of breaking or damaging the weld. The protective insulating washer between the header and the anode pellet provides mechanical protection and positioning as well as improvement in electrical performance. High temperature solder between the header and enclosing case provides a hermetically sealed unit which will retain its original characteristics under the most adverse ambient conditions.

Frequent "in process" manufacturing and quality assurance tests and checks of capacity, dc leakage, and dissipation factor along with 100% aging at elevated temperature contributes heavily to making *tan*-TI-*cap* capacitors type SCM uniformly stable. All units receive a final 100% check of principal electrical parameters, including leakage stability and steady state dc leakage at elevated temperature, and all mechanical and visual features.

All lots of *tan*-TI-*cap* capacitors type SCM are tested for performance stability under rated temperature and voltage conditions prior to release for shipment. This test is performed on a lot sample basis and is run for 250 hours or until performance stability is established by successive time interval measurements of the principal parameters of each test capacitor.

tan-TI-*cap* capacitors type SCM meet and exceed the electrical and mechanical requirements of MIL-C-55057 (Sig C) and MIL-C-21720 (NAVY) specifications for solid tantalum capacitors.



case size	D +0.010 —0.005	L ±0.031	*A ±0.031	wire size AWG	avg. wt. gms.	with KEL-F insulating sleeve: D +0.020 —0.010	with KEL-F insulating sleeve: L ±0.062	with KEL-F insulating sleeve: avg. wt. gms.	with Mylar insulating sleeve**: D ±0.010	with Mylar insulating sleeve**: L ±0.031	with Mylar insulating sleeve**: avg. wt. gms.
F	0.125	0.250	0.482	24	0.4	0.162	0.337	0.5	0.135	0.322	0.4
B	0.175	0.438	0.688	24	1.1	0.210	0.525	1.3	0.185	0.510	1.2
G	0.279	0.650	0.888	22	2.7	0.315	0.735	3.1	0.289	0.722	2.8
H	0.341	0.750	0.988	22	3.3	0.377	0.835	3.9	0.351	0.822	3.4

* Dimension "A" determined by suspending a one-pound weight from one lead and rotating the case from the vertical position to the horizontal position, and then repeating the procedure for the other lead.

** Meets all requirements of MIL-C-55057 and MIL-C-21720, including dimensions.

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
P. O. BOX 312 • 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

*** EXPLANATION OF CATALOG NUMBER SYSTEM**

S C M 15 6 B P 015 ‡A †4

- Type Symbol — S
- Performance Characteristic — C
- Encapsulation Material — M
- Capacity Rating, $\mu\mu f$ (Significant Figures) — 15
- No. of Zeros to follow Significant Figs. — 6
- Case Size — B
- Polarity (Polar) — P
- Working Voltage (dc) Direct Reading — 015
- Insulating Sleeves Indicator — ‡A
- Capacity Tolerance Symbol — †4

‡ The letter "A" in the second to last position of the Catalog number specifies no insulating sleeves. Change the letter "A" to the letter "B" for KEL-F insulating sleeves, or to the letter "D" for Mylar sleeves. Capacitors with flexible polyvinyl insulating sleeves available on request.

† The number "4" in the last position of the Catalog number specifies standard ±20% capacity tolerance, or the number "2" in this position specifies standard 10% tolerance. Other tolerances available on request.

**See sections 6.0 and 8.0 for further detail.

NOMINAL CAPACITY 25°C (μf)	RATED DC WORKING VOLTAGE 85°C (volts)	CASE SIZE	*CATALOG NUMBER 20% TOLERANCE	*CATALOG NUMBER 10% TOLERANCE	SURGE VOLTAGE RATING 85°C (volts)	MAX. ESR AT NOMINAL CAPACITY 120 CPS 25°C (ohms)	**DC LEAKAGE INITIAL LIMITS (μa) 25°C	**DC LEAKAGE INITIAL LIMITS (μa) 85°C	**DC LEAKAGE INITIAL LIMITS (μa) 125°C
6 volt dc working voltage 85°C (4 volts dc 125°C)									
1.0	6	F	SCM105FP006A4	SCM105FP006A2	8	79.8	2.0	10.0	15.0
1.2	6	F		SCM125FP006A2	8	66.5	2.0	10.0	15.0
1.5	6	F	SCM155FP006A4	SCM155FP006A2	8	53.3	2.0	10.0	15.0
1.8	6	F		SCM185FP006A2	8	44.4	2.0	10.0	15.0
2.2	6	F	SCM225FP006A4	SCM225FP006A2	8	36.3	2.0	10.0	15.0
2.7	6	F		SCM275FP006A2	8	29.8	2.0	10.0	15.0
3.3	6	F	SCM335FP006A4	SCM335FP006A2	8	24.2	2.0	10.0	15.0
3.9	6	F		SCM395FP006A2	8	20.5	2.0	10.0	15.0
4.7	6	F	SCM475FP006A4	SCM475FP006A2	8	17.0	2.0	11.3	15.0
5.6	6	F		SCM565FP006A2	8	14.3	2.0	13.5	16.8
6.8	6	F	SCM685FP006A4	SCM685FP006A2	8	11.8	2.0	16.3	20.4
8.2	6	B		SCM825BP006A2	8	9.8	2.0	19.7	24.6

AVAILABLE RATINGS

NOMINAL CAPACITY 25°C (μf)	RATED DC WORKING VOLTAGE 85°C (volts)	CASE SIZE	*CATALOG NUMBER		SURGE VOLTAGE RATING 85°C (volts)	MAX. ESR AT NOMINAL CAPACITY 120 CPS 25°C (ohms)	**DC LEAKAGE INITIAL LIMITS (μa)		
			20% TOLERANCE	10% TOLERANCE			25°C	85°C	125°C
6 volts dc working voltage 85°C (4 volts dc 125°C) (continued)									
10	6	B	SCM106BP006A4	SCM106BP006A2	8	8.0	2.4	24.0	30.0
12	6	B		SCM126BP006A2	8	6.6	2.9	28.8	36.0
15	6	B	SCM156BP006A4	SCM156BP006A2	8	5.3	3.6	36.0	45.0
18	6	B		SCM186BP006A2	8	4.4	4.3	43.3	54.0
22	6	B	SCM226BP006A4	SCM226BP006A2	8	3.6	5.3	52.9	66.0
27	6	B		SCM276BP006A2	8	3.0	6.5	64.9	81.0
33	6	B	SCM336BP006A4	SCM336BP006A2	8	2.4	7.9	79.3	99.0
39	6	B		SCM396BP006A2	8	2.0	9.4	93.8	117.
47	6	B	SCM476BP006A4	SCM476BP006A2	8	1.7	11.3	113.	141.
56	6	B		SCM566BP006A2	8	1.4	13.5	135.	168.
68	6	G	SCM686GP006A4	SCM686GP006A2	8	1.2	16.3	163.	204.
82	6	G		SCM826GP006A2	8	1.0	19.7	197.	246.
100	6	G	SCM107GP006A4	SCM107GP006A2	8	0.8	24.0	240.	300.
120	6	G		SCM127GP006A2	8	0.7	28.8	288.	360.
150	6	G	SCM157GP006A4	SCM157GP006A2	8	0.5	36.0	360.	450.
180	6	G		SCM187GP006A2	8	0.4	43.3	433.	540.
220	6	H	SCM227HP006A4	SCM227HP006A2	8	0.4	52.9	529.	660.
270	6	H		SCM277HP006A2	8	0.3	64.9	649.	810.
330	6	H	SCM337HP006A4	SCM337HP006A2	8	0.2	79.3	793.	990.
10 volts dc working voltage 85°C (7 volts dc 125°C)									
1.0	10	F	SCM105FP010A4	SCM105FP010A2	13	79.8	2.0	10.0	15.0
1.2	10	F		SCM125FP010A2	13	66.5	2.0	10.0	15.0
1.5	10	F	SCM155FP010A4	SCM155FP010A2	13	53.3	2.0	10.0	15.0
1.8	10	F		SCM185FP010A2	13	44.4	2.0	10.0	15.0
2.2	10	F	SCM225FP010A4	SCM225FP010A2	13	36.3	2.0	10.0	15.0
2.7	10	F		SCM275FP010A2	13	29.8	2.0	10.8	15.0
3.3	10	F	SCM335FP010A4	SCM335FP010A2	13	24.2	2.0	13.2	16.5
3.9	10	F		SCM395FP010A2	13	20.5	2.0	15.6	19.5
4.7	10	F	SCM475FP010A4	SCM475FP010A2	13	17.0	2.0	18.8	23.5
5.6	10	B		SCM565BP010A2	13	14.3	2.2	22.4	28.0

