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EVALUATION OF HERMETICALLY SEALED
WET SLUG TANTALUM CAPACITORS

By A.F. Busto

September, 1969

Prepared under Contract No. NAS 12-2004 by

FANSTEEL, INC.
Compton, California

Electronic Research Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Fansteel, Incorporated
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SUMMARY

Tantalum packages for wet slug tantalum capacitors, incorporating a glass-to-tantalum seal and a welded header-to-case seal, have been developed which exhibit hermeticity and resistance to reverse voltage. These two factors are mandatory where such capacitors are to be used in high reliability applications.

Tantalum encased capacitors meeting the T-3 physical and electrical MIL specifications were produced to a nominal 60V, 65 μf and tested with burn-in, life, reverse voltage, incremental ambient step stress, temperature cycling and immersion and surge voltage tests to ascertain their reliability and weaknesses.

All units were subjected to burn-in: 54 hours at 85°C, 18 hours at 125°C. Failure to endure the burn-in occured in 48 per cent of the units of which 90 per cent failed due to electrolyte leakage in the glass seal.

These failures were exclusively in the glass matrix, not in the matched glass-to-tantalum seal, indicating that the seal was not in compression, but was failing in tension. A minor redesign in the tantalum header thickness is indicated to rectify this condition. All of the elevated temperature tests verified this basic design weakness.

The reverse voltage tolerance tests indicated a high tolerance to -1.0V, a moderate tolerance up to 500 hours for -1.5V and a low tolerance beyond -2.0V.

INTRODUCTION

Several major requirements must be met in the design of a reliable package for wet tantalum electrolytic capacitors. First, a true hermetic seal must be achieved. Second, materials must be chosen which are resistive to the corrosive action of the sulfuric acid electrolyte.

The present capacitors typically use a silver case as the container and cathode connection. However, in the event transient or accidental reverse polarity voltages are applied to the capacitor, the tantalum cathode-sulfuric acid electrolyte-silver anode system behaves like a plating bath, and silver plates out on the tantalum slug and degrades or destroys the unit. Thus for a more reliable device it is necessary to choose a case material which will not plate out on the tantalum anode.

The total capacitance (C_t) of the finished device consists of two capacitances in series - the capacitance of the tantalum anode (C_a) and the capacitance of the cathode case (C_c). Thus

$$\frac{1}{C_t} = \frac{1}{C_a} + \frac{1}{C_c}$$

It is, therefore, necessary to invest the case with as high capacitance as possible in order not to reduce the overall capacitance of the device.

$$C = \frac{KA}{D}$$

where C = capacitance

K = dielectric constant

A = area of capacitor conductive plates

D = thickness of insulator

It can be seen that the capacitance of the case is directly proportional to its surface area, and one way to keep the capacitance high is to make the effective surface area very large.

Finally, although not absolutely necessary, it would be desirable to have a package design which lends itself well to simple production methods for the assembly of finished capacitors.

Fansteel Metallurgical Corporation has developed a hermetically sealed all tantalum package which appears to meet all the requirements for this type of unit.

The insulating seal around the anode lead is a matched tantalum-glass-tantalum seal. That is, there is an actual chemical bond between the glass and the tantalum anode lead and tantalum header. This, as opposed to the commonly used compression seal which provides only a mechanical pressure seal.

The case is also made of tantalum. A nickel cathode lead is welded to the outside of the case and the interior of the case is coated with an adherent platinum sponge. The platinum provides the large effective surface area necessary to keep the cathode capacitance high. Sample tests have shown the tantalum case capacitance to be equivalent to that of a silver can. Since the case is of the same material as the tantalum anode the problem of plating metal out on the anode when the unit is subjected to reverse polarity is theoretically eliminated.

The case is inserted into a heated welding jig and filled with electrolyte. No metering or special fill equipment is required. The header and anode assembly are then inserted into the case, forcing excess electrolyte to overflow. This insures that each unit is properly filled.

The header is welded to the can and the unit is completely sealed by a series of overlapping resistance welds around the perimeter of the case. When the capacitor is removed from the heated jig and cools to room temperature a small ullage is created due to the contraction of the electrolyte. The presence of this buffer volume plus the strength of the case itself permits the unit to operate at elevated temperatures where the pressure of the expanded electrolyte might otherwise rupture the case.

This program was designed to test a representitive sample of the tantalum package to define the limits of reliablility and pinpoint any weaknesses in the device. To do so, 180 units, all of which were subjected to a 72 hour burn-in at full rated temperature and voltage, were subjected to the following tests: life, reverse voltage tolerance, incremental ambient step stress, temperature cycling and immersion and surge voltage. Fifty-five units were submitted to NASA-ERC for parallel testing.

TEST PROGRAM PROCEDURE

Scope

The test program established controlled methods for the measurement, retrieval and storage of all data necessary to determine and document the reliability of the test capacitors. The methods included suitable means to control and validate the test instrumentation and to provide adequate procedures to maintain a satisfactory calibration program.

Preparation of Test Capacitors

The detail components that make up the T-3 capacitor are the pressed and sintered powder tantalum anodes with an integral tantalum lead, the deep drawn tantalum cathode (case), the tantalum header with the tantalum lead hermetically sealed with a matched glass seal, the plastic anode support between the case and the anodes, and the nickel anode and cathode leads.

Anodes. . . The anodes for this program were pressed and sintered with a .020 in. diameter tantalum lead. Acceptance tests based on a forming voltage of 270 volts and a test voltage of 240 volts resulted in an average product of capacitance times voltage of CV (270) ≈ 4748. This rating produced a nominal 55 to 65μf capcitance at 60 volts operating voltage.

Headers. . . The header design provides for a matched glass-to-tantalum seal with .020 in. tantalum lead. A flange was drawn and trimmed to accomplish a resistance welded header-to-can seal. After the glass hermetic seal was made, the header was ready for attachment of the anode.

Cases. . . The capacitor case was deep drawn and trimmed. Platinum was electrolytically deposited on the inside surface of the prepared case to increase the case capacitance.

Assembly. . . After welding the header lead to the anode lead, the anode film was formed to a nominal 65μf, 60 volts device. Assembly of the anode/header, spacer and case was completed with the overlapping resistance weld of the peripheral header flange to the case. This operation was accomplished with electrolyte in place and the capacitor assembly heated. Welding of the nickel leads to the case and anode lead completed the assembly.

Test Requirements

Burn-in. . .All parts were subjected to burn-in operation at 85°C ± 5° with full rated 60 volts voltage for 54 ± 3 hours duration, followed by 18 ± 1 hour at 125°C with derated voltage, 40 volts applied. The aging circuit had a total resistance, exclusive of the capacitor, but including fuse wiring and internal impedance of the power supply of not more than three ohms under any operation condition.

Fifty-five parts and one copy of the inspection and test requirements, indicating limits of acceptance for all appropriate characteristics, were forwarded to NASA/ERC.

All parts were made from the same lot of materials and processed in "indian file" sequence through the same processes. "Process" is meant to include screen-in and burn-in.

Life Test. . .Fifty (50) capacitors of 60 volts, 65µf rating were operated for 3000 hours at rated voltage, 40 volts and at full rated case temperature, 125°C. without resistors in series with them.

Reading intervals were initial (at temp.), 24, 100, 250, 500 hours and at 500 hour intervals thereafter.

Characteristics read at stated intervals and at full rated temperature were capacitance, dissipation factor, leakage current and impedance. Parts were then reduced to room temperature (25°C) and weight readings made to the nearest 0.01 mg.

Reverse voltage tolerance test. . .Reverse voltage tolerance was evaluated at room temperature (25°C) utilizing 60 capacitors. The duration of this test extended to 3000 hours during which time 10 test group parts were biased with -1.0 volt in the reverse direction. A test group of 10 parts was biased in the reverse direction with -1.0 volt for 1511 hours, -1.5 volts for 528 hours and -2.0 volts for 461 hours. A test group of 10 parts was biased in the forward direction with 1.0 volt for 1511 hours, the polarity was changed to the reverse direction with -1.5 volts for 528 hours and -2.0 volts for 461 hours. Another test group of 10 parts was continuously biased with -5 volts in the reverse direction. A fifth test group of 10 parts was continuously biased with -10 volts in the reverse direction. The control group of 10 pieces was continuously biased with +1 volt in the forward direction.

All parts (test group and control group) were initially discharged for five minutes then established in their respective biased conditions.

Reading intervals were initial (prior to initial discharge), 24, 100, 250, 500 hour intervals thereafter. The -5V and -10V test groups were continuously monitored for case damage with readings taken hourly until the parts failed.

Characteristics read were leakage current, capacitance and dissipation factor.

Incremental ambient step stress test. . . An incremental ambient temperature test was performed on 30 capacitors. Fifteen (15) capacitors were operated at rated voltage, 40 volts, and full rated temperature 125°C as the stress base. An equivalent control group was operated in the same environment at 50 per cent of rated voltage, 20 volts. At intervals of 168 hours the temperature was increased 10°C over the previous stress temperature until the test was terminated at 195°C.

Prior to increasing the temperature, parts were read (at temperature) for leakage current, capacitance, dissipation factor.

Temperature cycling. . . Ten (10) capacitors of the test group were tested in accordance with Method 102A of MIL-STD-202C. The 10 control group capacitors were kept at 25°C and measured only at steps 1 and 5 of Table 1. The following details and exceptions applied:

1. Conditioning prior to first cycle - 15 minutes at room ambient conditions.
2. Test Condition D, except that in Step 3 capacitors were exposed to full rated temperature, 125°C + 3°C - 0°C.
3. Measurements of test group capacitors were according to Table 1.

Immersion . . .

Following temperature cycling, capacitors were tested in accordance with Method 104A of MIL-STD-202C, Test Condition B.

1. A non-corrosive dye, Rhodamine B (tetraethyl-rhodamine) was added to both baths.
2. Temperature of cold bath: $0^\circ\ {}^{+0^\circ}_{-5^\circ}$C.
3. Duration of each immersion - thirty minutes; changes from one bath to the other were made in not more than 3 seconds.
4. Measurement after final cycle - Between 30 minutes and 4 hours after removal from the immersion bath, DC leakage, capacitance and equivalent series resistance were measured at room ambient temperature.

Examinations after test - Capacitors were visually examined for corrosion, and tested for leakage of electrolyte with a universal indicator solution. They were then opened and examined for penetration of dye.

TABLE 1

TEMPERATURES AND MEASUREMENTS FOR STABILITY TEST AT LOW AND HIGH TEMPERATURES

Readings made at steps 1, 2, 4 and 5 after 15 minutes soak in those temperatures. Parts subjected to 5 complete cycles.

Step	Temperature	Test
1.	25°C	DC Leakage Capacitance Equivalent Series Resistance
2.	Min. rated Temp. $-55°C\ ^{+0°C}_{-3°C}$	Impedance Capacitance
3.	25°C	None
4.	Max. rated Temp. $125°C\ ^{+3°C}_{-0°C}$	DC Leakage Capacitance Equivalent Series Resistance
5.	25°C	DC Leakage Capacitance Equivalent Series Resistance

Surge voltage test. . . Ten (10) capacitors of the test group were subjected to 1000 cycles of 46V DC surge voltage. The 10 control group capacitors were kept on full derated voltage charge, 40 volts, in the same environment for the duration of the surge stressing of the test group. The ambient temperature during cycling was the full rated temperature, 125°C. Each cycle of the test group had a 30 second surge voltage application followed by a 5-and-1/2 minute discharge period. Voltage application was made through a resistance of 1000 ± 100 ohms in series with the capacitor and the voltage source. Each cycle was performed in such a manner that the capacitor was discharged through the 1000 ohm resistor at the end of the 30 second application.

Before and after the test, all capacitors were visually examined for evidence of mechanical damage and read for leakage current, capacitance and equivalent series resistance. Leakage of electrolyte was checked with a universal indicator solution.

Quality assurance. . . All components were made from the same lot or consecutive lots of materials and processed at the same time or in "indian file" sequence through the same processes, including screenings, burn-ins, etc.

Parts were randomly selected from the homogeneous groups for Test and Control groups. They were permanently serial numbered. All data is individually referable to these numbers.

Summary of test requirements. . . The test procedure is summarized in Table 2, using the following symbols:

W	weight
C	capacitance
D	dissipation factor
L	leakage current
ESR	equivalent series resistance
Z	impedance
RT	room temperature
TB	test bench
BAL.	balance
A	"Precision" - Freas oven
E	Wilson oven
F	Wyle chamber
a	regulated voltage source
b	" "
c	" "
d	four channel regulated voltage source
e	surge voltage timer

TABLE 2

TEST PROCEDURE SUMMARY

Qty.	Condition	Tests: Before	Tests: During	Tests: After	Equipment: Test	Equipment: Environment	Duration: Hrs.	Duration: Days
255	BURN-IN 1st. - 85°C, 60V 2nd. - 125°C, 40V Fused	W, C, D, L		W, C, D, L, ESR	a TB Bal.	A	54 18 72	3
50	LIFE 125°C, 40V Fused	Intervals-24, 100 250, 500 hrs. Tested After Burn-in	C, D, L, Z, W	C, D, L, Z, W	c TB Bal.	E	3000	125
 10 10 10 10 10 10	REVERSE VOLTAGE Test -1.0V Test -1.0V -1.5V -2.0V Test +1.0V -1.5V -2.0V Test -5.0V Test -10.0V Control- +1.0V Fused	Intervals-24, 100 250, 500 hrs. Tested After Burn-in	L C D	L C D	d TB	Ambient 25°C	3000 1500 500 500 1500 500 500 2/3 Failed 2/3 Failed 3000	125
15	STEP STRESS Test - 125°C, 40V Control - 125°C, 20V Increase Temp. 10°C at 168 hr. intervals Fused	Intervals - 168 hrs. Tested After Burn-in	L C D	L C D	a,b TB	A	2/3 Failed or 200° C max. 1312	55
10	TEMPERATURE CYCLING & IMMERSION Control- 25°C Constant	Tested After Burn-in	Step 1 L C,D ESR	Step 5 L C,D ESR	TB	Ambient 25°C	1	1
10	Temp. Cycling-5 cycles Step Temp. °C 1 25 2 -55 3 25 4 125 5 25 15 min./step	Tested After Burn-in	D,L,C,ESR D,L,Z,C, D, L,C,ESR D,L,C,ESR		TB	RT F RT F Rt	1^+	1

TABLE 2 (cont'd)

TEST PROCEDURE SUMMARY

Qty.	Condition	Tests			Equipment		Duration	
		Before	During	After	Test	Environment	Hrs.	Days
Test & Cont. from Temp. Cyc.	Immersion Cycles – 2 Duration 30 min. Baths: Hot 65° $^{+5°}_{-10°}$ tap water Cold 0° $^{+0}_{-5°C}$ Addition to baths Rhodamine B Transfer Time 3 sec. max.	Tested After Burn-in		Elapsed Time 1/2 hr. min. 4 hr. max. L C ESR @ RT	TB	A tap water bath brine bath	3	1
 10 10	SURGE VOLTAGE Control –40V Constant @125°C Test –46V 30 Sec. Surge 5 1/2 min. discharge Constant @125°C Series resistance 1000 ohms	 Tested After Burn-in		 L C, D ESR	 a TB b, e TB	 A	 100	 4

Test Procedures

Measurement of Capacitance and Dissipation Factor. . . The instrument used for these measurements was a General Radio Model 1617 Capacitance Bridge. This instrument was coupled with a test scanner and auxiliary power supply which allowed sequential selection of each 10 test capacitors which were installed on a carrier tray. The design of the scanner and auxiliary equipment provides for a five-point measurement on each capacitor, reducing to negligable amounts the effect of stray capacitance and lead resistance due to connection to the test device.

A capacitor can be thought to consist of reactive and resistive elements which may be considered as series (Cs and Rs) or parallel (Cp and Rp) parameters. The actual parameter measured by the GR Model 1617 Capacitance Bridge is Cp. The relation between Cp and Cs is:

$$Cs = Cp\ (1 + D^2)$$

Where D is the dissipation factor.

It can be seen from the following table that when D of a capacitor is small, the error introduced by using Cs or Cp interchangeably is negligble.

Consider a 65 μf capacitor.

When Df is	and Cp is	Cs is	Error
0%	65μf	65μf	0%
1%	65μf	65.0065μf	.01%
5%	65μf	65.1625μf	.25%
10%	65μf	65.65μf	1%

DC leakage current. . . D. C. Leakage current of each device was measured using the scanner with a Keithley Model 410 Micro-microameter Serial No. 259 connected in the system. The stability of the auxiliary power supply was sufficiently high to make negligible the effect of charge (discharge) currents due to variation in power supply voltage. This current, I charge = $C\frac{de}{dt}$, due to the rate of variation of supply voltage, can be sufficiently large to introduce a substantial error in the measurement unless this precaution was taken.

Additionally, all insulation used in the system had sufficiently high insulation resistance to provide a total system leakage resistance in excess of 10^{11} ohms. Measurements of 0.1 microamperes at 100 volts was thus made to an accuracy of 1% with the test scanner and test power supply.

Measurement of Equivalent Series Resistance and Impedance. . . These measurements were not performed directly with the Model 1617A Capacitance Bridge, but were calculated from the measured values of C and D. Where these measurements were required, the values of C and D were also recorded.

Voltage . . . All test voltage sources were fitted with individual voltmeters to indicate operation voltage levels and gross changes should they occur. Additionally, each source was equipped with a jack to allow calibration and precise adjustment utilizing a suitable transfer standard.

Time. . .The surge voltage test required the charge and discharge of the test capacitors at precise time intervals. The control circuitry to accomplish the test utilized timers driven from synchronous motors whose accuracy is proportional to the frequency stability of the power line. The line frequency was sufficiently accurate and stable to constitute a satisfactory time reference for a test of this type.

Temperature measurement. . . The temperature of the various ovens was continuously monitored with suitable thermometers, after initial zone calibration with thermocouples of traceable accuracy.