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
P. O. BOX 312 • 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

AVAILABLE RATINGS

NOMINAL CAPACITY 25°C (μf)	RATED DC WORKING VOLTAGE 85°C (volts)	CASE SIZE	*CATALOG NUMBER		SURGE VOLTAGE RATING 85°C (volts)	MAX. ESR AT NOMINAL CAPACITY 120 CPS 25°C (ohms)	**DC LEAKAGE INITIAL LIMITS (μa)		
			20% TOLERANCE	10% TOLERANCE			25°C	85°C	125°C
10 volts dc working voltage 85°C (7 volts dc 125°C) (continued)									
6.8	10	B	SCM685BP010A4	SCM685BP010A2	13	11.8	2.7	27.2	34.0
8.2	10	B		SCM825BP010A2	13	9.8	3.3	32.8	41.0
10	10	B	SCM106BP010A4	SCM106BP010A2	13	8.0	4.0	40.0	50.0
12	10	B		SCM126BP010A2	13	6.6	4.8	48.0	60.0
15	10	B	SCM156BP010A4	SCM156BP010A2	13	5.3	6.0	60.0	75.0
18	10	B		SCM186BP010A2	13	4.4	7.2	72.0	90.0
22	10	B	SCM226BP010A4	SCM226BP010A2	13	3.6	8.8	88.0	110.
27	10	B		SCM276BP010A2	13	3.0	10.8	108.	135.
33	10	B	SCM336BP010A4	SCM336BP010A2	13	2.4	13.2	132.	165.
39	10	B		SCM396BP010A2	13	2.0	15.6	156.	195.
47	10	G	SCM476GP010A4	SCM476GP010A2	13	1.7	18.8	188.	235.
56	10	G		SCM566GP010A2	13	1.4	22.4	224.	280.
68	10	G	SCM686GP010A4	SCM686GP010A2	13	1.2	27.2	272.	340.
82	10	G		SCM826GP010A2	13	1.0	32.8	328.	410.
100	10	G	SCM107GP010A4	SCM107GP010A2	13	0.8	40.0	400.	500.
120	10	G		SCM127GP010A2	13	0.7	48.0	480.	600.
150	10	H	SCM157HP010A4	SCM157HP010A2	13	0.5	60.0	600.	750.
180	10	H		SCM187HP010A2	13	0.4	72.0	720.	900.
220	10	H	SCM227HP010A4	SCM227HP010A2	13	0.4	88.0	880.	1100.
15 volts dc working voltage 85°C (10 volts dc 125°C)									
1.0	15	F	SCM105FP015A4	SCM105FP015A2	20	79.8	2.0	10.0	15.0
1.2	15	F		SCM125FP015A2	20	66.5	2.0	10.0	15.0
1.5	15	F	SCM155FP015A4	SCM155FP015A2	20	53.3	2.0	10.0	15.0
1.8	15	F		SCM185FP015A2	20	44.4	2.0	10.8	15.0
2.2	15	F	SCM225FP015A4	SCM225FP015A2	20	36.3	2.0	13.2	16.5
2.7	15	F		SCM275FP015A2	20	29.8	2.0	16.2	20.2
3.3	15	F	SCM335FP015A4	SCM335FP015A2	20	24.2	2.0	19.8	24.8
3.9	15	B		SCM395BP015A2	20	20.5	2.3	23.4	29.2
4.7	15	B	SCM475BP015A4	SCM475BP015A2	20	17.0	2.8	28.2	35.2
5.6	15	B		SCM565BP015A2	20	14.3	3.4	33.6	42.0
6.8	15	B	SCM685BP015A4	SCM685BP015A2	20	11.8	4.1	40.8	51.0
8.2	15	B		SCM825BP015A2	20	9.8	4.9	49.3	61.5

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
P. O. BOX 312 • 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

AVAILABLE RATINGS

NOMINAL CAPACITY 25°C (μf)	RATED DC WORKING VOLTAGE 85°C (volts)	CASE SIZE	*CATALOG NUMBER 20% TOLERANCE	*CATALOG NUMBER 10% TOLERANCE	SURGE VOLTAGE RATING 85°C (volts)	MAX. ESR AT NOMINAL CAPACITY 120 CPS 25°C (ohms)	**DC LEAKAGE INITIAL LIMITS (μa) 25°C	**DC LEAKAGE INITIAL LIMITS (μa) 85°C	**DC LEAKAGE INITIAL LIMITS (μa) 125°C
15 volts dc working voltage 85°C (10 volts dc 125°C) (continued)									
10	15	B	SCM106BP015A4	SCM106BP015A2	20	8.0	6.0	60.0	75.0
12	15	B		SCM126BP015A2	20	6.6	7.2	72.0	90.0
15	15	B	SCM156BP015A4	SCM156BP015A2	20	5.3	9.0	90.0	113.
18	15	B		SCM186BP015A2	20	4.4	10.8	108.	135.
22	15	B	SCM226BP015A4	SCM226BP015A2	20	3.6	13.2	132.	165.
27	15	G		SCM276GP015A2	20	3.0	16.2	162.	202.
33	15	G	SCM336GP015A4	SCM336GP015A2	20	2.4	19.8	198.	248.
39	15	G		SCM396GP015A2	20	2.0	23.4	234.	292.
47	15	G	SCM476GP015A4	SCM476GP015A2	20	1.7	28.2	282.	352.
56	15	G		SCM566GP015A2	20	1.4	33.6	336.	420.
68	15	G	SCM686GP015A4	SCM686GP015A2	20	1.2	40.8	408.	510.
82	15	H		SCM826HP015A2	20	1.0	49.3	493.	615.
100	15	H	SCM107HP015A4	SCM107HP015A2	20	0.8	60.0	600.	750.
120	15	H		SCM127HP015A2	20	0.7	72.0	720.	900.
150	15	H	SCM157HP015A4	SCM157HP015A2	20	0.5	90.0	900.	1130.
20 volts dc working voltage 85°C (13 volts dc 125°C)									
1.0	20	F	SCM105FP020A4	SCM105FP020A2	26	79.8	2.0	10.0	15.0
1.2	20	F		SCM125FP020A2	26	66.5	2.0	10.0	15.0
1.5	20	F	SCM155FP020A4	SCM155FP020A2	26	53.3	2.0	12.0	15.0
1.8	20	F		SCM185FP020A2	26	44.4	2.0	14.4	18.0
2.2	20	F	SCM225FP020A4	SCM225FP020A2	26	36.3	2.0	17.6	22.0
2.7	20	B		SCM275BP020A2	26	29.8	2.2	21.6	27.0
3.3	20	B	SCM335BP020A4	SCM335BP020A2	26	24.2	2.6	26.4	33.0
3.9	20	B		SCM395BP020A2	26	20.5	3.1	31.2	39.0
4.7	20	B	SCM475BP020A4	SCM475BP020A2	26	17.0	3.8	37.6	47.0
5.6	20	B		SCM565BP020A2	26	14.3	4.5	44.8	56.0
6.8	20	B	SCM685BP020A4	SCM685BP020A2	26	11.8	5.4	54.4	68.0
8.2	20	B		SCM825BP020A2	26	9.8	6.6	65.7	82.0
10	20	B	SCM106BP020A4	SCM106BP020A2	26	8.0	8.0	80.0	100.
12	20	B		SCM126BP020A2	26	6.6	9.6	96.0	120.
15	20	B	SCM156BP020A4	SCM156BP020A2	26	5.3	12.0	120.	150.
18	20	G		SCM186GP020A2	26	4.4	14.4	144.	180.
22	20	G	SCM226GP020A4	SCM226GP020A2	26	3.6	17.6	176.	220.

NOMINAL CAPACITY 25°C (μf)	RATED DC WORKING VOLTAGE 85°C (volts)	CASE SIZE	*CATALOG NUMBER 20% TOLERANCE	*CATALOG NUMBER 10% TOLERANCE	SURGE VOLTAGE RATING 85°C (volts)	MAX. ESR AT NOMINAL CAPACITY 120 CPS 25°C (ohms)	**DC LEAKAGE INITIAL LIMITS (μa) 25°C	**DC LEAKAGE INITIAL LIMITS (μa) 85°C	**DC LEAKAGE INITIAL LIMITS (μa) 125°C
20 volts dc working voltage 85°C (13 volts dc 125°C) (continued)									
27	20	G		SCM276GP020A2	26	3.0	21.6	216.	270.
33	20	G	SCM336GP020A4	SCM336GP020A2	26	2.4	26.4	264.	330.
39	20	G		SCM396GP020A2	26	2.0	31.2	312.	390.
47	20	G	SCM476GP020A4	SCM476GP020A2	26	1.7	37.6	376.	470.
56	20	H		SCM566HP020A2	26	1.4	44.8	448.	560.
68	20	H	SCM686HP020A4	SCM686HP020A2	26	1.2	54.4	544.	680.
82	20	H		SCM826HP020A2	26	1.0	65.7	657.	820.
100	20	H	SCM107HP020A4	SCM107HP020A2	26	0.8	80.0	800.	1000.
120	20	H		SCM127HP020A2	26	0.7	96.0	960.	1200.
35 volts dc working voltage 85°C (23 volts dc 125°C)									
1.0	35	F	SCM105FP035A4	SCM105FP035A2	46	79.8	2.0	14.0	17.5
1.2	35	B		SCM125BP035A2	46	66.5	2.0	16.8	21.0
1.5	35	B	SCM155BP035A4	SCM155BP035A2	46	53.3	2.1	21.0	26.3
1.8	35	B		SCM185BP035A2	46	44.4	2.5	25.2	31.6
2.2	35	B	SCM225BP035A4	SCM225BP035A2	46	36.3	3.1	30.8	38.5
2.7	35	B		SCM275BP035A2	46	29.8	3.8	37.8	47.3
3.3	35	B	SCM335BP035A4	SCM335BP035A2	46	24.2	4.6	46.2	57.8
3.9	35	B		SCM395BP035A2	46	20.5	5.5	54.7	68.3
4.7	35	B	SCM475BP035A4	SCM475BP035A2	46	17.0	6.6	65.8	82.4
5.6	35	B		SCM565BP035A2	46	14.3	7.9	78.5	98.2
6.8	35	B	SCM685BP035A4	SCM685BP035A2	46	11.8	9.5	95.2	119.
8.2	35	G		SCM825GP035A2	46	9.8	11.5	115.	144.
10	35	G	SCM106GP035A4	SCM106GP035A2	46	8.0	14.0	140.	175.
12	35	G		SCM126GP035A2	46	6.6	16.8	168.	210.
15	35	G	SCM156GP035A4	SCM156GP035A2	46	5.3	21.0	210.	263.
18	35	G		SCM186GP035A2	46	4.4	25.2	252.	316.
22	35	G	SCM226GP035A4	SCM226GP035A2	46	3.6	30.8	308.	385.
27	35	H		SCM276HP035A2	46	3.0	37.8	378.	473.
33	35	H	SCM336HP035A4	SCM336HP035A2	46	2.4	46.2	462.	578.
39	35	H		SCM396HP035A2	46	2.0	54.7	547.	683.
47	35	H	SCM476HP035A4	SCM476HP035A2	46	1.7	65.8	658.	824.

SPECIFICATIONS AND TEST CONDITIONS

1.0 general. *tan*-TI-*cap* solid tantalum capacitors which meet the following requirements are classified as type SCM. Limits and methods of test are rigidly maintained. Uniform test equipment and techniques are maintained for each production lot, thus assuring uniformly good capacitor performance.

All test equipment is adjusted to proper working order and proper calibration prior to testing.
Unless otherwise specified herein testing tolerances shall be:
Temperature, ±2°C; Voltage dc, ±1% of the measured value;
Voltage ac, ±5% of the measured value.

Where tests are run at any specified temperature the units shall be stabilized at that temperature for at least one (1) hour prior to measurement.

2.0 capacity.

2.1 *Method of Measurement.* Measurements shall be made using a polarized capacitance bridge; the bridge including the fixture and the precision null detector are to be within ±2% accuracy. Rated dc working voltage of the capacitor under test less 1 volt shall be used. The ac measuring signal shall be 120 ±5 cycles per second. The test ac voltage applied for capacitors rated 0 to 100 microfarads shall be 0.5 volts RMS maximum; for capacitors rated 101 microfarads and greater the ac testing voltage shall be 0.15 volts RMS maximum.

2.2 *Limits.*

2.2.1 The capacity of each unit shall be within the allowed tolerance (as shown under available ratings) of the nominal rated capacity when measured per section 2.1 of this specification at 25 ±5°C.