Prior to operation of any of the temperature tests, each test chamber was loaded in its usual manner, and fitted with a minimum of nine (9) thermocouples. The thermocouple array was specified to locate one TC in each corner and one in the center. The corner thermocouples were no more than three inches, nor less than two inches away from the chamber walls. After a suitable time has been allowed for temperature stabilization, the thermocouples were scanned and the temperature at each point determined. The total chamber gradient at each test temperature was determined from the data thus presented, and was within the acceptable temperature variation.

Weight measurement. . . Each capacitor was weighed at the time it was serialized to the nearest .01 mg at 25°C on a Sartorius Digital Analytical Balance Type 2604. Weights of the undamaged capacitors were taken again after Life Test, Reverse Voltage Test, Incremental Ambient Step Stress Test, and Surge Voltage Test. Weight deviations were expected to be positive indications of electrolyte leakage but visual observation provided a superior and absolute criterian.

Visual examination . . .Visual examination of test capacitors incorporated, in addition to use of electrolyte leakage indicators, the gross dimensional changes resulting from expansion of the electrolyte and gasses, the physical changes in the glass seal including chipping and cracking, the integrity of the weld seal and lead welds, and any other random changes which could be identified at 10 X magnification.

The test units were visually examined at all transfer points such as loading and unloading, except where speed of transfer obviated capability of examination such as in Immersion Tests.

Test Equipment

The major items of test equipment are tabulated in Table 3 and described in the following section.

Test trays. . . Test trays were made from G-11 glass epoxy laminate fitted with clips to hold the test capacitors. A second set of clips was provided to accomodate installation of pig-tail fuses or load resistors as required. An output connector was provided allowing two connections to be made to the positive end of each capacitor, one directly to the capacitor clip and the second to the capacitor clip through the clipped-in fuse. On the "common" side of the capacitor clips, one lead was brought out from each side of the common bus. The resulting four leads to each capacitor constituted a four terminal connection allowing the measurement of dissipation factor to be made with negligible effect due to lead and contact resistance.

For tests where parameter measurements were made at temperature, the chamber was fitted with back-to-back wired connectors and a shorting plug inserted in the outer connector. For parameter read-out, the shorting plug was removed and a test head connected to the test scanner inserted in its place. The operation of the test system was then the same as if the test tray were inserted directly into the scanner. The positive leads (current and potential) in the test head cable were shielded and guarded to overcome the effect of stray capacitance. This feature, together with the fourpoint wiring preserved the integrity of the measurement whether it was made by testing the components inside the chamber or by inserting directly into the scanner.

A schematic diagram and photograph of the test tray are shown in Figures 1 and 2.

Burn-in, surge voltage and step stress oven. . . A "Precision" - Freas Model 625A mechanical convection oven, Figure 3, was fitted with an array of back-to-back wired connectors to allow installation of sixteen test trays, and to operate them under controlled conditions of voltage and environmental stress. The wiring of the array provided parallel application of the burn-in voltage to all the test devices, each connected in series with a 1 ampere fuse. One power-supply could thus power the entire load, with protection provided through the individual fusing of each test position. The total resistance in series with each test device did not exceed 1 ohm.

Life test oven. . . The life test was conducted in the Wilson B1503

TABLE 3

TEST EQUIPMENT

Description	Manufacturer	Model	Serial No.
Capacitance Bridge	General Radio	1617A	343
Micro-Microammeter	Keithley	410	259
Precision Balance	Sartorius	2604A	142943
Power Supply-100V	Hewlett-Packard	6299A	7M0645
Power Supply Multiple Low Voltage	Frey	PS 1164M	Special
Power Supply-100V	Electronic Measurement Co. Inc.	224 AM	3209
Power Supply-150 V	Electronic Measurement Co. Inc.	229 AM	8431
Power Supply	Sorensen	DCR 300-5A	652
Capacitor Test Scanner	Frey	CTS 1161	Special
Test Trays	Fansteel	11600B	1-26
Oven-Mech. Convection	"Precision"-Freas	625A	15-1396-X6
Oven-Mech. Convection	Wyle	C106.640B	101
Oven-Mech. Convection	Wilson	B 1503	Special

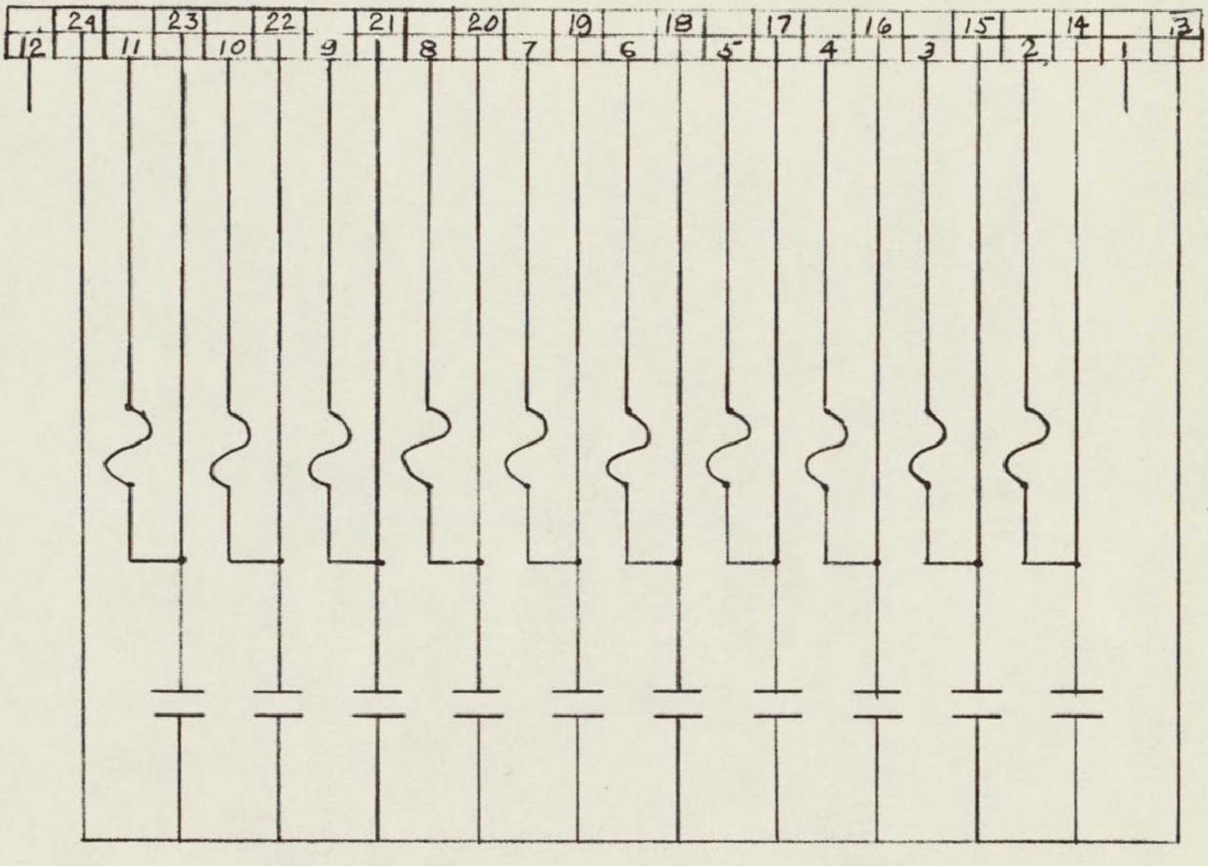


FIGURE 1. Test Tray Wiring Schematic

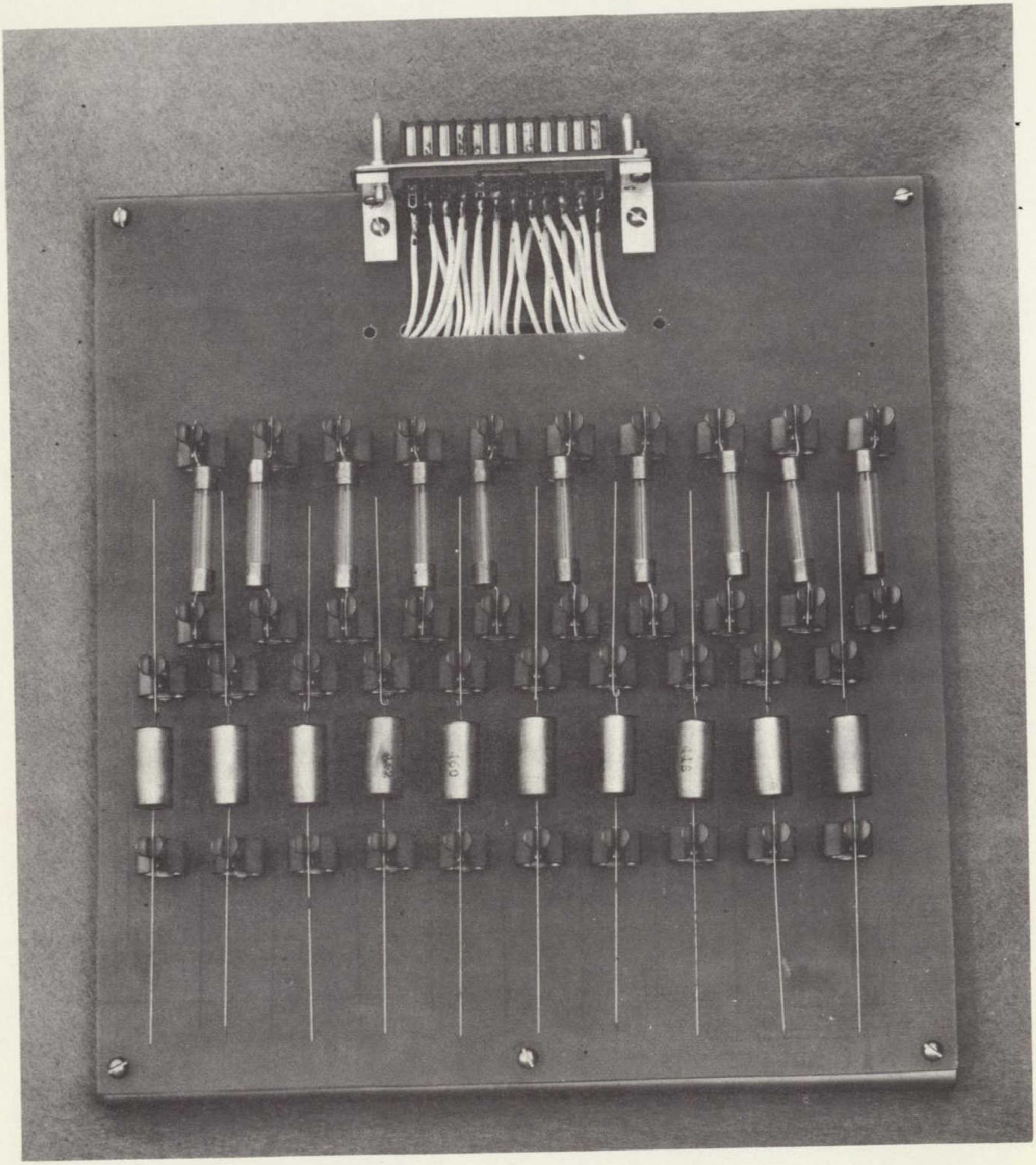
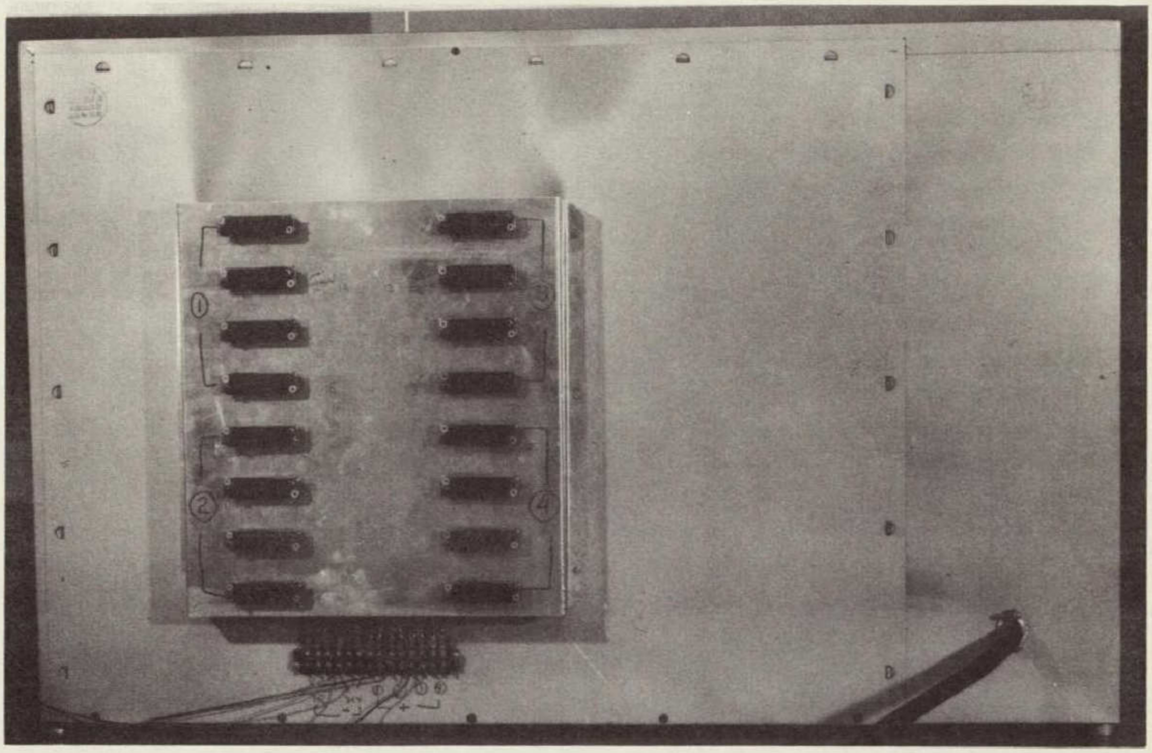


FIGURE 2. Test Tray



"Precision" - Freas mechanical convection oven connectors

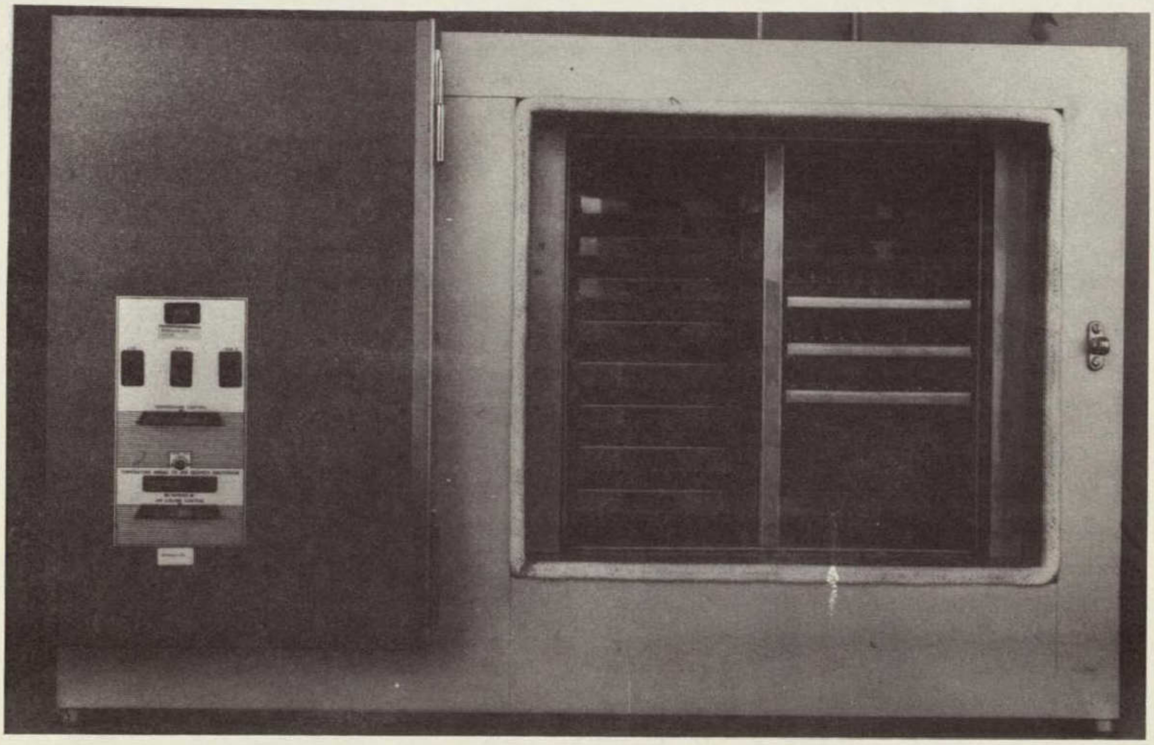


FIGURE 3. Three trays plugged into the "Precision" oven

mechanical convection oven Figure 4, that was fitted with back-to-back wired connectors, allowing access to each test tray from a remote testing location. For the powered life test, shorting plugs installed in the outer connector electrically connected each test capacitor in series with its protecting fuse to the life test voltage source. For parameter read-out with the capacitors operating at temperature, the shorting plug was removed and was replaced by the scanner test head.

Temperature cycling oven. . . The temperature cycling test was conducted in the Wyle Model C106-640-B mechanical convection oven, Figure 5, fitted with a solenoid valve and CO_2 source. The door of the chamber was fitted with feed-through wiring to connectors, allowing power application and parameter measurements.

Portable test bench. . . The capacitance bridge, microammeter, power supply and test scanner were mounted on a portable test bench, Figure 6, to provide convenient access to the ovens and ambient test rack positions through a conductor harness.

The capacitance test bridge, General Radio Model 1617A, was used to measure C and D directly and to measure ESR and Z indirectly (by computation from measured values of C and D). The accuracy of the bridge is as follows:

Capacitance (Range 0 to 0.11F)	±1% ±1 pF, smallest division 2pF; residual ("zero") capacitance approximately 4pF.
Dissipation Factor (Range 0 to 10)	±0.001 ±0.01C (in F) ±2%

The measurement power supply, Hewlett-Packard Model 6299A (MPB-3) maintained the following limits:

Regulation Line - 0.01% + 2 mv (change from 105 to 125V)
Load - 0.01% + 2 mv (no load to full load)

The test scanner, Frey Model CTS 1161, consisted of a shielded and guarded switching assembly that allowed the application of a soak voltage to all the capacitors on a basic test tray (10 units) and the individual selection of each position for the measurement of capacitance, dissipation factor and DC leakage current.