2.2.2 Capacity change with temperature. Maximum capacity deviation from the initial 25 ±5°C measurement shall not exceed the following:

Temperature	−55°C	+85°C	+125°C
%Capacity Change	−10%	+10%	+15%

2.2.3 Capacity of each unit measured at succeeding 25 ±5°C shall be within ±3% of initial 25°C measurement.

3.0 working voltage vs ambient temperature. Rated dc working voltage is that voltage which is maximum for continuous duty operation of each capacitor and shall be in accordance with the following table:

Ambient Temperature	25°C	85°C	125°C
	6 w v dc	6 w v dc	4 w v dc
	10 "	10 "	7 "
	15 "	15 "	10 "
	20 "	20 "	13 "
	35 "	35 "	23 "

4.0 surge voltage.

4.1 *Definition.* The surge voltage is the maximum voltage to which the capacitor shall be subjected under any circumstance. This shall include peak ac ripple and any transients at the highest line voltage.

4.2 *Method of Measurement.* Surge voltage tests shall be run with a 1000 ±10% ohm resistor in series with each capacitor during the test. The capacitors shall withstand 1000 successive cycles of rated surge voltage for the proper ambient temperature. Each cycle shall consist of 30 seconds on voltage and 4½ minutes off voltage.

4.3 *Surge Rating.* Surge voltage rating for each capacitor shall be in accordance with the following table:

Rated WV at 85°C	85°C Surge Voltage	Rated WV at 125°C	125°C Surge Voltage
6	8	4	6
10	13	7	10
15	20	10	15
20	26	13	20
35	46	23	35

4.4 *Limits.* After surge test the capacitance of each capacitor shall be within 10% of its initial measurement. DF and DC leakage shall meet their initial requirements.

5.0 dissipation factor (DF).

5.1 *Definition.* Dissipation factor is an indication of a capacitor's power factor (PF) and of its equivalent series resistance (ESR). It is often expressed in %, and is calculated in accordance with the formula: DF (%) = $2\pi fRC$ times 100, where f is the test frequency in cycles per second (cps), R is the equivalent series resistance (ESR) at the test frequency, in ohms, and C is the capacitor's capacitance in farads.

5.2 *Method of Measurement.* DF shall be measured in the same manner as prescribed in section 2.1 of this specification.

5.3 *Limits.* DF limits shall be equal to or less than values shown in the following table:

Temperature °C	DF (%)
−55	8
25	6
85	8
125	8

6.0 dc leakage current.

6.1 *Definition.* DC leakage current is the measured steady state direct current which flows through the capacitor as a result of the impressed DC voltage. Its limits in microamperes shall be calculated using nominal rated capacity in microfarads, rated 25°C working voltage, and constant limit multipliers from section 6.3.

6.2 *Method.* Measurements shall be made using a steady dc power source and shall be made at the proper rated dc working voltage for each ambient temperature condition. The test capacitor shall be electrified at the proper dc voltage for each test condition and 3 minutes of elapsed time shall be permitted to meet the leakage requirements of this specification.

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
P. O. BOX 312 • 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

6.3 *Limits.* Maximum dc leakage requirements shall be in accordance with the following table:

Ambient Temperature	dc leakage — µa/µf — volt or µa, whichever is greater	
	µa/µf — volt	Limit — µa
25°C	0.04	2
85°C	0.4	10
125°C	0.5	15

NOTE: (See Available Ratings Tables on previous pages)

7.0 leakage stability. Instantaneous variation in dc leakage current of a capacitor under operating conditions is a measure of its leakage stability.

7.1 *Method of Measurement.* Leakage stability shall be measured at the proper high test temperature using a battery power supply or equivalent noise free source. A cathode ray oscilloscope with a vertical sensitivity of 1 millivolt per centimeter or better shall be used. A test circuit as shown below is used for this measurement.

7.2 *Limits.* When measured per section 7.1 the observed leakage stability shall not exceed 0.2 mv at 25 ±5°C, or 1.0 mv at 85°C, and 1.0 mv at 125°C when measured peak-to-peak for an elapsed time of 10 seconds after allowing 1 minute of electrification at the proper rated dc working voltage for the desired test temperature.

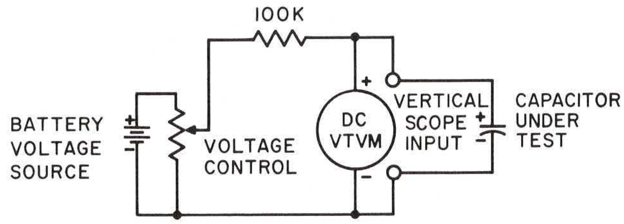
8.0 acceptance life tests.

8.1 *Method.* Samples shall be subjected to the proper rated working voltage for the ambient test temperature. AC ripple imposed shall not exceed the values indicated in the Application Section of this specification, nor shall the total combined DC and AC voltage exceed the limits specified in section 3.0 of this specification.

All tests shall be run with a 1000 ±10% ohm resistor in series with each capacitor.

8.2 *Limits.* When tested in accordance with section 8.1, the capacitors shall meet the limits as stated in table I.

LEAKAGE STABILITY TEST CIRCUIT



Oscilloscope has 1 megohm input impedance
DC VTVM has minimum 11 megohm input impedance

TABLE I

Test Time Hours	Test Temperature °C	Capacitance Requirement	DF (%)	DC Leakage Requirement
0	25	*IR	6	*IR
1-2	85	—	—	*IR
1-2	125	—	—	*IR
250	85	—	—	*IR
250	125	—	—	*IR
250	25	±10% **IM	6	*IR
1000	85	—	—	125% of *IR
1000	125	—	—	125% of *IR
1000	25	±10% **IM	6	*IR
2000	85	—	—	125% of *IR
2000	25	±10% **IM	6	125% of *IR

*IR — Initial Requirement of this specification.

**IM — Initial Measured value of each capacitor.

8.3 For any test duration, one limit failure in each 25 units tested shall be permitted.

9.0 solder and flux. External solder shall be smooth and unbroken with no pin holes or girdle on the surface of the enclosing case.

Flux shall be rosin type or approved equal which will permit the capacitors to meet the requirements of this specification.

10.0 leads.

10.1 *Eccentricity.* Maximum eccentricity of either lead shall be 0.010 inches when measured immediately adjacent to the enclosing case.

10.2 *Pull Test.* Either lead shall withstand a 3-pound pull in any direction for 30 seconds without damage to the lead or the capacitor.

10.3 *Bend Test.* Both leads shall withstand five (5) bends without breakage. In order to conduct this test the capacitor shall be placed in a vertical position and a one (1) pound weight attached to one lead end. Slowly rotate the capacitor to a horizontal position and return to vertical. Succeeding bends shall be made in alternate directions until a total of five (5) bends have been accomplished.

10.4 *Twist Test (alternate to Section 10.3).* Where required and specified by a purchaser a lead twist test as stated in MIL-C-21720 (NAVY), paragraph 4.7.2.2 may be substituted.

11.0 insulating sleeves. Capacitors under this specification may be supplied with either KEL-F or Mylar insulating sleeves on the capacitor enclosing case when an insulated unit is required.