A three position switch labeled "Test" - "Off" - "Charge-Discharge" was provided to allow the components on the test tray to be charged to the programmed test voltage or discharged to zero volts through individual series 1000 ohm resistors. When in the "charge-discharge" position, push button switches allowed accomplishment of the desired function. In the "test" position all parts were connected to the soak voltage, until the position selector was switched to a component line. In this case the selected capacitor was switched from "soak" and connected

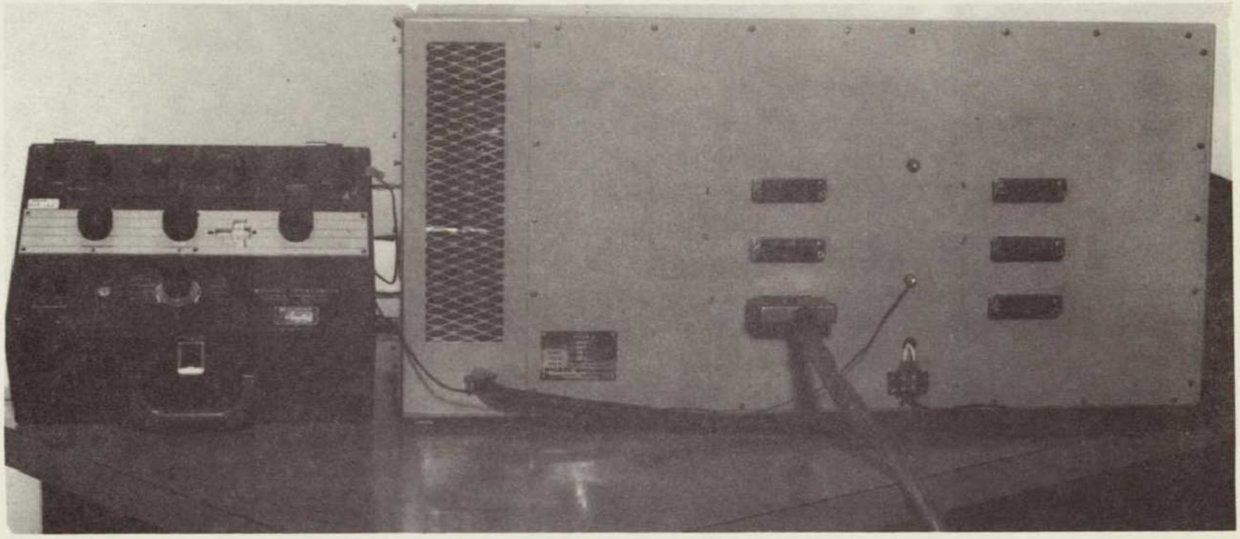


FIGURE 4. Wilson mechanical convection oven
Illustrating back-to-back connectors

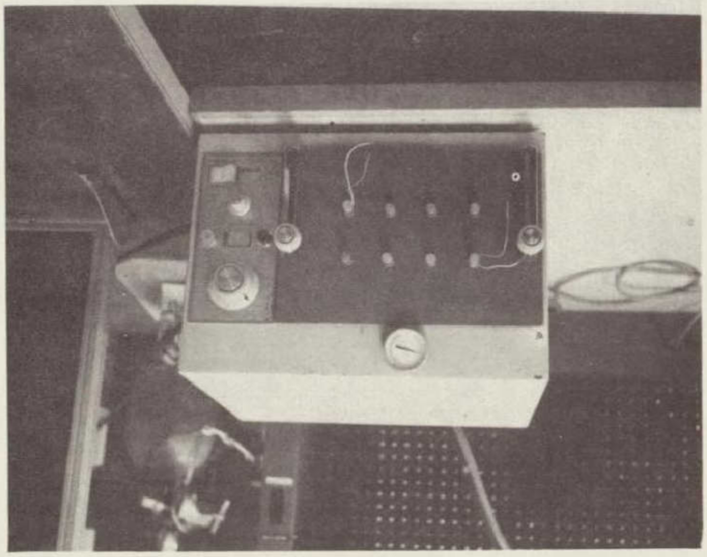


FIGURE 5. Wyle mechanical convection oven with CO_2 cooling.

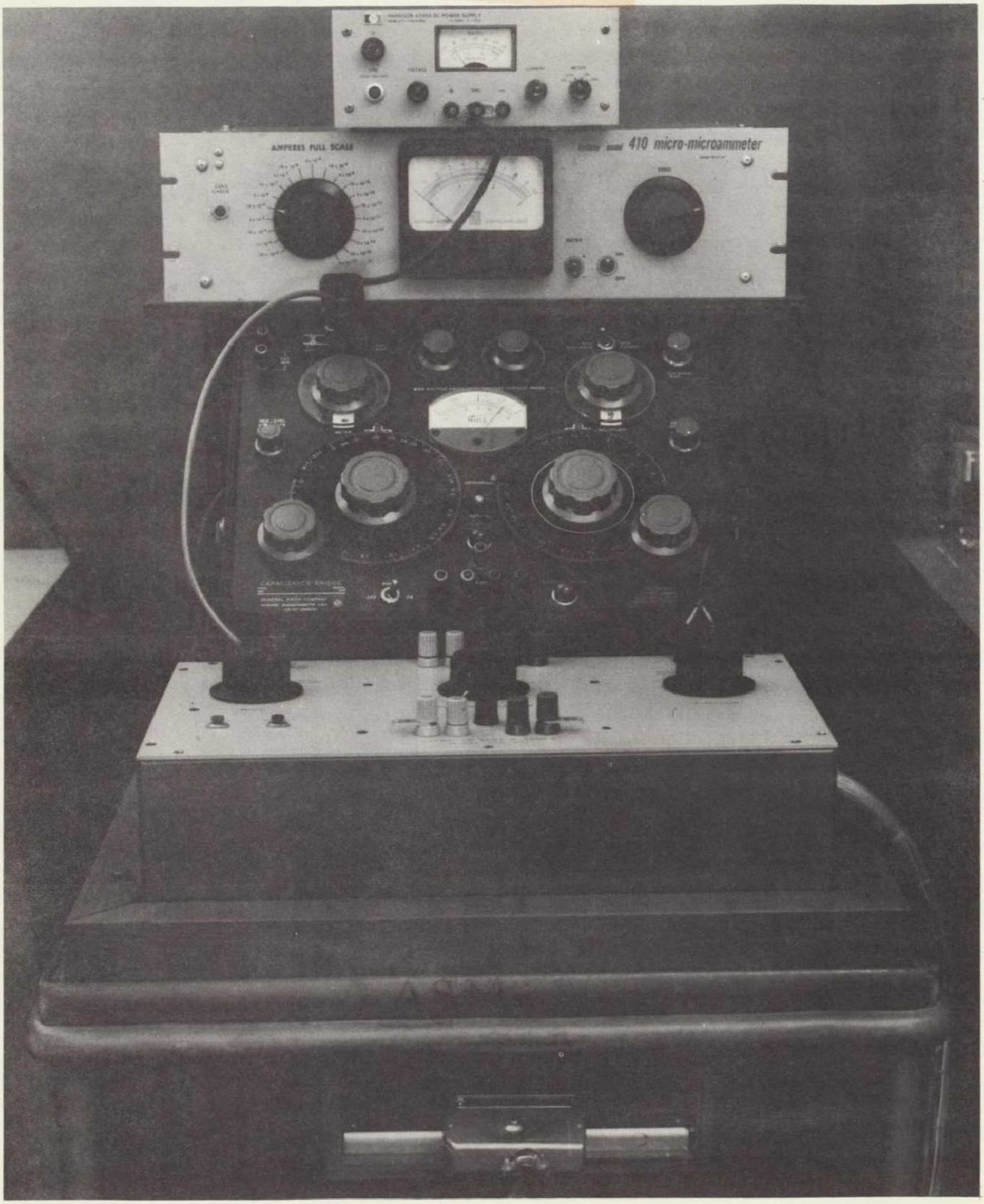


FIGURE 6. Portable Test Bench

to the bridge terminals. As the test power supply provided both the "soak" and "test" voltage, no transients occurred when switching. The charge-discharge resistors similarly prevented the occurence of any transients when either of these functions were required. The schematic of test scanner is shown in Figure 7.

Room ambient rack. . . The room ambient rack was wired in a manner identical to the life test oven. This rack relied on the plant environmental control system to maintain a constant 25°C ambient condition.

Surge voltage timer. . . The surge voltage timer control, Frey Model PCC1160, consisted of two panel mounted electro-mechanical timers connected in a "flip-flop" circuit and a cycle counter, Figure 8. Timer A was adjustable from 0-60 seconds and timer B, from 0 to 10 minutes. The two timers controlled a contactor which allowed application of charge voltage for 30 seconds followed immediately by the discharge cycle of 5-1/2 minutes. For this test, the test trays were fitted with 1000 ohm ± 10%, 5 watt resistors in lieu of the fuses. Charge and discharge thus occurred through the 1000 ohm resistor in series with each test capacitor.

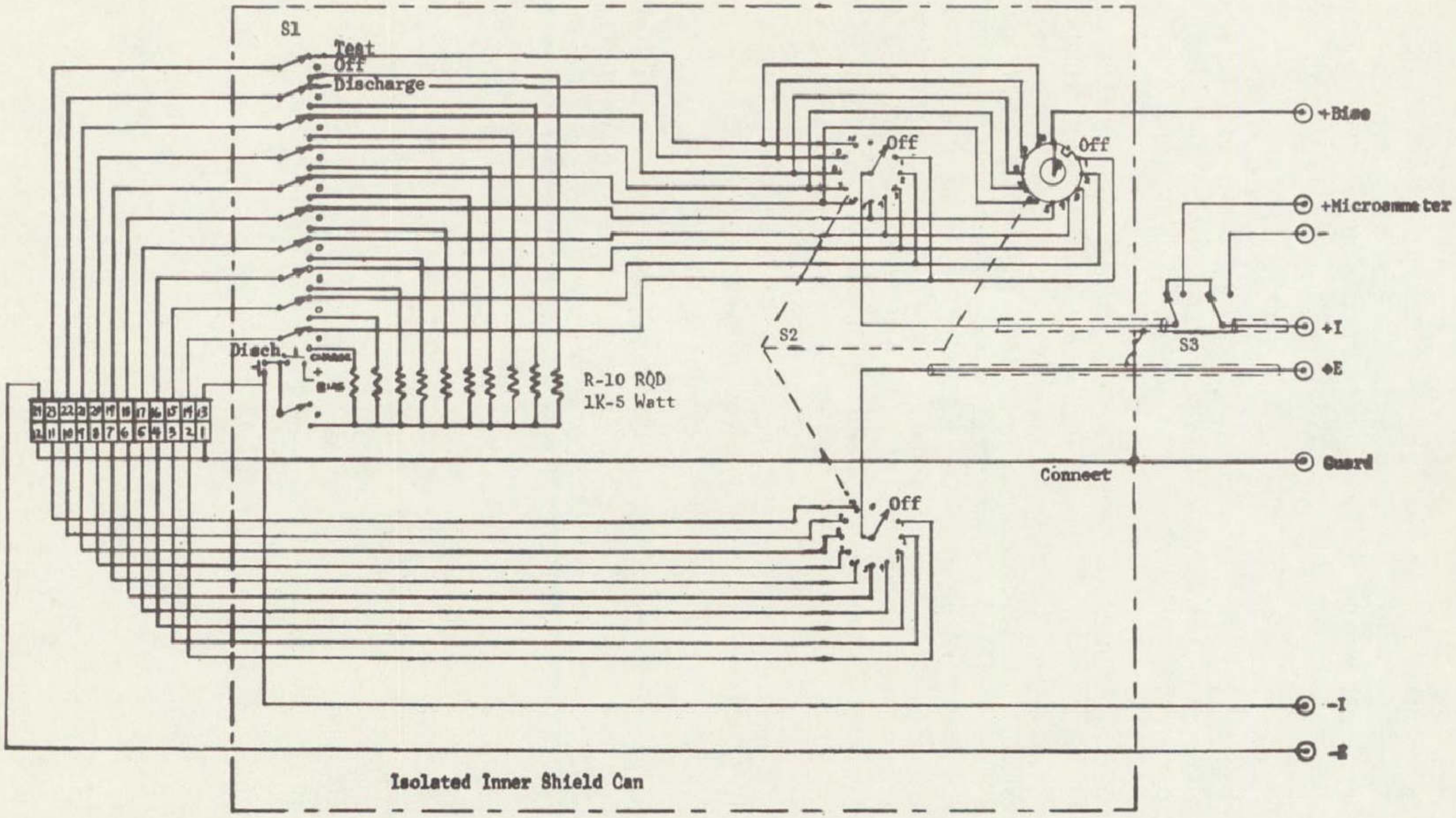
The cycle counter provided an accurate indication of the elapsed power cycles. A schematic of the surge voltage timer is shown in Figure 9.

Low voltage power supply. . . A special low voltage regulated power supply, Frey Model PS-1164M, Figure 10, was designed and constructed to provide regulated forward and reverse voltage during the Reverse Voltage Tolerance Test. It was designed to the following specifications:

Input Voltage·	115V, 60 cycles, 100 watts
Output Voltage:	2 channels 0.5V to 8V @ 2.54 ADC 2 channels 0.5V to 14V @ 1.5 ADC
Regulation line:	Change 105 to 125V, reg. ± 0.1%
load:	No load to full load, reg. ± 0.1%
Output Impedance:	0.01 ohm DC to 100 H_z

Automatic short circuit protection: individual voltage calibration controls: floating outputs, (ground positive or negative terminal), meter, range switch and channel selector switch.

During the Reverse Voltage Test, Channel 4 was revised to provide a voltage of 0 to 15 volts to accommodate the increase in test modes available at one time. One tray was maintained at +1.0V, one at -1.0V, and two trays were put on -1.5V, then -2.0V.