11.1 KEL-F insulating sleeves are a clear fluorocarbon thermoplastic material having a volume resistivity of 1.2 X 10^{18} ohms — cm and dielectric strength of 530 volts per mil at 50% relative humidity and 25°C. Other properties of this material are: Zero moisture absorption; high impact strength; non-flammable; chemically inert; and exceptionally stable and resistant to temperature from −190°C to +190°C.

11.2 Mylar insulating sleeves are a transparent polyester plastic material with a volume resistivity of 1 X 10^{19} ohm-centimeter at 25°C and a dielectric strength of 4000 volts per mil at 25°C when tested in accordance with ASTMD 149-44. It has a moisture absorption of less than 0.5% after 1 week immersion in tap water at 25°C. It is highly resistant to chemical and solvent attacks and has a melting point of 250°C.

11.3 *Method of Testing*. The sleeved capacitors shall be placed in a conducting fixture which provides line electrical contact along two surfaces of the body length. With the anode and cathode leads connected together a voltage of 2000 v dc shall be applied between leads and holding fixture for one minute without damage to capacitor or sleeving.

11.4 *Limits*. The insulation resistance when measured in the above manner except with a 500 v dc potential, shall be at least 100 megohms.

12.0 moisture resistance.

12.1 *Method*. Samples shall be tested per MIL-STD-202A, Method 106. The following exceptions shall apply:

(a) Mounting. Capacitors must be securely fastened by normal mounting means except during measurement.
(b) Sample conditioning prior to first cycle not applicable.
(c) Polarization and load not applicable.
(d) Final Measurement. Within 2 to 6 hours after the final cycle of this test including removal from the humidity chamber, the capacitors shall be measured for capacity, dissipation factor and dc leakage at 25 ±5°C.
(e) Visual examination. Capacitors shall be visually examined for evidence of corrosion.

12.2 *Limits*. After test, capacity, DF and dc leakage shall meet the requirements of 2.0, 5.0 and 6.0 at 25 ±5°C.

13.0 seal. The capacitors shall be completely immersed in deionized water at room temperature and a vacuum of 24" Hg. applied. The liquid level shall be well above the highest point of units tested in order to readily detect leaks. No repetitive bubbling of the units will be permitted.

14.0 reduced pressure. 14.1 *Method*. The capacitors shall be subjected to a pressure equivalent to a 100,000 Ft. altitude (0.315" Hg) at 25°C for five (5) minutes after which rated voltage shall be applied. After three (3) minutes of applied voltage the units shall be returned to room pressure at 25°C and measured for capacity, DF, and dc leakage.

14.2 *Limits*. When measurements are made per section 14.1 of this specification the measured values shall meet initial requirements of this specification. No arcing shall be evident during this test.

After completion of tests per section 14.1 the capacitors shall meet the requirements of section 13.0 (seal test)

15.0 temperature and immersion cycling. 15.1 *Temperature cycling*. Capacitors shall be tested per method 102 of MIL-STD-202A with the following exceptions:

(a) Conditioning prior to first cycle shall be 15 minutes at standard temperature.
(b) Test condition D shall be used except in step 3, sample units shall be tested at applicable ambient temperature.
(c) Measurement after cycling not applicable.

15.2 *Immersion cycling*. Capacitors shall be tested per method 104 of MIL-STD-202A with the following exceptions:

(a) Test condition B shall be used with the addition of a non-corrosive dye, Rhodamine B, in both baths.
(b) Measurements after cycling — Within 30 minutes after removal from final immersion bath, capacity, DF and dc leakage shall be measured.
(c) Visual examination — Capacitors shall be visually examined for evidence of corrosion then opened and examined for evidence of penetration of dye.

15.3 *Limits* after completion of tests in accordance with section 15.1 and 15.2 of this specification, DF and dc leakage shall meet initial requirements. Capacity shall not change more than 5% from initial measurement.

16.0 corrosion. When tested per test condition B, Method 101 of MIL-STD-202A, there shall be no harmful corrosion, and at least 90% of any exposed metallic surface of the capacitors shall be unaffected.

17.0 vibration. 17.1 *Low frequency method*. The capacitors shall be tested in accordance with method 201A of MIL-STD-202A, except they shall be securely body mounted.

17.2 *High frequency method*. The capacitors shall be tested in accordance with method 204, condition B of MIL-STD-202A except they shall be securely body mounted.

17.3 *Limits*. After test in accordance with sections 17.1 and 17.2 of this specification DF and dc leakage of the capacitors shall meet initial requirements and capacity shall not have changed more than 5% from its initial measurement.

18.0 acceleration. 18.1 *Test Conditions*. The capacitors shall be securely body mounted and then subjected to an accelerating force of 100g for a period of ten (10) seconds in each of two mutually perpendicular planes, parallel to the axis and perpendicular to the axis.

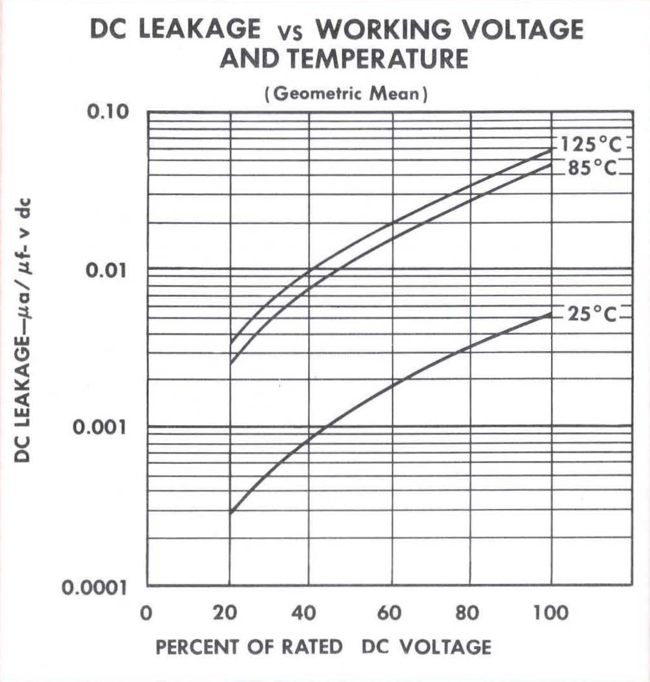
18.2 *Limits*. Upon completion of test per section 18.1 of this specification DF and dc leakage shall meet initial requirements and capacity shall not have changed more than 3% from its initial measurement.

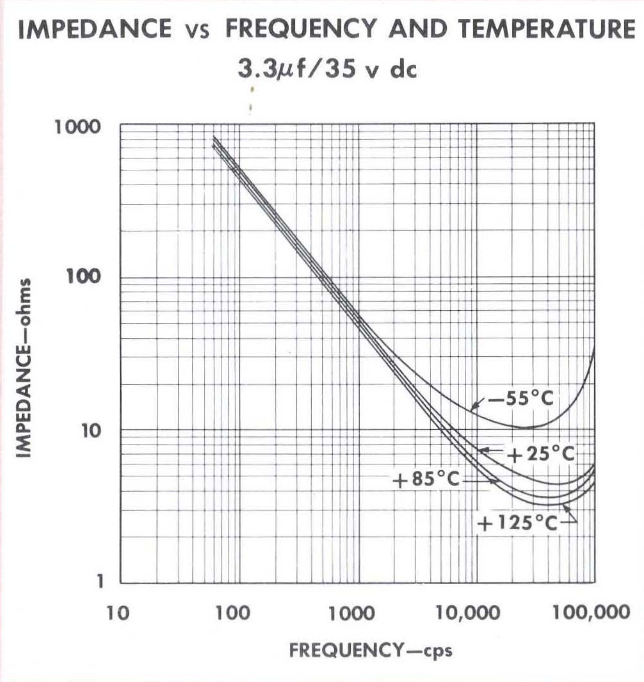
19.0 shock. All units shall meet the requirements for shock of MIL-T-19500A, or MIL-S-4456. As a result of test, capacity shall not change more than 5% from its initial value; DF and dc leakage shall meet initial requirements.

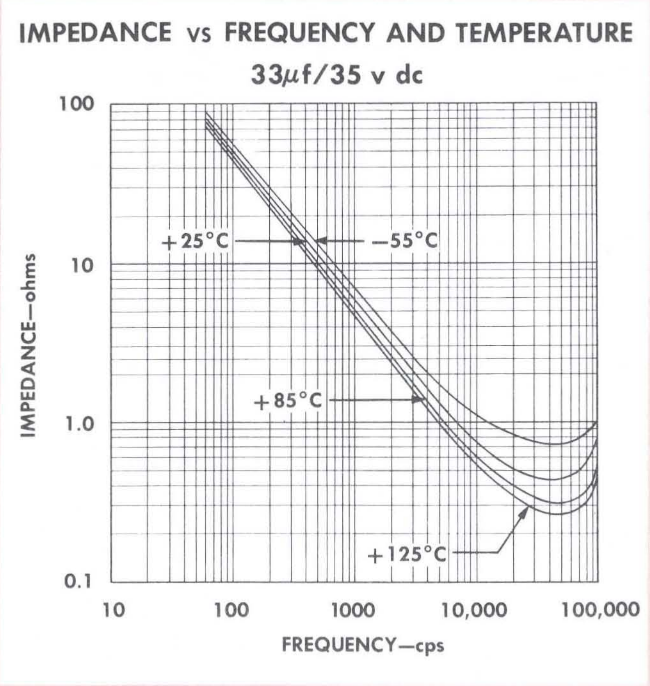
20.0 marking (symbolization). All markings on the capacitor shall be in legible black type which shall remain legible throughout all tests imposed under this specification. The marking or symbolization of each unit shall include the following (where space permits):

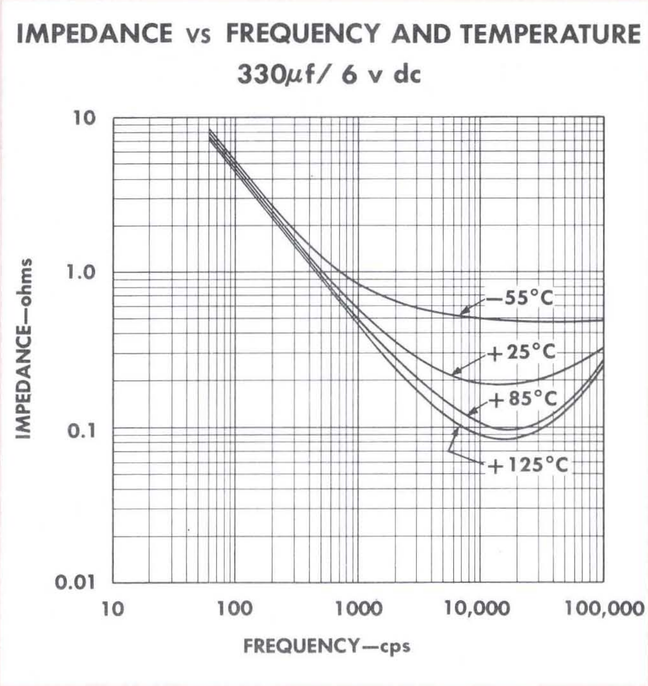
(a) Line 1 — Manufacturer's symbol and polarity +
(b) Line 2 — Manufacturer's type designation and tolerance symbol. SCM-4
(c) Line 3 — Capacitance rating in mfd and dc working voltage in volts. XXMXXV
(d) Line 4 — Manufacturer's date code (where case size permits) and polarity. MO-YR+ (viz., 10-59)

TOLERANCE NOTE: The number "1" designates ±5% (available on special order).
The number "2" designates a capacity tolerance of ±10%.
The number "4" designates ±20%.
The number "9" designates special tolerance to customer specifications.


DC LEAKAGE vs WORKING VOLTAGE AND TEMPERATURE
(Geometric Mean)
0.10
0.01
0.001
0.0001
DC LEAKAGE—μa/μf-v dc
125°C
85°C
25°C
0
20
40
60
80
100
PERCENT OF RATED DC VOLTAGE

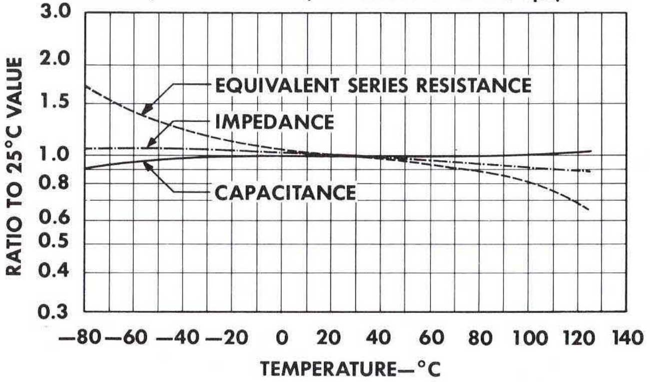

IMPEDANCE vs FREQUENCY AND TEMPERATURE
3.3μf/35 v dc
1000
100
10
1
IMPEDANCE—ohms
−55°C
+25°C
+85°C
+125°C
10
100
1000
10,000
100,000
FREQUENCY—cps


IMPEDANCE vs FREQUENCY AND TEMPERATURE
33μf/35 v dc
100
10
1.0
0.1
IMPEDANCE—ohms
+25°C
−55°C
+85°C
+125°C
10
100
1000
10,000
100,000
FREQUENCY—cps

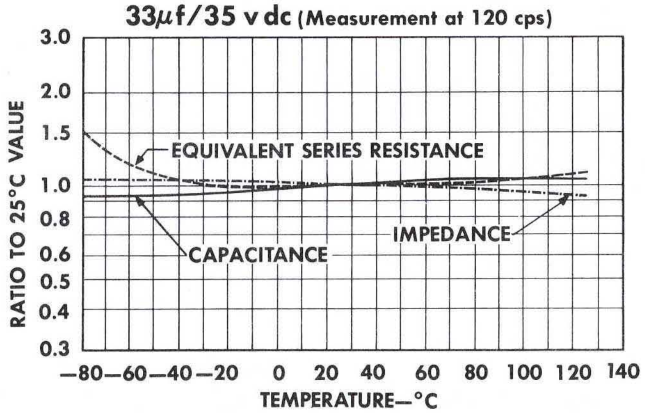

IMPEDANCE vs FREQUENCY AND TEMPERATURE
330μf/ 6 v dc
10
1.0
0.1
0.01
IMPEDANCE—ohms
−55°C
+25°C
+85°C
+125°C
10
100
1000
10,000
100,000
FREQUENCY—cps