FUGURE 7. Test Scanner Schematic

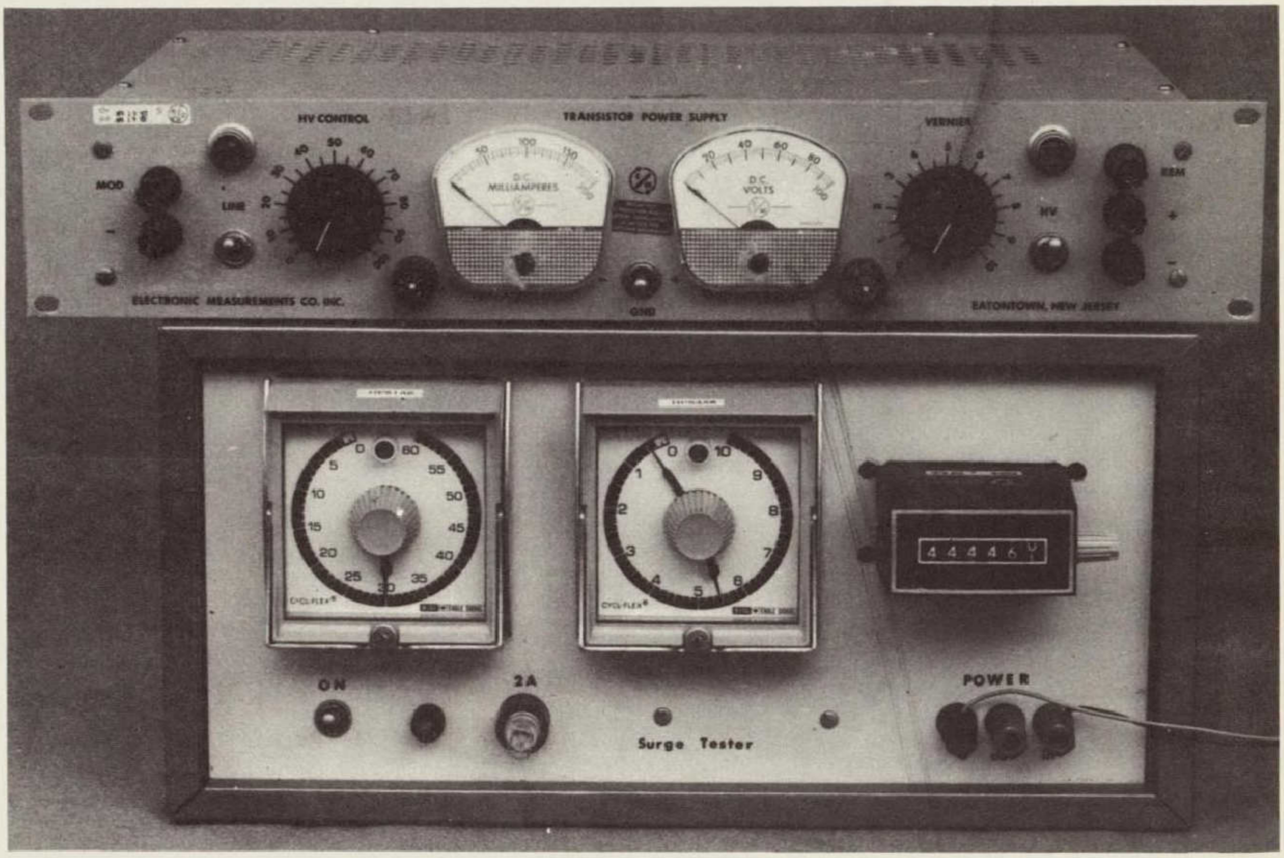


FIGURE 8. Surge Voltage Timer and Power Supply

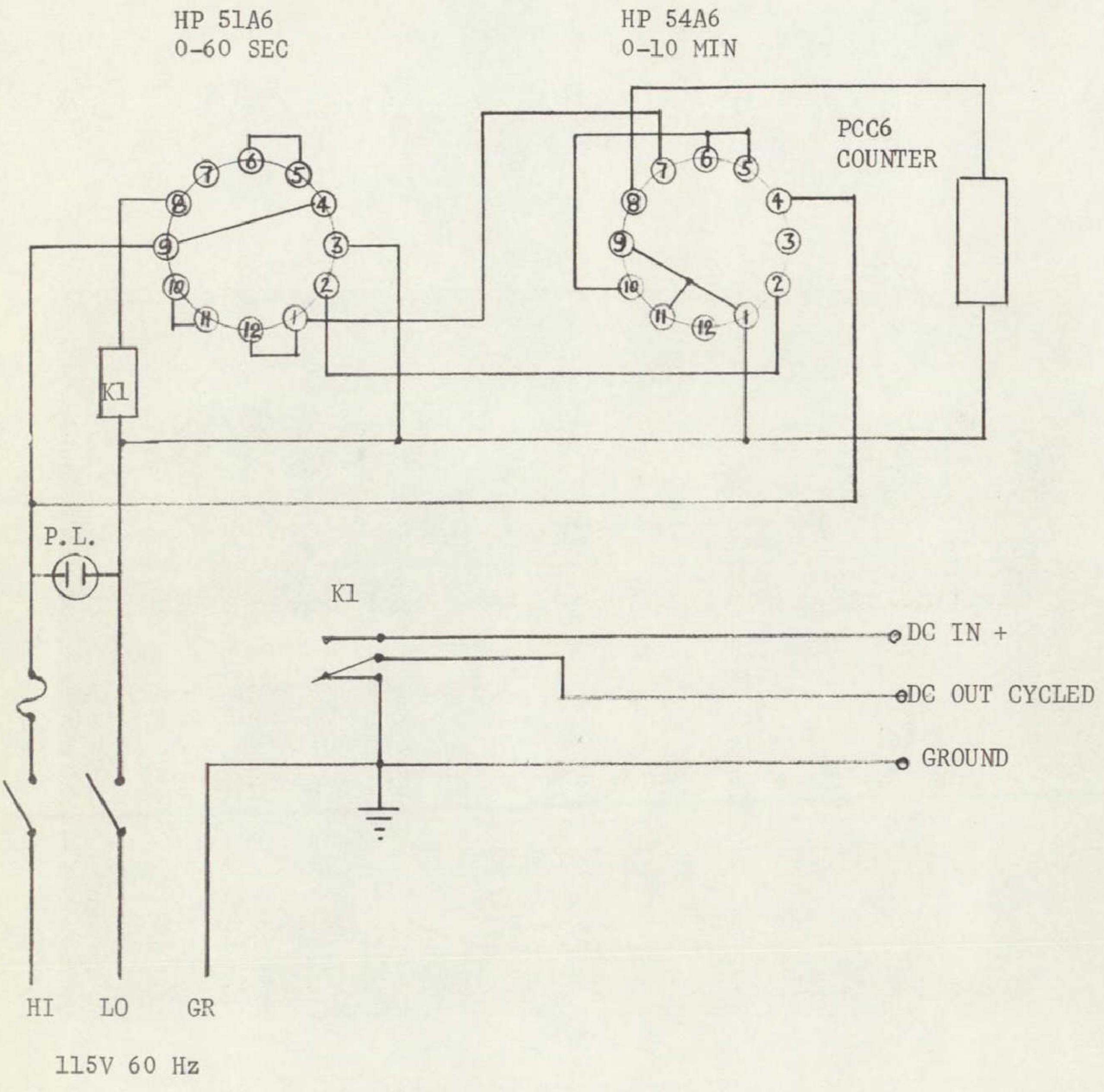


FIGURE 9. Surge Voltage Power Cycle Controller

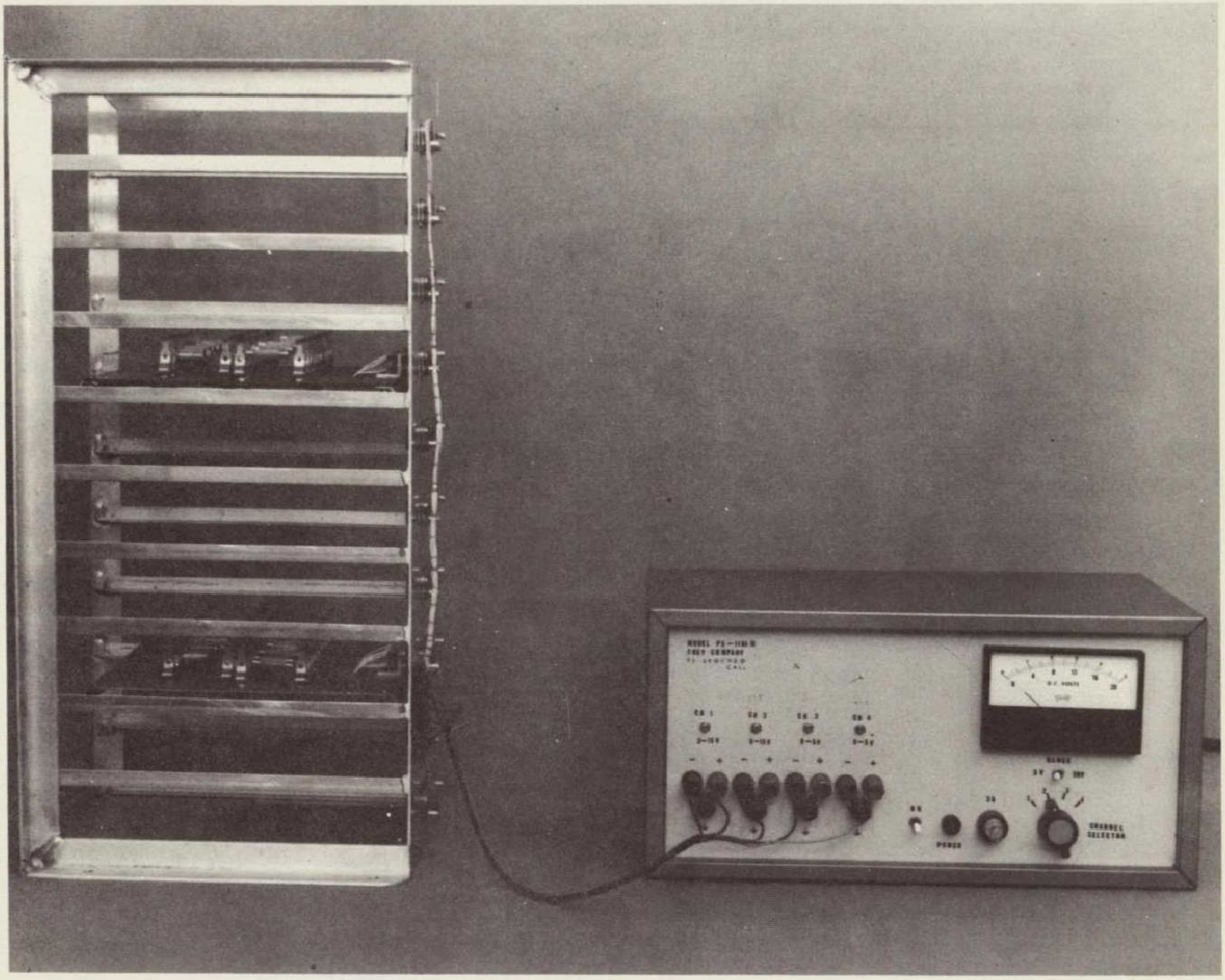


FIGURE 10. Low Voltage Power Supply and Test Rack

Test power supplies. . . The environmental test power supplies met the following general specifications:

(a) Voltage Regulation Line and Load - ± 1%

(b) Output Impedance - Less than 1 ohm, DC to 100 CPS

(c) Ripple Voltage - Less than 100 mV RMS

This requirement for the ripple voltage specification was that the AC current in the capacitor resulting from the ripple be held to a negligible effect on the reliability of the capacitor.

Precision balance. . . A Sartorius balance capable of reading to .01mg measured the weights of the completed capacitors before and after testing.

Failure Criteria

Mechanical. . . Mechanical failure was defined, for the purpose of this program, as electrolyte leakage or broken leads. Electrolyte leakage was established by weight loss and/or visual appearance of electrolyte verified by pH tests.

Broken leads were established by visual examination and/or electrical continuity check.

Dimensional changes were reported but did not constitute failure except as they effect mechanical failures.

Electrical. . . Electrical failure criteria was defined as variation beyond the following limits of leakage current, equivalent series resistance and capacitance range.

Maximum DC Leakage. . .

+25°C:	2.04µa
+85°C and 125°C:	16.3µa

Maximum Equivalent Series Resistance. . . 6 ohms

Capacitance Change. . .

-55°C	-32%
+85°C:	+14%
+125°C:	+16%

RESULTS OF TESTS

Burn-In

Summary of Data. . . A total of 469 capacitors were put on the Burn-In test yielding 242 acceptable units for additional test, or a 52% yield. Of the 242 units accepted, 24 units exceeded 2μa D.C. leakage at 25°C. The 227 rejected parts were all mechanical failures, primarily electrolyte leakage in the glass seal. Three units had internal electrical shorts.

Test data for all units committed to the Burn-In Test is tabulated in Appendix A.

Equivalent series resistance. . . In all cases the equivalent series resistance measured less than 6 ohms, ranging from a minimum of .345 ohm to 1.767 ohms, with the major grouping between .5 and .7 ohms.

Capacitance change after burn in, measured at 25°C, decreased appr&ximately 2%.

Mechanical integrity of the case, header, leads and seal weld of the header to the case was, without exception, acceptable.

Glass-to-Tantalum seals. . . Analyzing the glass seal leakage problem that has been so evident during the progress of this program, a matched seal, wherein there is a chemical bond between the glass and the tantalum, was consistantly confirmed. The failures ocurred in in the glass body, not in the glass-to-tantalum seal.

Extensive development of glass formulations, fusing parameters, metal preparation and dimensional studies prior to this program resulted in the header design utilized in this T-3 package. It was not until the capacitor manufacturing processes were optimized for the purpose of producing test units on this program that the glass failure was recognized as a trend rather than as isolated results of process variations. This led to the following stress analysis of the glass/header subassembly.

The glass failure occurred in a generally diametrical pattern, not necessarily initiating at the lead or passing through the lead-to-glass seal. Annealing did not eliminate the failure or change the mode of failure. Calculating $\frac{ID}{OD}$ ratio of the tantalum header at the seal area required to produce zero tensile forces in the glass according to Dr. H. Adams equation (ref):

$$\frac{ID}{OD} = \left[\frac{1 - \frac{Eg}{Em}}{1 + (1-2\ \mu m)\ \frac{Eg}{Em}} \right]^{1/2}$$

Where: Eg = modulus of elasticity of glass
Em = modulus of elasticity of tantalum
μm = Poison's ratio of tantalum

yields $\frac{ID}{OD}$ = .712 for this glass-to-tantalum system.

The tantalum thickness of .006 in. and ID of .100 in. utilized in this design yield and $\frac{ID}{OD}$ ratio = .893, or 25 per cent greater than the theoretical zero stress ratio. Maintaining the existing design ID, a zero tension condition in the glass would require a tantalum thickness of .020 in.

Because of the long manufacturing lead time required to produce the optimum header thickness, it was not possible to incorporate the redesign in this program without interrupting the program schedule. There exists a high probability that mechanical failures would have been drastically reduced with the incorporation of the .020 thick header, enhancing the experimental data by increasing the sampling size.

Life

Summary of data. . .Of the 50 capacitors committed to Life Test at 125°C, 40V, a total of 16 failed, 12 by glass seal leakage, 4 by high D.C. leakage at temperature and 1 by internal shorting. A summary tabulation Table 4 is graphed in Figure 11. Test data is in Appendix B.

It can be seen that the internal D.C. leakage can occur randomly during the life cycle. Mechanical glass failure occurred primarily in the first 500 hours.

Analysis of the glass failures again verified a good matched chemical seal, with failure due to tensile fracture in the glass body.

The intermittant nature of the D.C. leakage on units that were classified as failures indicated a minute breakdown in the anodic film on the tantalum anode. Analysis of similar units discussed in the Reverse Voltage section confirmed this type of failure.

Reverse Voltage Tolerance

Summary of data. . . Applied voltage in the reverse direction caused increasing D.C. leakage in excess of the maximum specified

TABLE 4

LIFE TEST SUMMARY

TIME	TRAY NO.					TOTAL FAIL		
Hrs.	1	2	3	4	5	No. & Mode	This Test	Accum. Fail
0							0	0
24	-6 L		-6M	-6M	-7M	1L, 3M	4	4
115							0	4
282			-1M, -5M	-1M	-6L	3M, 1L	4	8
500			-4M, -8M		-5M	3M	3	11
1192							0	11
1505	-4S					1S	1	12
2007							0	12
2511					-3M	1M	1	13
3015				-3L	-2M, -4M	1L, 2 M	3	16
TOTAL	2	0	5	3	6		16	16

L = D.C. Leakage

M = Mechanical Failure (Glass)

S = Short

Example: -6M designates the device position 6 on the tray number heading the column and the type failure M, mechanical.

LIFE TEST

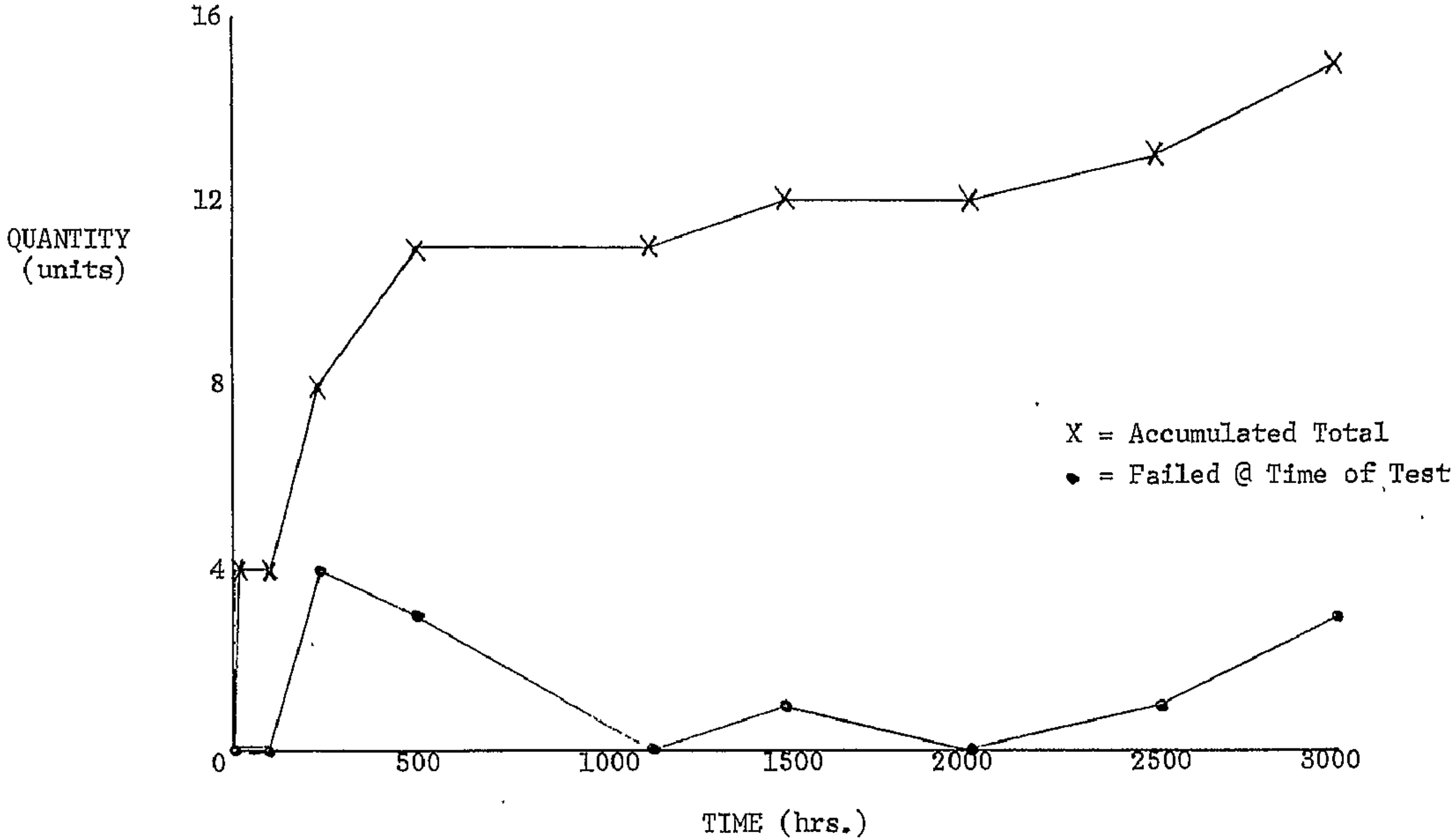


FIGURE 11.

with increased time and voltage. Reverse voltage in excess of 1.0 volt caused high failure rates in less than an hour at -5.0 volts and -10.0 volts, and within 519 hours at -1.5 volts. Tables 5 and 6, Reverse Voltage Tolerance Failures, illustrate these results.

Continuous reverse voltage not exceeding one volt has some deleterious effect on D.C. leakage as evidenced by the 30 to 50% failure at up to 1500 hours on trays 9 and 8 respectively. However, reversal of polarity may minimize this adverse effect.

A final test after the 3000 hours of trays 8, 9, 10 and 11 was made after 18 hours soaking at 25°C, 60V straight polarity to determine the effect of continuous reverse voltage on normal operation voltage and polarity. It can be seen from Table 6, Failure Reversals, that out of six devices which had previuously exceeded 2.04 μa D.C. leakage and returned to within limits, three did so after polarity reversal.

No evidence of platinum migration was found. It is more probable that the anodic oxide film failure cured itself by reforming at reversal of voltage back to straight polarity.

That three out of twenty devices are within acceptable leakage limits after 2500 hours is evidence that the device will tolerate intermittant voltage reversals up to -2.0 volts. Test data is in Appendix C.

Failure analysis. . . Electrical measurements were made on the units that failed at -5.0V and -10.0V and the data obtained is contained in Table 7. On several of the units the dissipation factor varied with the position of the capacitor during test. Such behavior is generally associated with a shortage of electrolyte, since as the position of capacitor is altered from horizontal to one vertical position or the other, the anode capacitance is in series with a varying cathode capacitance and the series resistance in the electrical network will vary. This was later verified by drilling a hole in the capacitor case, and removing the electrolyte with a hypodermic needle, and observing the electrolyte volume.