PERFORMANCE AND APPLICATION DATA

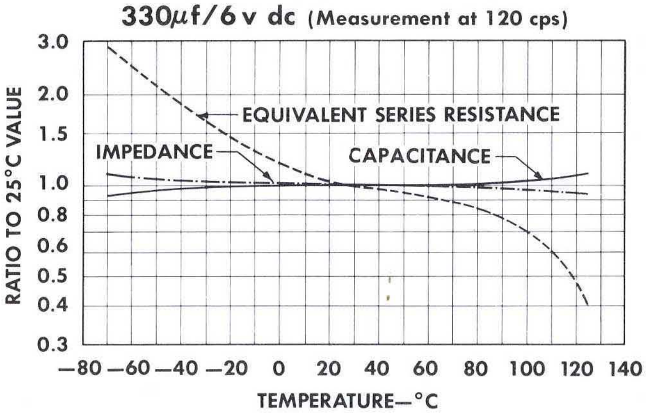
IMPEDANCE, CAPACITANCE, EQUIVALENT SERIES RESISTANCE vs TEMPERATURE
3.3μf/35 v dc (Measurement at 120 cps)



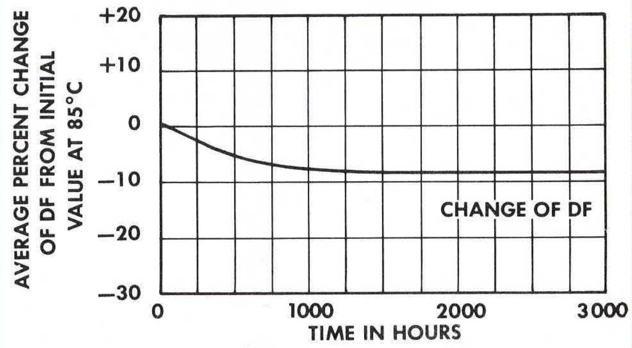
IMPEDANCE, CAPACITANCE, EQUIVALENT SERIES RESISTANCE vs TEMPERATURE
33μf/35 v dc (Measurement at 120 cps)

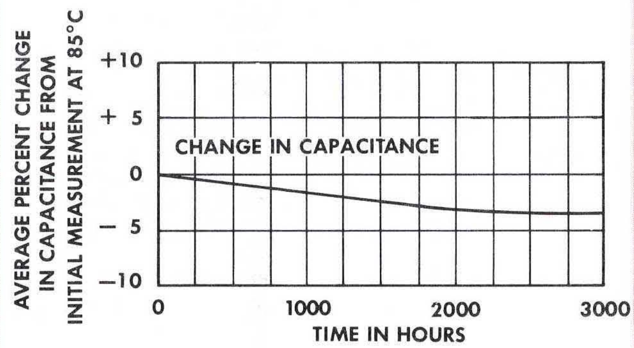


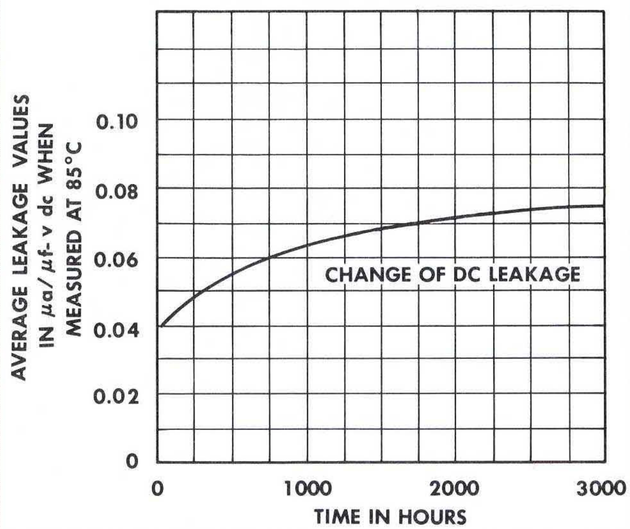
IMPEDANCE, CAPACITANCE, EQUIVALENT SERIES RESISTANCE vs TEMPERATURE
330μf/6 v dc (Measurement at 120 cps)



DC LEAKAGE, CAPACITANCE, AND DISSIPATION FACTOR vs TIME





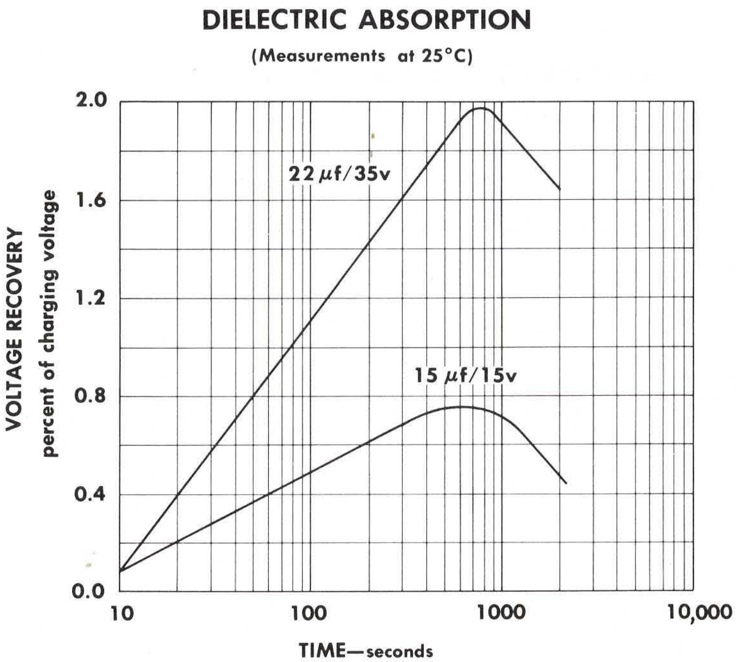


TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
P. O. BOX 312 • 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

definitions and relationships—

capacitor characteristics. The important *tan*-TI-*cap* capacitor characteristics are: impedance, dielectric absorption, leakage, power factor, and dissipation factor. Dielectric absorption and leakage are properties of the dielectric material, whereas the capacitor's physical and chemical properties affect impedance, power factor, and dissipation factor.

impedance. Since capacitors in the electrolytic range have resistance as well as capacitance, an impedance is introduced in the circuit. This impedance will vary with the frequency of the applied voltage. In most cases, the actual capacitor impedance at the principal operating frequency is a more direct indication of capacitor performance in a circuit than power factor, dissipation factor, or leakage.



dielectric absorption. Dielectric absorption (sometimes called dielectric hysteresis or dielectric "soak") is the characteristic of a dielectric which determines the ability of the capacitor to deliver its stored energy in a short period of time. This characteristic may be observed by the reappearance of potential across the capacitor after it has been shorted and the short removed. It is an important and often critical characteristic for RC timing networks, triggering systems and phase shift networks.