The D.C. leakage was very high on all but two units, and it was out of the specification limits on these two. Where D.C. leakage was in the milliampere range, the test voltage was applied for only 15 seconds. With such high leakage levels, the gas build-up in the capacitor could cause it to blow-up. Longer voltage application would not reduce the leakage substantially.

When the electrical measurements were completed the capacitor case was pierced with a hole, the electrolyte removed, and the case carefully cut open at the seal. This operation was carried out using a lathe and a cutting tool. When completed the anode which was connected to the anode lead and seal could be removed from the case. Every effort was

TABLE 5

REVERSE VOLTAGE TOLERANCE FAILURES
AT -1.0V, -1.2V, and -2.0V
D.C. Leakage ≥ 2.0 μa

TRAY NO.	CONTROL 11	9	10			8		
Applied Voltage	+1.0	-1.0	+1.0	-1.5	-2.0	-1.0	-1.5	-2.0
Time								
0								
24		2						
100						1		
244						3		
524								
1007						1		
1511		1						
			(10)			(5)		
1679				3			2	
2039				3			1	
				(4)			(2)	
2183					1			
2519					2			
3000		1						
FAIL	0	4	0	6	3	5	3	0

( )→ Indicates remaining acceptable units to next test condition

TABLE 6

REVERSE VOLTAGE TOLERANCE
FAILURE REVERSALS

TRAY No.	CAP No.	FAILED hrs.	FAILED mode	OK @ hrs.	FAILED	NET GAIN
8	297	244	L	2519		
8	294	244	L	3000		
9	326	Initial	L	244	Final	
9	324	24	L	Final		
10	342	24	L	Final		
10	339	2039	L	Final		
10	333	2519	L	3000		
Total				7	1	6

TABLE 7

REVERSE VOLTAGE TOLERANCE FAILURES
At -5.0V and -10.0V

CAP. No.	TEST VOLTS	TYPE OF FAILURE	CAPACITANCE µFD	D DIAL	D.C. LEAKAGE @ 25°C, 60V µa		
					2 min.	15 sec.	Open Beaker
252	-10V	Fuse	61.6	4.0	Shorted		
253	-10V	Case Bulge	70.0	10.5	40.0		
256	-10V	Fuse	58.0	4.3		3.0	
257	-10V	Electrolyte Leak.	56.0	2.7	42.0		
258	-10V	Fuse	64.0	2.0		1.0	
259	-10V	Voltage Dropped	59.2	5.8		6.5	
260	-10V	Voltage Dropped	58.2	9.2		2.5	
264	-10V	Fuse	59.5	3.2		3.5	
266	-10V	Fuse	65.0	4.8		2.0	
268	-10V	Fuse		8.6		3.5	
270	-5V	Electrolyte Leak.	56.8	1.0	9.0		Scintillated
272	-5V	Electrolyte Leak.	53.7	2.7		1.0	
273	-5V	Fuse	55.2	2.0	26.0		
275	-5V	Electrolyte Leak.	58.0	4.4	400.0		
276	-5V	Electrolyte Leak.	56.0	3.0		3.0	Scintillated
250	-5V	Case Bulge	56.0	2.4		3.5	
282	-5V	Case Bulge	55.5	1.9		1.0	
283	-5V	Case Bulge	55.2	1.3	64.0		Scintillated
284	-5V	Electrolyte Leak.	56.2	1.5	90.0		
286	-5V	Voltage Dropped	54.2	1.1	5.0		Scintillated

made not to damage the anodes mechanically. The cases and anodes were examined visually under a microscope. The platinum black coating on the cases was in excellent condition. There was no indication that the coating had come off during the test. The anodes showed no discoloration or areas where scintillation had occurred. The anode color was good. An open beaker D.C. leakage measurement was taken on four anodes including the two lowest leakage units at 60 volts in 21% sulfuric acid. In each case scintillation occurred, indicating a poor quality anodic film. Although it is possible that mechanical damage might have occurred during the time the anode was being removed from its case there was no visual indication of this. The more probable explanation is that damage to the anodic film occurred during the reverse voltage test.

Incremental Ambient Step Stress

Summary of data. . .Electrolyte leakage at the glass seal caused 11 out of 12 failures in the test group of 15 units and 11 out of 13 failures in the control group of 15 units. Two-thirds of the test units had failed after 1032 hours at the temperature plateau of 175°C and two-thirds of the control units, had failed after 1368 hours at the 195°C maximum test temperature. This reduced failure rate of the control group at one-half rated voltage indicates a possible effect of voltage on elevated temperature life. Table 8 tabulates the time and mode of failures. Experimental Step Stress Test data is in Appendix D.

Figure 12 illustrates a marked slope change in the Accumulated Totals curves at 528 hours and 145°C in both the test and control groups. This change indicates a maximum stress level on the glass seal caused by expansion of the electrolyte rather than any electrical change since the failures are primarily mechanical. By having the glass under compression with the redesigned header utilizing thicker tantalum, a higher stress temperature could be tolerated.

Temperature Cycling and Immersion

Summary of data. . .The temperature cycling and immersion test results revealed no weaknesses in the devices. In both test and control groups all of the devices increased or remained the same in capacitance except one in the control group. Similar results were observed in the D.C. leakage measurements. Where unit No. 440 had a high D.C. leakage initially, it increased during testing. No mechanical failures were evidenced.

Examination of the internals of the capacitor revealed no die penetration after testing. The anodic film color was good and continuous. The platinum deposit on the interior of the case was intact and continuous.

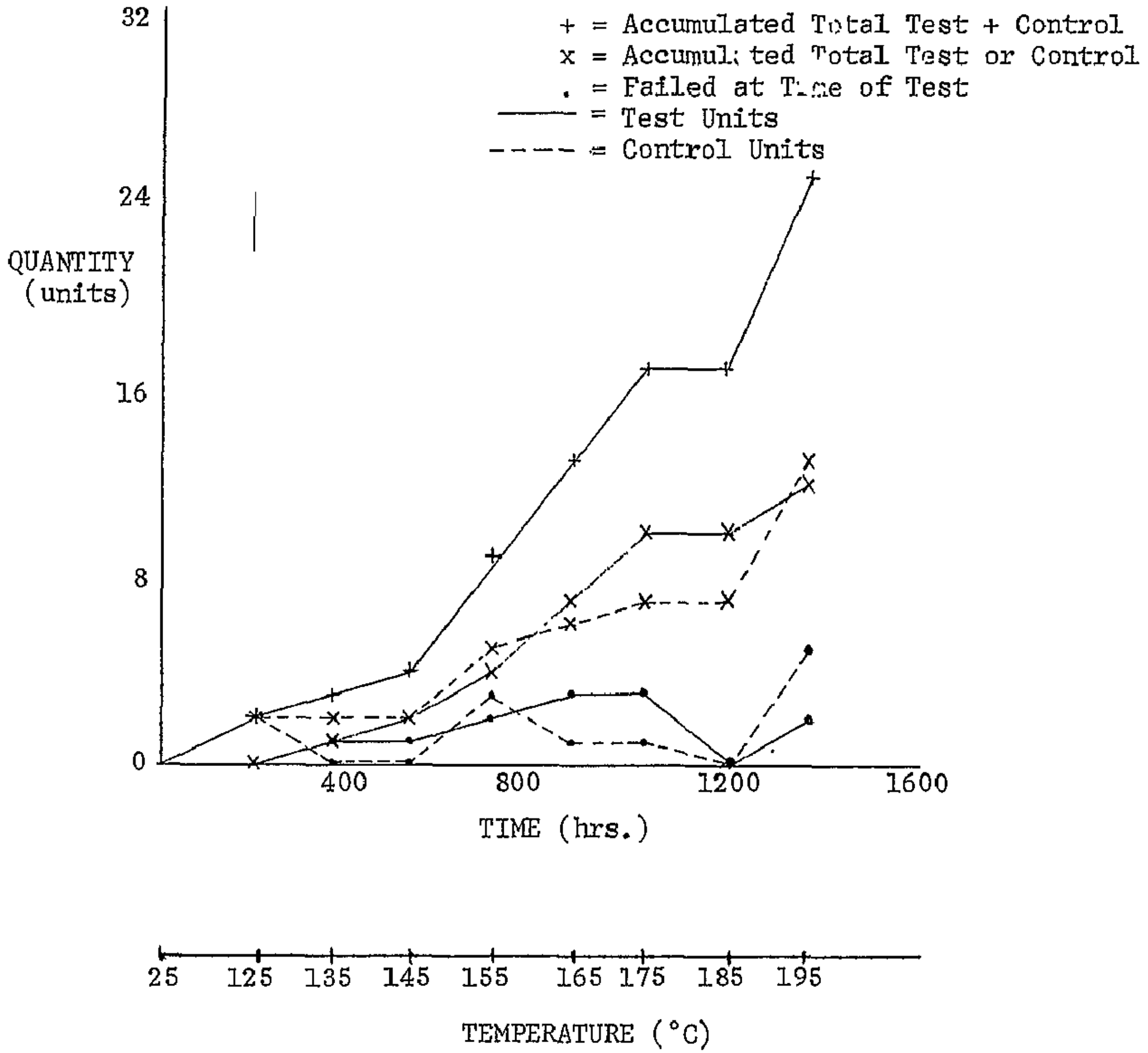
Test measurement data is in Appendix E of this report.

TABLE 8

INCREMENTAL AMBIENT STEP STRESS

		TEST			CONTROL		
Time hrs.	Temp. °C	Voltage V	Failure Mode	Failure Total Accum.	Voltage V	Failure Mode	Failure Total Accum.
Initial	25	60	0	0	60	0	0
192	125	40	0	0	20	2L	2
360	135	40	1L	1	20	0	2
528	145	40	1M	2	20	0	2
696	155	40	2M	4	20	3M	5
864	165	40	3M	7	20	1M	6
1032	175	40	3M	10	20	1M	7
1200	185	40	0	10	20	0	7
1368	195	40	2M	12	20	5M	12
Final	25	60	0	12	60	1L	13
Total		1L, 11M			2L, 11M		

INCREMENTAL AMBIENT STEP STRESS



FUGURE 12.

Surge Voltage

Summary of Data. . . There were no major changes in the mechanical or electrical conditions of the test capacitors after the surge voltage application. Two of the control units, which were exposed to the 125°C, 40V test conditions without application of 46V intermittant surge voltage, increased in leakage beyond the 2.04μa limit at 25°C after testing. One unit rose from 1.35μa to 2.2μa, and the other unit rose from 2.2μa, which was initially above the acceptable limit, to 22.5μa after exposure.

Unit No. 231 indicated a gross change of .00136g. loss of weight after testing. Examination of the seal indicated salt deposited on the header, apparently carried over from the initial manufacturing process. After washing the unit in hot water, alcohol and acetone, an additional weight loss of .00196g. was observed. The weight remained stable at this level and no cracks or leaks were observed. It was concluded that the weight change was caused by the change in weight of the externally adsorbed electrolyte.

CONCLUSIONS AND RECOMMENDATIONS

Results of testing the T3 solid slug tantalum capacitor verified its high electrical stability under various degrees of electrical and atmospheric stress. Temperature cycling and surge voltage, within the limits of this program, had no effect on the functional stability of the units.

Although the glass seal has not been optimized, the weld seal exhibited perfect reliability.

The glass-to-tantalum reaction exhibited good reliability in that all of the mechanical glass failures occurred in the glass matrix, not at the glass-to-tantalum interfaces. A header design which would place the glass in compression would eliminate most of the seal failures.

The reverse voltage tolerance of this package is very promising. Prolonged exposure to -1.0V and intermittant exposure to -2.0V appears tolerable without experiencing catastrophic failure in the device. Prolonged exposure to -5.0V and greater appears to be excessively damaging to the device.

It is recommended that additional work be undertaken to optimize the header design wherein the glass seal would be a combined matched and compressive hermetic seal.

The reverse voltage tolerance of this capacitor package should be studied in a matrix of cyclic tests which would more realistically simulate the application of reverse voltage wherein the voltage-time factor could be determined.

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REFERENCE

Dr. H. Adams: Compressed Glass-to-Metal Seals. Journal of the Society of Glass Technology, Vol. 38, 1954.

APPENDIX A

Burn-In Test Data

FANSTEEL, INC.
Electronic Materials Lab.
NAS 12-2004

BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	3:45PM	12/18/68	60V	85°C	
Change	9:45PM	12/20/68	40V	125°C	54 hrs.
Stable	10:18PM	12/20/68	40V	125°C	
Stop	4:18PM	12/21/68			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	001	7.97471	56.0	.0190	3.2	7.97472	54.6	.0181	1.8	.439	X			NASA
	002	8.08436	55.0	.0185	1.5	8.08842	54.1	.0175	0.19	.430	X			"
	003	7.84756	57.0	.0223	11.0							M		"
	004	7.74125	55.0	.027	15.0							M		"
1	005	7.77701	56.6	.028	2.0	7.77710	55.8	.0214	0.18	.508	X			"
	006	7.92046	57.1	.0195	1.2	7.91472	56.1	.0195	130.0			M		"
	007	7.99644	54.6	.0178	4.2							M		"
	008	8.12158	55.0	.0168	1.7	8.12156	54.0	.0185	0.55	.454	X			"
	009	7.92798	54.3	.017	1.2	7.92782	53.5	.0191	0.18	.474	X			"
	010	7.97350	56.2	.019	3.2	7.97367	55.2	.023	0.65	.553	X 6	4	60%	"
	011	8.02898	56.8	.018	4.8	8.02922	55.3	.016	0.82	.384	X			"
2	012	8.07923	55.3	.020	12.0							M		"
	013	8.00532	54.2	.019	7.0	8.00550	53.0	.0165	0.60	.412	X 2	3	67%	"

Key: M–Mechanical (Leak)

L–D.C. Leakage

Short – Internal Short Circuit

FANSTEEL, INC.
Electronic Materials Lab.
NAS 12-2004

BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10:05 am	1/28/69	60V	85°C	
Change	4:05 pm	1/30/69	40V	125°C	54 hrs.
Stable	5:05 pm	1/30/69	40V	125°C	
Stop	11:05 am	1/31/69			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	014	7.76395	53.6	.0262	3.4							M		NASA
	015	7.84775	53.1	.0184	9.7	7.84704	52.1	.0155	0.4	.394	X			"
	016	7.90790	53.7	.0197	2.4							M		"
	017	8.06652	54.9	.0222	1.5	8.06556	53.9	.0158	3.0	.389	X		High L	"
1	018	7.98324	52.6	.0187	0.75	7.97384	52.0	.0166	0.50			M		"
	019	7.98746	53.0	.0194	0.96		52.2	.0176	0.60			M		"
	020	7.72951	52.9	.0260	4.4							M		"
	021	7.65299	53.0	.0288	1.25	7.65211	52.2	.0248	1.25	.625	X			"
	022	7.90940	55.9	.0213	0.90	7.90917	55.1	.0168	0.45	.405	X			"
	023	7.99146	54.5	.0199	5.5						4	M 6	40%	"
	024	7.74229	53.9	.0241	4.4	7.74144	53.2	.0220	0.55	.549	X			NASA
	025	8.00660	53.1	.0172	1.5							M		"
	026	7.76470	53.8	.0175	3.2	7.76345	53.0	.0163	3.3	.408	X			"
	027	7.68013	53.1	.0182	3.5	7.67873	52.5	.0170	0.65			M		"
2	028	7.46132	53.4	.0475	1.25	7.46024	52.5	.0480	0.40	1.212	X			"
	029	7.46191	52.0	.065	4.1	7.46078	51.1	.0595	1.7	1.545	X			"
	030	7.94866	53.1	.0172	2.35							M		"
	031	7.57872	52.3	.044	0.7	7.57741	51.9	.0420	0.30	1.074	X			"
	032	7.79390	56.2	.0194	1.5	7.79224	55.3	.0185	1.0	.444	X			"
	033	7.95153	54.3	.0183	3.9	7.95061	53.8	.0140	0.45	.345	X 7	3	70%	"
	034	7.49160	53.6	.0505	1.70							M		NASA
	035	7.76508	54.0	.0210	2.75							M		"
3	036	7.72959	52.7	.0167	8.5							M		"
	037	7.96432	51.9	.0210	0.85							M		"
	038	7.45728	53.0	.0750	1.10	7.45472	52.3	.0650	0.70	1.650		M		"
	039	7.91897	53.3	.0276	1.20	7.91873	53.0	.0152	0.85	.380	X			"

FANSTEEL, INC.
Electronic Materials Lab.
NAS 12-2004

BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10:05 am	1/28/69	60V	85°C	
Change	4:05 pm	1/30/69	40V	125°C	54 hrs.
Stable	5:05 pm	1/30/69	40V	125°C	
Stop	11:05 am	1/31/69			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	040	7.56287	54.1	.0358	1.75							M		NASA
3	041	7.83116	52.8	.0178	0.75							M		"
	042	7.88637	54.4	.0195	0.55							M		"
	043	7.80445	54.7	.0220	3.2						1	M 9	10%	"
	044	7.71287	54.2	.0275	3.1							M		NASA
	045	7.56923	54.5	.0319	0.95							M		"
	046	7.78888	54.2	.0216	8.0	7.78779	53.0	.0188	0.75	.470	X			"
	047	7.88482	54.5	.0214	13.0	7.88359	53.0	.0195	1.75	.488	X			"
4	048	7.70075	53.9	.0265	1.3							M		"
	049	7.94337	53.4	.0221	3.3							M		"
	050	7.89429	53.3	.0180	3.5							M		"
	051	7.65446	52.7	.0279	0.7	7.65296	51.6	.0235	0.30	.604	X			"
	052	7.65994	52.6	.0203	2.5							M		"
	053	8.02044	57.0	.0195	2.0	8.01886	56.0	.0155	1.05	.367	X 4	6	40%	"
	054	7.94495	54.9	.0190	4.1	7.94463	54.0	.0147	4.5	.361	X		High L	NASA
	055	7.94146	52.6	.0188	5.2							M		"
	056	7.84210	52.8	.0208	8.4	7.84180	51.8	.0146	2.3	.373	X		High L	"
	057	7.97099	52.9	.0195	2.5	7.97051	52.1	.0169	1.0	.430	X			"
5	058	7.65296	55.6	.0310	3.1							M		"
	059	7.80738	54.8	.0205	4.0							M		"
	060	7.71532	54.3	.0200	2.65							M		"
	061	7.98043	54.9	.0210	2.15							M		"
	062	7.80758	53.2	.0229	1.4							M		"
	063	7.79667	54.7	.0255	3.2	7.79471	53.8	.0213	1.1	.525	3	M 7	30%	"
6	064	7.78074	55.2	.0203	0.95							M		NASA
	065	7.44355	51.8	.0490	3.8	7.44337	50.6	.0475	0.35	1.243	X			"

FANSTEEL, INC.
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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10:05 am	1/28/69	60V	85°C	
Change	4:05 pm	1/30/69	40V	125°C	54 hrs.
Stable	5:05 pm	1/30-69	40V	125°C	
Stop	11:05 am	1/31/69			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	066	7.53752	54.0	.0241	2.8							M		NASA
	067	7.76858	52.6	.0255	0.7	7.76760	51.9	.0180	0.30	.460	X			"
6	068	7.64356	52.8	.0302	2.7							M		"
	069	7.37358	53.8	.0738	0.95							M		"
	070	8.03218	54.9	.0173	2.1	8.03182	53.9	.0163	0.90	.401	X			"
	071	7.69194	52.0	.0265	1.85							M		"
	072	7.76388	55.8	.0238	1.8							M		"
	073	7.73263	55.8	.0258	5.2						3	M	30%	"
	074	7.73910	54.0	.0252	4.0							M		NASA
	075	7.72415	54.3	.0211	21.0	7.72388	53.3	.0158	0.50	.393	X			"
	076	7.81024	52.8	.0216	4.0	7.81012	51.9	.0171	0.55	.437	X			"
	077	7.70414	53.8	.0264	1.2							M		"
7	078	7.53543	53.4	.0319	1.9	7.41651	52.0	.0590	0.45			M		"
	079	7.75422	54.2	.0535	15.0							M		"
	080	7.68799	53.1	.0245	1.1							M		"
	081	7.85353	55.3	.0208	2.8	7.85494	54.5	.0159	0.50	.387	X			"
	082	7.73913	54.8	.0249	2.15	7.72927	53.7	.0200	0.40	.494		M		"
	083	7.61871	54.2	.0282	68.0						3	M	30%	"
	084	7.69089	54.2	.0222	1.1	7.69006	52.8	.0201	0.65	.505	X			NASA
	085	7.60775	55.9	.0338	120.0	7.60779	54.2	.0300	1.3	.733	X			"
	086	7.79559	52.5	.0191	3.6							M		"
	087	8.00441	54.9	.0173	1.8	8.00441	53.9	.0150	0.85	.369	X			"
8	088	7.37652	52.5	.0378	4.9	7.37634	51.0	.0343	1.9	.891	X			"
	089	7.69541	55.0	.0229	2.25							M		"
	090	7.72035	55.5	.0203	2.5							M		"
	091	7.72359	55.8	.0211	3.5	7.72326	54.5	.0200	0.65	.487	X			"

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Electronic Materials Lab.
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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10:05 am	1/28/69	60V	85°C	
Change	4:05 pm	1/30/69	40V	125°C	54 hrs.
Stable	5:05 pm	1/30/69	40V	125°C	
Stop	11:05 am	1/31/69			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	092	7.68935	54.0	.0211	1.5							M		NASA
8	093	7.72912	53.7	.0210	5.0						5	M 5	50%	"
	094	7.70340	56.0	.0219	3.6	7.69437	54.0	.0185	1.05			M		NASA
	095	7.99092	53.0	.0205	1.5							M		"
	096	7.75420	53.5	.0261	1.9							M.		"
	097	8.02337	53.9	.0165	38.0							M		"
	098	7.80312	55.0	.0239	48.0							M		"
9	099	7.66646	54.1	.0218	1.3	7.66618	53.1	.0246	1.4	.615	X			"
	100	7.68355	53.6	.0250	0.75	7.68258	52.6	.0222	0.25	.559	X			"
	101	7.92226	56.1	.0204	1.6							M		"
	102	7.94087	53.8	.0185	2.4	7.94065	52.7	.0152	2.6	.383	X		High L	"
	103	7.89090	52.9	.0187	3.0	7.89060	52.1	.0151	1.3	.384	X 4	6	40%	"
10	104	7.88188	54.9	.0200	2.4	7.88150	53.5	.0155	0.65	.385	X			NASA
	105	7.72019	52.8	.0185	180.0							M		"
	106	7.72070	52.8	.0260	300.0	7.72042	51.2	.0215	0.60	.557	X			"
	107	7.78100	53.6	.0250	17.0	7.78042	52.6	.0205	1.55	.516	X			"
	108	7.61512	53.7	.0291	7.5						3	M. 2	60%	"

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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10:45 am	2/11/69	60V	85°C	
Change	4:45 pm	2/13/69	40V	125°C	54 hrs.
Stable	5:45 pm	2/13/69	40V	125°C	
Stop	11:45 am	2/14/69	40V		72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	109	7.75084	53.9	.0268	9.2	7.75010	52.5	.0205	1.2	.518	X			NASA
	110	7.82727	53.5	.0245	1.15	7.82693	52.8	.0165	1.6	.414	X			"
	111	7.87403	54.0	.0263	60.0							M		"
	112	7.74597	53.1	.0265	15.0		49.0	.129	4.8			M		"
2	113	7.76544	54.6	.0240	1.7							M		"
	114	7.69608	55.3	.0182	2.7	7.69594	54.5	.0148	0.70	.360	X			"
	115	7.79168	52.5	.0271	1.0	7.79064	51.8	.0235	0.55	.601	X			"
	116	7.78817	54.1	.0268	4.3							M		"
	117	7.44144	53.3	.0559	0.60							M		"
	118	7.72036	53.2	.0237	1.55						4	M 6	40%	"
	119	7.92262	52.8	.0210	4.2	7.92221	51.6	.0151	2.7	.388	X		HighL	NASA
	120	7.79380	52.5	.0261	2.05	7.79300	51.7	.0215	2.4	.551	X		HighL	S.S.
	121	7.71262	53.2	.0251	2.3							M		NASA
	122	7.76023	53.2	.0279	2.6	7.75995	52.8	.0149	0.80	.374	X			"
1	123	7.78710	53.9	.0245	3.8							M		"
	124	7.75680	52.1	.0260	2.8							M		"
	125	7.73334	52.8	.0250	25.0	7.73305	51.7	.0212	3.5	.544	X		High L	"
	126	7.80242	52.8	.0200	2.9	7.80210	52.0	.0151	0.80	.385	X			"
	127	7.55758	54.8	.0365	2.8	7.55728	53.9	.0285	0.35	.702	X			"
	128	7.75938	53.5	.0251	0.75	7.75908	52.5	.0216	0.25	.545	X 7	3	70%	"
	129	7.77777	53.0	.0272	4.0		51.9	.0301	2.55			M		S.S.
	130	7.77052	53.1	.0280	1.25		51.9	.0392	0.90			M		"
10	131	7.71985	53.2	.0288	1.05	7.72014	52.2	.0254	0.35	.645	X			"
	132	7.67160	52.8	.0228	2.25		51.5	.0300	0.40			M		"
	133	7.73594	54.7	.0251	1.35		53.2	.0339	1.75			M		"
	134	7.76771	54.6	.0251	3.0		53.7	.0208	1.45			M		"

* Step Stress

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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10:45 am	2/11/69	60V	85°C	
Change	4:45 pm	2/13/69	40V	125°C	54 hrs.
Stable	5:45 pm	2/13/69	40V	125°C	
Stop	11:45 am	2/14/69	40V		72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	135	7.70195	53.9	.0275	1.75	7.70206	52.8	.0209	0.25	.525	X			S.S.*
10	136	7.81305	52.1	.0241	19.0	7.80130	51.0	.0192	26.0			M		"
	137	7.70821	52.3	.0242	16.0		50.8	.0410	3.8			M		"
	138	7.75455	52.5	.0245	1.7	7.75470	51.8	.0192	0.55	.491	X 3	7	30%	"
	139	7.76296	53.8	.0271	6.5							M		S.S.*
	140	7.76581	55.2	.0264	1.0	7.76597	54.0	.0225	0.35	.553	X			"
	141	7.37662	52.4	.1591	25.0	7.37675	50.5	.207	0.60	.543	X			"
	142	7.75211	52.8	.0260	1.9	7.75231	51.8	.0208	0.60	.532	X			"
6	143	7.72399	53.1	.0261	8.8	7.72212	52.0	.0238	11.0			M		"
	144	7.94688	54.1	.0206	9.2							M		"
	145	7.77026	54.9	.0270	0.85	7.77020	53.9	.0229	1.5	.564	X			"
	146	7.75931	55.9	.0247	2.45	7.75949	54.9	.0195	1.05	.471	X			"
	147	7.73937	57.0	.0240	2.5							M		"
	148	7.79450	52.8	.0254	3.8	7.79474	51.9	.0205	1.35	.524	X 6	4	60%	"
	149	7.82022	53.7	.0269	0.95							M		S.S.*
	150	7.90375	52.8	.0188	3.0							M		"
	151	7.82626	51.8	.0275	80.0							M		"
	152	7.80021	54.1	.0237	4.2							M		"
8	153	7.80527	54.2	.0180	2.35							M		"
	154	7.82429	55.2	.0271	3.6	7.82447	54.8	.0209	0.9	.506	X			"
	155	7.75263	53.1	.0273	1.5	7.75280	52.7	.0228	0.9	.574	X			"
	156	7.79646	53.1	.0258	5.2							M		"
	157	7.79653	53.9	.0202	2.65							M		"
	158	7.76782	52.5	.0248	1.5	7.76789	51.8	.0203	0.70	.519	X 3	7	30%	"
	159	7.76768	54.5	.0276	9.4							M		S.S.*
7	160	7.72738	53.0	.0285	3.3	7.72736	52.1	.0228	1.4	.580	X			"

* Step Stress

FANSTEEL, INC.
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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10:45 am	2/11/69	60V	85°C	
Change	4:45 pm	2/13/69	40V	125°C	54 hrs.
Stable	5:45 pm	2/13/69	40V	125°C	
Stop	11:45 am	2/14/69	40V		72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	161	7.78945	54.3	.0265	40.0	7.78925	53.0	.0232	2.0	.580	X			S.S.
	162	7.85347	56.8	.0187	25.0	7.85332	55.5	.0161	10.5	.385		High L		"
	163	7.80872	54.9	.0253	31.0							M		"
7	164	7.72147	53.4	.0268	50.0							M		"
	165	7.98117	54.9	.0178	86.0							M		"
	166	7.77923	54.2	.0284	130.0							M		"
	167	7.79430	52.5	.0258	265.0	7.79340	51.8	.0210	0.80	.537	X			"
	168	7.86742	56.1	.0236	2.6	7.86707	55.1	.0222	1.4	.535	X 4	6	40%	"
	169	7.97065	52.8	.0175	4.0							M		S.S.
	170	7.74034	53.2	.0250	16.0							M		"
	171	7.82534	54.2	.0238	3.2							M		"
	172	7.75797	53.6	.0282	0.95							M		"
3	173	7.96097	52.8	.0225	1.0							M		"
	174	7.70434	53.7	.0290	2.8							M		"
	175	7.86232	55.4	.0274	4.0							M		"
	176	7.74698	53.0	.0225	5.0							M		"
	177	7.72634	52.9	.0245	2.2							M		"
	178	7.76250	55.4	.0254	3.4						0	M10	0	"
	179	7.81443	55.0	.0210	68.0							M		S.S.
	180	7.79569	55.4	.0190	2.2		54.6	.0158	1.05			M		"
9	181	7.75492	53.2	.0290	44.0							M		"
	182	7.77551	52.8	.0265	11.0							M		"
	183	7.68640	54.3	.0308	19.0						0	M 5	0	"

*Step Stress

FANSTEEL, INC.
Electronic Materials Lab.
NAS 12-2004
BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	9:05 am	3/4/69	60V	85°C	
Change	3:05 pm	3/6/69	40V	125°C	54 hrs.
Stable	3:45 pm	3/6/69	40V	125°C	
Stop	9:45 am	3/7/69			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
1	184	7.69859	55.6	.029	2.8	7.69610	54.0	.0283	0.22	.695	X			S. S.*
	185	7.84045	56.3	.021	3.5	7.84042	55.1	.0178	0.27	.429	X			"
	186	7.69212	54.3	.0259	4.2							M		"
	187	7.81483	54.8	.044	2.75	7.81469	53.5	.0227	0.32	.563	X			"
	188	7.63624	54.1	.0291	1.4	7.63626	53.0	.0250	0.35	.625	X			"
	189	7.76368	53.8	.060	1.5							M		"
	190	7.66448	56.0	.0265	0.90	7.66385	55.0	.0231	0.45	.557	X			"
	191	7.71434	53.8	.044	5.2	7.71395	52.6	.0255	0.35	.642	X			"
	192	7.71170	54.0	.030	1.85							M		"
	193	7.72807	51.7	.0332	7.8						6	M 4	60%	"
2	194	7.84464	56.5	.0265	5.3							M		S. S.*
	195	7.76381	54.8	.0264	32.0	7.76371	53.3	.0208	1.35	.517	X			"
	196	7.92115	54.2	.0240	4.0							M		"
	197	7.76696	54.9	.0260	1.9							M		"
	198	7.70932	53.8	.0295	2.2	7.70920	52.5	.0275	0.21	.694	X			"
	199	7.73480	55.8	.0330	2.3	7.73467	54.7	.0290	0.45	.604	X			"
	200	7.58376	54.3	.0370	3.2	7.57526	53.0	.0310	1.2			M		"
	201	7.83241	53.7	.0236	1.25	7.83214	52.6	.0214	0.18	.539	X			"
	202	7.77118	55.8	.0294	3.2							M		"
	203	7.82483	54.9	.0292	2.2						4	M 6	40%	"
3	204	7.76189	53.3	.0295	3.5	7.73677	51.9	.0372	15.5	.951	X			S. S.*
	205	7.81733	54.9	.0231	2.6							M		"
	206	7.85638	54.5	.0220	1.55	7.85630	53.3	.0205	0.45	.510	X			"
	207	7.81737	55.8	.0250	3.5							M		"
	208	7.98835	53.8	.0192	9.8	7.98755	52.5	.0190	0.50			M		"
	209	7.75084	56.0	.0294	9.2							M		"

* Step Stress

FANSTEEL, INC. Electronic Materials Lab. NAS 12-2004 BURN IN TEST	PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
	Start	9:05 am	3/4/69	60V	85°C	
	Change	3:05 pm	3/6/69	40V	125°C	54 hrs.
	Stable	3:45 pm	3/6/69	40V	125°C	
	Stop	9:45 am	3/7/69			72 hrs

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
3	210	7.79170	55.0	.0268	5.8							M		S.S.*
	211	7.82029	53.5	.0231	10.0	7.82008	52.5	.0278	2.0	.702	X			"
	212	7.71626	54.9	.0276	2.8							M		Surge
	213	7.75535	56.1	.0285	1.0						3	M 7	30%	"
4	214	7.70198	55.9	.0302	2.5	7.70180	53.5	.0220	0.25	.546	X			Surge
	215	7.82146	55.1	.0240	1.9							M		"
	216	7.84569	54.1	.0228	1.35							M		"
	217	7.84115	53.4	.0211	2.6	7.84115	52.4	.0195	1.0	.494	X			"
	218	7.72878	53.8	.0305	1.45	7.72824	52.5	.0308	0.14	.778	X			"
	219	7.84233	55.2	.0168	3.5							M		"
	220	7.75358	55.8	.0260	2.75	7.75343	54.6	.0258	0.8	.626	X			"
	221	7.69117	53.5	.0277	4.0	7.69107	52.4	.0698	0.2	1.767	X			"
	222	7.63641	53.8	.0555	200.0	7.63639	52.1	.0222	1.0	.565	X			"
	223	7.73857	53.5	.0250	3.0	7.73860	52.4	.0247	1.55	.625	X 7	3	70%	"
5	224	7.79592	57.0	.0270	60.0							M		Surge
	225	7.83652	54.9	.0224	70.0	7.83630	53.7	.0400	0.65	.988	X			"
	226	7.76112	54.1	.0245	170.0							M		"
	227	7.78744	54.6	.0274	27.0	7.78720	53.5	.0306	0.65	.759	X			"
	228	7.70473	53.5	.0262	10.0	7.70460	52.1	.0303	0.8	.771	X			"
	229	7.50876	55.2	.0582	140.0	7.50870	53.3	.0560	1.1	1.393	X			"
	230	7.73358	54.5	.0299	1.30	7.73327	53.2	.0268	1.5	.668	X			"
	231	7.66789	52.2	.0352	2.75	7.66708	50.8	.0300	0.32	.783	X			"
	232	7.79890	55.8	.0310	450.0							M		"
	233	7.76373	52.9	.0300	2.45						6	M 4	60%	"
6	234	7.70040	55.0	.0339	1.5	7.70045	53.5	.0254	0.13	.630	X			Surge
	235	7.63060	55.1	.0291	1.45							M		"