The dielectric absorption curves which are shown above were established by charging the *tan*-TI-*cap* capacitors at rated voltage for one hour, then discharging through a dead short for one minute. The voltage recovery was measured with a high impedance electrometer at prescribed intervals to establish the points on the curves. Increasing the ambient temperature shifts the dielectric absorption curve to the left, but does not affect the amplitude nor the shape of the curve. Shortening the charging time, lengthening the discharge time, or decreasing the magnitude of the charging voltage will result in the reduction of the peak amplitude of the dielectric absorption curve, but will have very little effect on its characteristic shape or its position with reference to the abscissa.

leakage. Leakage denotes the amount of direct current (not charging current) that will flow steadily through a capacitor. It is an important consideration when the capacitor is used in coupling or other applications where a dc voltage is imposed upon the capacitor.

power factor. Power factor is numerically equal to the cosine of the capacitor's phase angle

$$\text{Power Factor} = \cos\theta = \frac{\text{ESR}}{\sqrt{\text{ESR}^2 + X_c^2}}$$

when ESR = equivalent series resistance in ohms, and X_c = capacitive reactance in ohms.

This characteristic appraises the total capacitor losses, which include dielectric losses due to leakage and dielectric absorption, and ohmic losses due to contacts, leads and high frequency skin-effects. The ohmic losses have a pronounced effect on the capacitor's power factor, and become particularly important as frequency is increased. The better the capacitor, the lower will be the power factor.

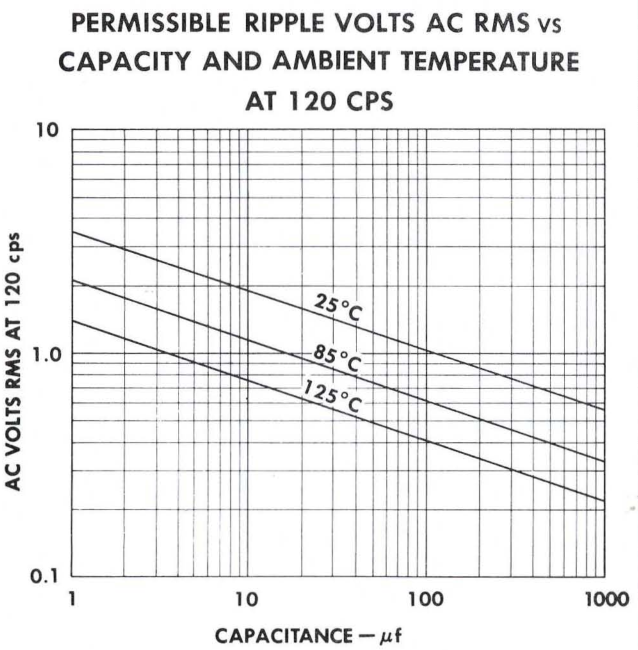
dissipation factor. The dissipation factor is numerically equal to the cotangent of the capacitor's phase angle.

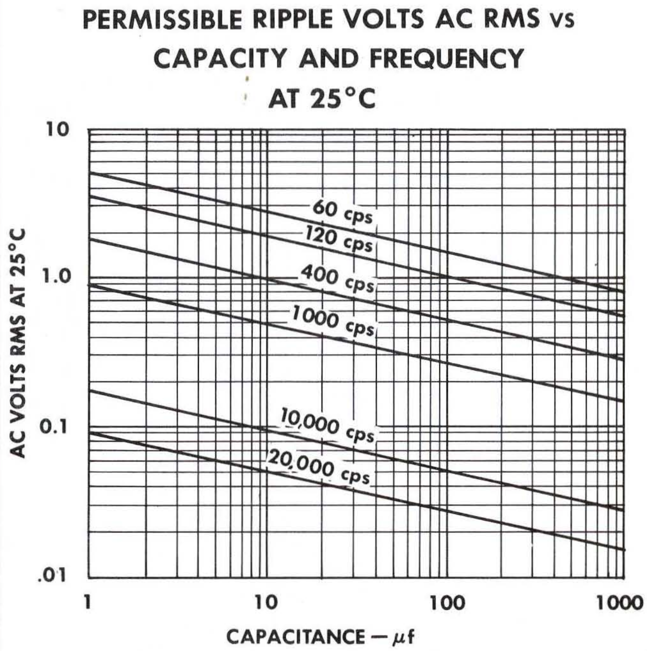
$$\text{DF} = \text{cotangent}\ \theta = \frac{\text{ESR}}{X_c}$$

This term is encountered in capacitor testing, since many bridges give a direct reading of dissipation factor. Similar to power factor, a low value indicates a better capacitor. For phase angles greater than −80°, there is very little difference, numerically, between dissipation factor and power factor. The relationship between power factor and dissipation factor is:

$$\text{Power Factor} = \text{DF}\sqrt{\frac{1}{1 + \text{DF}^2}}$$

Generally, power factor and dissipation factor are expressed as percentages.





a-c ripple voltage. A capacitor type SCM may be operated with an impressed ac or ripple voltage provided the capacitor does not exceed its heat dissipation limits as established by the above charts. Total heat dissipation limits are affected by both the ambient operating temperature and the equivalent heating effect of the operating frequency as compared to the 120 cps test frequency.

For example — from the ambient temperature curves above, a 10 mfd capacitor of any voltage may be operated at 1.9 volts rms, 120 cps, 25°C; or at 0.75 volts rms, 120 cps, 125°C. If, however, this same capacitor is subjected to a ripple frequency of 1000 cps, the permissible ripple voltage must be reduced by the ratio of permissible ac at 120 cps from the frequency curve above, as follows: 1.9 times $\frac{0.47}{1.9}$ equals 0.47 volts rms, at 25°C, 1000 cps; or 0.75 times $\frac{0.47}{1.9}$ equals 0.19 volts rms at 125°C, 1000 cps.

In no case shall the sum of the applied dc bias voltage and the peak of the ac ripple voltage exceed the rated dc working voltage for the applicable ambient temperature.

AC voltage permissible as determined by the above charts may be applied when the DC voltage is zero or near zero, provided the negative peak of the ac voltage does not exceed the allowable reverse voltage limits of one (1) volt at 85°C or 0.67 volts at 125°C.

reverse voltage. *tan*-TI-*cap* capacitors type SCM may be operated continuously at a reverse voltage of up to one (1) volt at 85°C or 0.67 volts at 125°C without destructive change in their performance.

shelf life. *tan*-TI-*cap* capacitors shall be stored for 5000 hours in a forced air oven at a temperature of 85 ± 5°C with no voltage applied. After removal from the chamber, they shall be cooled to 25 ± 5°C and measured. Capacitance shall not have changed more than 5% from the initial value, dissipation factor shall not exceed 150% of initial limit and direct-current leakage shall meet the initial limit.

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
P. O. BOX 312 • 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

PRINTED IN U. S. A.