* Step Stress

FANSTEEL, INC.
Electronic Materials Lab.
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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	9:05am	3/4/69	60V	85°C	
Change	3:05pm	3/6/69	40V	125°C	54 hrs.
Stable	3:45pm	3/6/69	40V	125°C	
Stop	9:45am	3/7/69			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	236	7.71659	55.6	.0286	2.25	7.71657	54.6	.0249	0.80	.603	X			Surge
	237	7.63008	54.2	.0290	6.0							M		"
	238	7.65147	54.2	.0318	120.0	7.65145	52.5	.0356	0.70	.899	X			"
6	239	7.92286	53.2	.0205	1.8	7.92283	52.3	.0201	0.33	.510	X			"
	240	7.71294	54.0	.0355	4.8							M		"
	241	7.64114	54.8	.0341	3.6	7.63682	53.8	.0300	0.45	.739		M		"
	242	7.90413	53.2	.0215	7.8	7.90414	52.2	.0185	0.25	.470	X			"
	243	7.66067	55.8	.0300	8.1	7.66052	54.5	.0290	0.80	.706	X 6	4	60%	"
	244	7.75553	55.2	.0290	16.0	7.75553	54.0	.0250	3.5	.614	X		High L	T C & I
	245	7.72436	56.0	.0270	25.0							M		"
	246	7.56901	53.6	.0638	3.0	7.56908	52.3	.0538	0.42	1.365	X			"
	247	7.72504	Short	-----	-----							Shorted		"
7	248	7.68696	52.8	.0251	1.8							M		"
	249	7.63006	53.1	.0261	75.0	7.62981	52.0	.0250	1.25	.638	X			"
	250	7.79079	55.0	.0275	1.7	7.79087	54.0	.0258	2.1	.634	X		High L	"
	251	7.72443	54.2	.0281	2.15							M		"
	252	7.74774	54.7	.0295	4.1	7.74777	53.9	.0215	2.2	.530	X			"
	253	7.97826	55.1	.0168	4.6	7.97806	54.2	.0160	0.68	.391	X 6	4	60%	"
	254	7.66764	52.8	.0315	1.35	7.64218	51.0	.0321	0.98			M		Reverse
	255	7.71514	55.7	.0358	1.4							M		"
	256	7.70109	53.0	.0310	1.95	7.70106	51.8	.0305	0.30	.780	X			"
8	257	7.73122	55.1	.0280	4.6	7.73121	53.9	.0245	0.66	.603	X			"
	258	7.73848	54.2	.0405	1.7	7.73836	53.1	.0290	0.39	.725	X			"
	259	7.68041	53.8	.0330	2.85	7.68047	52.7	.0390	2.0	.982	X			"
	260	7.77590	54.1	.0282	2.6	7.77590	52.9	.0255	0.80	.639	X			"
	261	7.68475	56.2	.0310	2.5							X		"

FANSTEEL, INC. Electronic Materials Lab. NAS 12-2004 BURN IN TEST	PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
	Start	9:05am	3/4/69	60V	85°C	
	Change	3:05pm	3/6/69	40V	125°C	54 hrs.
	Stable	3:45pm	3/6/69	40V	125°C	
	Stop	9:45am	3/7/69			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
8	262	7.69913	52.7	.0282	7.8							M		Reverse
	263	7.71291	53.7	.0295	1.45						5	M 5	50%	"
9	264	7.74529	54.8	.0205	1.55	7.74529	53.8	.0220	0.16	.542	X			Reverse
	265	7.67545	55.6	.0280	2.85							M		"
	266	7.77421	53.4	.0291	0.80	7.77434	52.5	.0235	0.31	.593	X			"
	267	7.70205	54.8	.0305	1.25							M		"
	268	7.76757	55.4	.250	20.0	7.76751	54.5	.0229	0.70	.557	X			"
	269	7.43509	55.0	.0655	6.0							M		"
	270	7.77597	56.3	.0271	4.2	7.77539	55.1	.0195	0.85	.470	X			"
	271	7.72376	54.5	.0272	1.05							M		"
	272	7.65794	53.2	.0223	2.8	7.65815	52.5	.0185	0.22	.467	X			"
	273	7.67139	54.8	.0305	3.0	7.67167	53.8	.0339	0.80	.835	X 6	4	40%	"
10	274	7.65361	54.5	.0300	3.1							M		Reverse
	275	7.79142	53.5	.0220	7.7	7.79171	52.3	.0191	1.0	.485	X			"
	276	7.74288	55.0	.0205	1.0	7.74295	54.0	.0180	0.22	.442	X			"
	277	7.77856	56.0	.0275	1.0							M		"
	278	7.72982	53.8	.0288	1.15							M		"
	279	7.99138	53.7	.0187	3.6							M		"
	280	7.54899	56.0	.0373	1.9							M		"
	281	7.71197	54.9	.0295	5.8	7.71200	53.6	.0255	0.43	.631	X			"
	282	7.73753	54.7	.0300	3.4	7.73750	53.5	.0273	0.61	.677	X			"
	283	7.66509	55.4	.0503	0.85	7.66506	54.2	.0560	0.29	1.369	X 5	5	50%	"
11	284	7.87498	55.4	.0180	1.35	7.87498	54.2	.0170	0.21	.416	X			Reverse
	285	7.73470	52.3	.0300	2.15		51.2	.0341	0.29			M		"
	286	7.72870	53.9	.0284	1.1	7.72890	52.8	.0248	0.16	.623	X			"

FANSTEEL, INC. Electronic Materials Lab. NAS 12-2004 BURN IN TEST	PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
	Start	9:05am	3/4/69	60V	85°C	54 hrs.
	Change	3:05pm	3/6/69	40V	125°C	
	Stable	3:45pm	3/6/69	40V	125°C	
	Stop	9:45am	3/7/69			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	287	7.98323	52.8	.0180	1.70							M		Reverse
	288	7.52699	54.6	.0410	1.65		53.2	.0420	0.65			M		"
	289	7.76972	54.5	.0190	5.3							M		"
11	290	7.72298	56.1	.0259	60.0							M		"
	291	7.75822	52.7	.0290	1.2							M		"
	292	7.54981	53.8	.0335	3.5	7.54984	52.5	.0318	2.1	.803	X		High L	"
	293	7.62721	53.2	.0270	3.8						3	M 7	30%	"
	294	7.76006	54.5	.0262	2.15	7.75992	53.1	.0229	0.54	.572	X			Reverse
	295	7.84440	57.6	.0275	6.5	7.84429	56.3	.0229	0.12	.540	X			"
	296	7.69389	56.3	.0370	3.7	7.69367	55.1	.0314	0.28	.757	X			"
	297	7.71913	57.0	.0295	1.90	7.71905	55.7	.0217	0.24	.517	X			"
12	298	7.89618	55.9	.0190	2.20	7.89599	54.8	.0172	1.15	.416	X			"
	299	7.68057	56.2	.0202	24.0							M		"
	300	7.77710	53.0	.0230	2.60	7.77698	52.0	.0166	0.25	.423	X			"
	301	7.77007	57.1	.0268	2.25	7.76924	55.6	.0215	1.25	.513	X			"
	302	7.94550	56.2	.0175	2.65	7.94545	55.0	.0161	0.41	.388	X		90%	"
	303	7.77872	54.1	.0255	4.6	7.77853	53.1	.0239	3.2	.598	X 9	1	High L	"
	304	7.79627	57.1	.0212	3.1	7.79612	55.9	.0181	0.43	.430	X			Reverse
	305	7.69477	56.0	.0254	2.55	7.68579	54.6	.0222	0.51	.539		M		"
	306	7.72838	55.3	.0218	2.65							M		"
13	307	7.59211	56.7	.0333	4.3							M		"
	308	7.75644	57.0	.0251	4.2	7.75448	55.8	.0227	1.2	.539		M		"
	309	7.69160	54.1	.0232	6.8	7.68569	53.1	.0170	3.8	.425		M		"
	310	7.73672	56.7	.0298	3.0							M		"
	311	7.74407	56.2	.0290	7.1							M		"

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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	9:05 am	3/4/69	60V	85°C	
Change	3:05 pm	3/6/69	40V	125°C	54 hrs.
Stable	3:45 pm	3/3/69	40V	125°C	
Stop	9:45 am	3/7/69			72 hrs.

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
13	312	7.72706	56.2	.0195	2.65	7.72710	55.0	.0221	2.8	.532	X		High L	Reverse
	313	7.70658	55.2	.0230	1.9	7.70492	54.2	.0205	0.88	.501	2	M. 8	20%	"
14	314	7.74352	55.3	.0290	4.1	7.74353	53.9	.0270	5.5	.665	X		High L	Reverse
	315	7.67701	54.6	.0231	80.0	7.67405	53.2	.0271	5.1		1	M 1	50%	"

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Electronic Materials Lab.
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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	8:50 AM	3/11/69	60V	85°C	
Change	2:50 PM	3/13/69			54 hrs.
Stable	3:05 PM	3/13/69	40V	125°C	
Stop	9:05 AM	3/14/69			72 hrs

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	316	8.03557	55.9	.0200	1.45	8.03557	54.6	.0178	0.22	.432	X			Reverse
	317	7.70643	55.4	.0252	1.4							M		"
	318	7.67843	59.3	.0322	3.4							M		"
	319	7.81054	56.0	.0290	1.6							M		"
1	320	7.75883	55.2	.0320	2.25	7.75859	54.2	.0300	0.51	.733	X			"
	321	7.77546	56.9	.0271	2.8	7.77544	56.1	.0220	0.38	.520	X			"
	322	7.82143	55.7	.0234	1.55	7.82154	54.9	.0212	0.23	.512	X			"
	323	7.81686	54.9	.0223	3.3							M		"
	324	7.77966	54.4	.0196	2.2	7.77976	53.5	.0184	3.1	.456	X		High L	"
	325	7.79207	56.2	.0327	2.6						5	5	50%	"
	326	7.84254	56.0	.0271	4.6	7.84243	54.5	.0198	6.0	.482	X		High L	Reverse
	327	7.64103	55.1	.0220	1.87	7.64094	54.1	.0213	0.42	.522	X			"
	328	7.84516	57.0	.0213	5.5							M		"
	329	7.78611	56.3	.0228	1.9	7.78604	55.1	.0303	1.7	.730	X			"
2	330	7.98797	59.0	.0192	6.5	7.98788	58.0	.0169	0.68	.387	X			"
	331	7.79656	54.3	.0202	1.65	7.79638	53.2	.0340	0.39	.848	X			"
	332	7.77060	57.5	.0230	1.95	7.76620	56.2	.0402	0.34			M		"
	333	7.86441	58.9	.0215	2.4	7.86417	57.6	.0234	0.86	.539	X			"
	334	7.78035	55.8	.0240	9.4	7.78017	54.8	.0230	5.3	.557	X		High L	"
	335	7.86989	55.0	.0240	3.9	7.86966	54.1	.0219	0.40	.537	X 8	2	80%	"
	336	7.79014	55.7	.0286	2.75							M		Reverse
	337	7.75402	54.9	.0218	3.7							M		"
3	338	7.74516	54.7	.0261	3.9	7.74488	53.5	.0245	0.43	.608	X			"
	339	7.69160	56.3	.0254	3.8	7.69128	54.9	.0243	1.35	.587	X			"
	340	7.70687	56.9	.0240	1.1	7.70670	56.0	.0197	0.21	.466	X			"
	341	7.72340	54.5	.0296	4.5							M		"

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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	8:50am	3/11/69	60V	85°C	
Change	2:50pm	3/13/69			54 hrs
Stable	3:05pm	3/13/69	40V	125°C	
Stop	9:05am	3-14-69			72 hrs

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	342	7.79596	57.0	.0289	2.45	7.79586	56.3	.0223	0.81	.526	X			Reverse
3	343	7.87361	54.1	.0245	9.4							M		"
	344	7.77325	56.0	.0240	4.8							M		"
	345	7.70569	54.9	.0231	2.25	7.70556	53.9	.0214	0.30	.527	X 5	5	50%	"
	346	7.83856	56.8	.0238	2.5							M		
	347	7.63328	53.9	.0255	1.3	7.63316	57.6	.0222	0.26	.512	X			"
	348	7.79332	56.9	.0259	4.3	7.79327	55.8	.0214	2.0	.508	X			"
	349	7.76523	56.0	.0263	4.0	7.76517	54.8	.0228	1.20	.552	X			"
4	350	7.77892	55.3	.0236	3.4	7.77889	54.2	.0237	1.15	.579	X			"
	351	7.79474	56.4	.0202	6.5	7.79465	55.1	.0259	0.76	.624	X			"
	352	7.79503	55.7	.0281	4.5	7.79502	54.3	.0252	1.75	.616	X			"
	353	8.04823	55.2	.0220	4.0							M		"
	354	7.78141	54.8	.0228	2.0	7.78146	53.6	.0183	0.49	.453	X			"
	355	7.83800	55.3	.0210	32.0	7.82274	54.2	.0260	4.0		7	M 3	70%	"
	356	7.76260	Short	----------	----------							Short		Reverse
	357	7.74352	57.5	.0315	4.2							M		"
	358	7.77908	56.2	.0275	3.3							M		"
	359	7.87929	56.8	.0251	1.7	7.87936	55.4	.0231	0.58	.553	X			"
5	360	7.76945	57.5	.0170	400.0	7.76946	56.1	.0551	0.54	1.303	X			"
	361	7.81271	55.0	.0277	17.5	7.81275	54.0	.0269	0.40	.661	X			Life-
	362	7.75192	54.0	.0262	2.2	7.75185	53.2	.0231	0.29	.576	X			Test
	363	7.87048	55.2	.0238	7.9	7.87048	54.2	.0216	0.49	.528	X			"
	364	7.78337	55.3	.0240	3.7	7.78323	54.5	.0343	3.0	.834	X		High L	"
	365	7.76845	55.8	.0256	2.4	7.76852	55.0	.0338	0.43	.814	X 7	3	70%	"
15	366	7.57919	53.9	.0296	5.0	7.57923	52.6	.0247	2.40	.622	X		High L	Life-
	367	7.83525	56.2	.0260	6.2	7.83475	54.9	.0223	0.51	.539	X 2	0	100%	Test

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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10;15 AM	3/19/69	60V	85°C	
Change	4:15 PM	3/21/69			54 hrs
Stable			40V	125°C	
Stop	10:15 AM	3/22/69			72 hrs

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	368	7.73412	58.2	.0268	0.65	7.73414	57.0	.0253	0.12	.588	X			Life
	369	7.65992	56.4	.0300	150.0	7.65991	55.1	.0215	1.2	.518	X			"
	370	7.72407	57.3	.0249	1.1							M		"
	371	7.59483	54.8	.0242	0.65	7.59482	53.6	.0212	0.45	.525	X			"
5	372	7.64194	55.5	.0265	0.6	7.64196	54.8	.0268	0.39	.649	X			"
	373	7.92226	55.5	.0212	4.0	7.92230	54.5	.0230	0.54	.560	X			"
	374	7.69908	55.9	.0285	1.25	7.69917	55.0	.0222	1.7	.535	X			"
	375	7.86685	55.0	.0200	4.8	7.86691	54.3	.0050	22.0			L		"
	376	7.71378	54.8	.0261	1.7	7.71375	53.8	.0550	1.3	1.355	X			"
	377	7.65078	55.2	.0206	2.4	7.64986	54.4	.0263	0.45	.641	X 8	2	80%	"
	378	7.66135	59.2	.0302	2.4	7.65049	57.8	.0088	0.30			M		Life
	379	7.49612	56.3	.0330	3.8	7.49615	55.0	.0306	0.14	.737	X			"
	380	7.74722	56.8	.0200	7.0	7.74715	55.9	.0341	0.35	.810	X			"
	381	7.66965	57.2	.0270	1.85	7.66953	56.2	.0260	0.93	.613	X			"
6	382	7.71281	54.8	.0224	1.15	7.71270	53.8	.0203	0.45	.500	X			"
	383	7.58758	55.2	.0251	1.55	7.58751	54.7	.0261	0.22	.633	X			"
	384	7.71956	55.1	.0263	7.0	7.71949	54.2	.0227	0.75	.555	X			"
	385	7.85388	56.8	.0180	1.4							M		"
	386	7.82925	56.2	.0213	1.4	7.82916	55.2	.0179	0.36	.430	X		80%	"
	387	7.74560	58.2	.0245	22.5	7.74548	57.1	.0219	8.8	.509	X 8	2	High L	"
	388	7.53233	58.1	.0300	0.65	7.53222	56.9	.0265	0.27	.618	X			Life
	389	7.74817	56.9	.0269	3.2							M		"
7	390	7.68711	54.6	.0242	12.0	7.68709	53.4	.0222	5.0	.551	X		High L	"
	391	7.74852	55.8	.0271	0.3	7.74686	54.9	.0121	1.4			M		"
	392	7.62472	57.5	.0268	4.6							M		"
	393	7.78499	55.8	.0181	2.9	7.78497	55.0	.0200	0.77	.482	X			"

FANSTEEL, INC. Electronic Materials Lab. NAS 12-2004 BURN IN TEST	PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
	Start	10:15 am	3/19/69	60V	85°C	
	Change	4:15 pm	3/21/69			54 hrs
	Stable			40V	125°C	
	Stop	10:15 am	3/22/69			72 hrs

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	394	7.74393	55.8	.0258	0.9	7.74393	55.0	.0224	0.48	.540	X			Life
7	395	7.77430	56.1	.0285	2.25	7.77432	55.3	.0211	2.1	.506	X		High L	"
	396	7.65685	57.0	.0269	1.85	7.65677	56.1	.0238	3.6	.563	X		High L	"
	397	7.80250	55.9	.0259	0.65	7.80240	55.1	.0255	0.32	.614	X 7	3	70%	"
	398	7.97199	57.5	.0190	1.4	7.97193	56.7	.0199	0.48	.465	X			Life
	399	7.66920	55.0	.0250	14.0	7.66904	53.3	.0340	0.58	.846	X			"
	400	7.65284	56.2	.0295	2.0	7.65281	54.9	.0263	0.27	.635	X			"
	401	7.70873	56.3	.0209	1.35							M		"
8	402	7.54385	56.5	.0525	1.6	7.54374	55.1	.0415	0.36	1.000	X			"
	403	7.63405	58.9	.0215	1.2							M		"
	404	7.98777	55.0	.0189	1.6	7.98718	54.1	.0192	0.59	.470	X			"
	405	7.70707	52.3	.0273	4.8							M		"
	406	7.73099	58.5	.0230	8.8	7.73058	57.5	.0290	4.4	.668	X		High L	
	407	7.67090	54.8	.0265	2.7	7.67087	53.9	.0291	0.55	.717	X 7	3	70%	Life
	408	7.67808	55.0	.0208	2.3		54.0	.0040	1.5			M		Life
	409	7.82314	54.2	.0189	3.0							M		"
	410	7.61000	54.7	.0233	4.0	7.61003	53.5	.0193	0.84	.479	X			"
	411	7.69550	59.0	.0271	4.5	7.69555	57.8	.0270	1.45	.619	X			"
9	412	7.73489	57.0	.0186	7.4							M		"
	413	7.83502	56.1	.0178	4.5	7.82411	55.0	.0013	13.5			M		"
	414	7.90491	56.1	.0198	0.9							M		"
	415	7.85598	53.1	.0199	4.6	7.85599	52.2	.0192	1.15	.487	X			"
	416	7.68567	59.1	.0275	1.15	7.68569	58.1	.0202	0.27	.461	X			"
	417	7.81421	54.8	.0214	4.7	7.81431	54.1	.0172	0.44	.422	X 5	5	50%	"
	418	7.81567	55.6	.0195	5.0	7.81553	54.0	.0214	1.8	.526	X			Life
10	419	7.81421	54.3	.0200	15.0									"

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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10:15 am	3/19/69	60V	85°C	
Change	4:15 pm	3/21/69			54 hrs
Stable			40V	125°C	
Stop	10:15 am	3/22/69			72 hrs

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	420	7.79772	55.0	.0181	22.0							M		Life
	421	7.74962	55.0	.0280	1.35	7.74977	54.0	.0740	0.38	1.818	X			"
	422	7.70079	55.3	.0221	1.8	7.70084	54.6	.0172	0.75	.417	X			"
	423	7.71840	60.0	.0261	2.45	7.71845	59.0	.0205	1.8	.461	X			"
10	424	7.66509	55.8	.0252	2.25	7.66466	54.4	.0210	1.1	.512	X			"
	425	7.68851	55.3	.0268	1.85	7.68849	54.3	.0219	0.38	.535	X			"
	426	7.78433	56.5	.0293	1.55	7.78434	55.4	.0245	0.50	.586	X			"
	427	7.67982	56.0	.0245	2.2	7.67982	55.0	.0215	0.45	.518	X 8	2	80%	"

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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10 AM	4/5/69	60V	85°C	
Change	4 PM	4/7/69			54 hrs
Stable			40V	125°C	
Stop	10 AM	4/8/69			72 hrs

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	428	7.67842	53.7	.0260	5.2	7.67842	52.5	.0209	0.31	.528	X			T C & I
	429	7.61913	54.8	.0253	0.37							M		"
	430	7.69921	58.4	.0290	14.0	7.69929	57.6	.0283	0.44	.652	X			"
	431	7.74791	55.0	.0273	2.2	7.74791	54.2	.0219	0.58	.535	X			"
12	432	7.70223	54.6	.0230	5.0							M		"
	433	7.67471	56.9	.0261	1.6	7.67467	55.8	.0231	1.75	.549	X			"
	434	7.76859	52.2	.0281	2.6							M		"
	435	7.68154	55.2	.0278	0.51							M		"
	436	7.64661	53.4	.0335	0.55							M		"
	437	7.69790	54.0	.0275	0.46	7.69773	53.2	.0228	0.28	.568	X 5	5	50%	"
	438	7.72502	55.1	.0270	6.5									T C & I
	439	7.70487	54.1	.0239	1.45									"
	440	7.58375	58.8	.0280	14.0	7.58400	57.5	.0262	5.6	.604	X		High L	"
	441	7.67215	55.0	.0270	0.70							M		"
13	442	7.57401	55.1	.0281	1.15	7.57420	54.2	.0327	0.45	.800	X			"
	443	7.79362	55.6	.0280	1.7							M		"
	444	7.69773	54.8	.0235	4.5							M		"
	445	7.62245	56.5	.0318	3.3	7.62249	55.5	.0250	0.61	.598	X			"
	446	7.70045	54.2	.0296	1.05	7.70047	53.4	.0230	0.35	.571	X			"
	447	7.57044	54.9	.0309	1.7	7.57037	54.2	.0223	0.68	.545	X 5	5	50%	"
	448	7.54028	55.8	.0293	1.6	7.54026	55.0	.0250	1.0	.602	X			T C & I
	449	7.72386	56.0	.0232	6.0							M		"
14	450	7.58081										Short		"
	451	7.68068	54.8	.0254	7.2							M		"
	452	7.62875	58.2	.0316	2.9							M		"
	453	7.69401	55.2	.0260	1.5							M		"

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BURN IN TEST

PROGRAM	TIME	DATE	VOLTAGE	TEMP.	TIME
Start	10:00am	4/5/69	60V	85°C	
Change	4:00pm	4/7/69			54 hrs
Stable	-		40V	125°C	
Stop	10:00am	4/8/69			72 hrs

		INITIAL				AFTER BURN IN								
TRAY No.	CAP No.	W gm	C µf	D	L µa	W gm	C µf	D	L µa	ESR ohm	ACCEPT	FAIL MODE	% ACCEPT	NEXT TEST
	454	7.76371	56.9	.0219	2.1							M		T C & I
14	455	7.80448	59.2	.0196	3.0	7.80446	58.5	.0179	0.44	.405	X			"
	456	7.84962	55.0	.0190	2.7							M		"
	457	7.76131	56.9	.0211	5.5						2	M- 8	20%	"
	458	7.74638	56.2	.0205	12.0	7.74653	54.9	.0162	0.90	.391	X			T C & I
	459	7.81257	56.0	.0194	6.5							M		"
	460	7.60681	55.5	.0251	8.5	7.60700	54.8	.0218	3.6	.528	X		High L	"
	461	7.86059	56.8	.0195	1.5							M		"
15	462	7.84090	57.0	.0200	2.2	7.84139	56.1	.0170	1.0	.402	X			"
	463	7.77787	57.5	.0207	3.1							M		"
	464	7.87945	56.9	.0210	7.0	7.87958	56.0	.0185	1.05	.438	X			"
	465	7.71782	56.0	.0234	2.0							M		"
	466	7.77090	54.9	.0192	2.6							M		"
	467	7.79603	56.8	.0230	3.3	7.79639	55.8	.0193	1.4	.458	X 5	5	50%	"
	468	7.71565	57.0	.0215	5.6	7.71570	56.0	.0184	1.5	.436	X			T C & I
16	469	7.78140	55.0	.0210	4.6							M.	50%	
Total											242	227	52%	
											High L	=(24)		

APPENDIX B

Life Test Data

FANSTEEL, INC. Electronic Materials Lab. NASA 12-2004

LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	W $gx10^3$	ACCEPT	FAIL MODE
1-1	361	25°C, 60V	Init.	54.2	.0233	2.35					
		125°C,40V	Init.	56.4	.0165	1.75	23.5	7.81273			
		"	24	55.8	.0145	1.0	23.8	7.81271	-.02		
		"	115	55.8	.0153	0.95	23.8	7.81270	-.01		
		"	282	55.8	.0161	0.72	23.8	7.81266	-.04		
		"	500	55.6	.0201	0.74	23.8	7.81265	-.01		
		"	1192	56.2	.0230	1.4	23.6	7.81270	+.05		
		"	1505	55.3	.0195	0.46	24.0	7.81264	-.06		
		"	2007	55.2	.0196	0.49	24.0	7.81264	-.0		
		"	2511	55.1	.0180	0.32	24.1	7.81265	+.01		
		"	3015	55.0	.0190	0.30	24.1				
		29°C,60V		53.7	.0246	0.130	24.7	7.81276	+.11	X	
1-2	362	25°C, 60V	Init.	53.3	.0260	0.13					
		125°C,40V	Init.	55.4	.0190	1.5	23.9	7.75192			
		"	24	55.0	.0179	0.84	24.1	7.75182	-.10		
		"	115	55.0	.0173	0.94	24.1	.775184	+.02		
		"	282	54.9	.0222	0.59	24.2	7.75178	-.06		
		"	500	54.8	.0172	0.69	24.2	7.75173	-.05		
		"	1192	55.1	.0200	1.35	24.1	7.75159	-.14		
		"	1505	54.8	.0190	0.53	24.2	7.75171	+.12		
		"	2007	54.6	.0185	1.20	24.3	7.75152	-.19		
		"	2511	54.2	.0189	0.38	24.4	7.75180	+.28		
		"	3015	54.2	.0190	0.41	24.4				
		29°C,60V		52.8	.0216	0.080	25.1	7.75176	-.04	X	
1-3	363	25°C, 60V	Init.	54.2	.0199	0.28					
		125°C,40V	Init.	56.3	.0160	2.2	23.6	7.87061			
		"	24	56.0	.0158	1.15	23.7	7.87052	-.09		
		"	115	55.9	.0150	1.0	23.7	7.87054	+.02		
		"	282	55.8	.0160	0.95	23.8	7.87051	-.03		
		"	500	55.8	.0170	0.86	23.8	7.87045	-.06		
		"	1192	56.1	.0175	1.35	23.6	7.87036	-.09		
		"	1505	55.8	.0156	0.63	23.8	7.87064	+.28		
		"	2007	55.5	.0162	0.60	23.9	7.87050	-.14		
		"	2511	55.3	.0195	0.41	24.0	7.87103	+.53		
		"	3015	55.4	.0169	0.38	23.9				
		29°C,60V		54.2	.0220	0.092	24.4	7.87100	-.03	X	

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LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	W $gx10^3$	ACCEPT	FAIL MODE
1-4	364	25°C-60V	Init.	54.8	.0192	0.80					
		125°C, 40V	Init.	56.5	.0158	3.4	23.5	7.78332			
		"	24	56.2	.0142	6.5	23.6	7.78323	-.09		
		"	115	56.1	.0363	4.4	23.8	7.78300	-.23		
		"	282	55.9	.0735	4.0	23.9	7.78269	-.31		
		"	500	55.9	.0207	2.9	23.7	7.78245	-.24		
		"	1192	56.2	.0197	3.8	23.6	7.78192	-.53		
		"	1505					7.78218	+.26		X
		"	2007			3.9		7.78177			Short
1-5	365	25°C 60V	Init.	55.0	.0199	0.12					
		125°C, 40V	Init.	56.9	.0145	2.2	23.3	7.76851			
		"	24	56.6	.0135	3.5	23.4	7.76851	0		
		"	115	56.6	.0141	1.25	23.4	7.76853	+ .02		
		"	282	56.5	.0183	1.8	23.5	7.76849	- .04		
		"	500	56.6	.0205	0.98	23.4	7.76842	- .07		
		"	1192	56.9	.0184	3.2	23.3	7.76836	- .06		
		"	1505	56.3	.0168	3.2	23.6	7.76858	+ .22		
		"	2007	56.2	.0185	1.5	23.6	7.76847			
		"	2511	55.8	.0194	3.1	23.8	7.76894	+ .47		
		"	3015	55.8	.0168	1.6	23.8				
		29°C,60V		54.5	.0199	0.11	24.3	7.76872	- .22	X	
1-6	366	25°C 60V	Init.	52.8	.0220	0.70					
		125°C, 40V	Init.	54.4	.0165	11.0	24.3	7.57925			
		"	24	54.1	.0155	21.0	24.5	7.57924	- .01		High L
		"	115	54.1	.0242	42.0	24.4	7.57921	- .03		
		"	282	54.1	.0175	33.0	24.5	7.57916	- .05		
		"	500	54.0	.0180	43.0	24.6	7.57915	- .01		
		"	1192	54.1	.0207	36.0	24.5	7.57908	- .07		
		"	1505	53.9	.0321	23.5	24.6	7.57936	+ .28		
		"	2007	53.9	.0212	28.5	24.6	7.57922			
		"	2511	53.9	.0176	23.5	24.6	7.57975	+ .53		
		"	3015	53.8	.0188	42.0	24.6				
		29°C,60V		52.8	.0223	0.46	25.1	7.57970	- .05		X

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LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	W $g \times 10^3$	ACCEPT	FAIL MODE
1-7	367	25°C 60V	Init.	54.9	.0490	0.10					
		125°C,40V	Init.	56.7	.0439	1.65	23.3	7.83479			
		"	24	56.4	.0239	1.0	23.8	7.83471	- .08		
		"	115	56.5	.0397	1.2	23.3	7.83460	- .11		
		"	282	56.3	.0900	1.25	24.0	7.83443	- .17		
		"	500	56.5	.1350	1.1	23.5	7.83410	- .33	No Leak	Crack
		"	1192	56.8	.0226	1.6	23.3	7.83325	- .85		in
		"	1505	56.2	.1720	0.9	23.9	7.83327	+ .02	-	Glass
		"	2007	56.2	.0218	4.2	23.9	7.83263	- .64		
		"	2511	55.9	.0204	0.43	23.7	7.83238	- .25		
		"	3015	55.9	.0580	0.85	23.7				
		29°C,60V		54.6	.0252	0.082	24.3	7.83202	- .36	X	
1-8	368	25°C 60V	Init.	57.3	.0291	0.10					
		125°C,40V	Init.	59.1	.0190	2.2	22.7	7.73422			
		"	24	58.9	.0180	1.55	22.7	7.73414	- .08		
		"	115	58.9	.0245	1.4	22.7	7.73417	+ .03		
		"	282	58.9	.0190	1.45	22.7	7.73415	- .02		
		"	500	58.8	.0195	1.0	22.6	7.73416	+ .01		
		"	1192	59.2	.0210	300.0	22.4	7.73407	- .09		
		"	1505	58.3	.0206	0.9	22.7	7.73436	+ .29		
		"	2007	58.3	.0218	4.6	22.7	7.73403	- .30		
		"	2511	58.3	.0162	0.9	22.7	7.73429	+ .26		
		"	3015	58.1	.0168	0.87	22.8				
		29°C, 60V		56.7	.0195	0.20	23.4	7.73443	+ .14	X	
1-9	369	25°C 60V	Init.	55.4	.0194	0.72					
		125°C, 40V	Init.	57.1	.0161	4.0	23.2	7.65989			
		"	24	56.9	.0159	2.35	23.3	7.65974	- .15		
		"	115	56.8	.0159	1.85	23.3	7.65976	+ .02		
		"	282	56.8	.0190	2.55	23.3	7.65986	+ .10		
		"	500	56.8	.0174	2.4	23.3	7.65982	- .04		
		"	1192	57.2	.0198	370.0	23.2	7.65969	- .13		High I
		"	1505	56.5	.0208	1.84	23.5	7.65994	+ .25		
		"	2007	56.5	.0198	4.3	23.5	7.65965	- .29		
		"	2511	56.3	.0175	2.35	23.6	7.66000	+ .35		
		"	3015	56.3	.0185	1.70	23.6				
		29°C, 60V		54.9	.0236	0.40	24.2	7.66005	+ .05	X	

LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L uh	Z ohm	W g	W $gx10^3$	ACCEPT	FAIL MODE
1-10	371	25°C 60V	Init.	53.9	.0200	0.07					
		125°C,40V	Init.	55.5	.0150	2.0	23.9	7.59478			
		"	24	55.1	.0142	1.55	24.1	7.59464	-.14		
		"	115	55.2	.0157	2.1	24.0	7.59462	-.02		
		"	282	55.1	.0148	1.5	24.1	7.59475	+.13		
		"	500	55.0	.0190	2.4	24.1	7.59468	-.07		
		"	1192	55.3	.0194	10.0	24.0	7.59450	-.18		
		"	1505	55.0	.0178	1.1	24.1	7.59490	+.40		
		"	2007	55.0	.0530	0.81	24.1	7.59448	-.42		
		"	2511	54.8	.0170	0.74	24.2	7.59517	+.69		
		"	3015	54.8	.0176	1.00	24.2				
		29°C,60V		53.4	.0188	0.17	24.8	7.59518	+.01	X	
2-1	372	25°C 60V	Init.	54.9	.0243	0.55					
		125°C,40V	Init.	56.9	.0172	2.8	23.2	7.64187			
		"	24	56.8	.0161	1.7	23.3	7.64185	-.02		
		"	115	56.7	.0169	1.05	23.4	7.64185	0		
		"	282	56.5	.0153	0.78	23.5	7.64188	+.03		
		"	500	56.4	.0181	0.76	23.5	7.64186	-.02		
		"	1192	56.9	.0231	1.05	23.3	7.64180	-.06		
		"	1505	56.2	.0191	0.59	23.6	7.64192	+.12		
		"	2007	56.2	.0269	0.70	23.6	7.64176	-.16		
		"	2511	56.0	.0173	0.45	23.7	7.64203	+.27		
		"	3015	55.9	.0166	0.43	23.7				
		29°C,60V		54.7	.0200	0.034	24.2	7.64226	+.23	X	
2-2	373	25°C 60V	Init.	54.8	.0220	0.48					
		125°C,40V	Init.	56.9	.0163	4.0	23.3	7.82221			
		"	24	56.5	.0153	2.9	23.5	7.92214	-.07		
		"	115	56.3	.0165	3.4	23.6	7.92214	0		
		"	282	56.3	.0210	3.2	23.6	7.92218	+.04		
		"	500	56.2	.0193	2.5	23.6	7.92216	-.02		
		"	1192	56.9	.0206	68.0	23.3	7.92208	-.07		HighL
		"	1505	55.9	.0170	1.68	23.7	7.92217	+.09		
		"	2007	56.2	.0216	34.8	23.6	7.92207	-.10		HighL
		"	2511	55.7	.0168	1.70	23.8	7.92212	+.05		
		"	3015	55.4	.0170	1.65	23.9				
		29°C,60V		54.1	.0202	0.16	24.5	7.92230	+.28	X	

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LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	W $gx10^3$	ACCEPT	FAIL MODE
2-3	374	25°C, 60V	Init.	55.2	.0202	0.61					
		125°C, 40V	Init.	57.0	.0190	4.6	23.3	7.69910			
		"	24	56.9	.0178	2.1	23.3	7.69890	-.20		
		"	115	56.8	.0176	1.5	23.3	7.69901	+.11		
		"	282	56.8	.0800	1.6	23.3	7.69907	+.06		
		"	500	56.8	.0170	1.5	23.3	7.69904	-.03		
		"	1192	57.0	.0200	10.5	23.3	7.69880	-.24		
		"	1505	56.6	.0181	1.7	23.4	7.69920	+.40		
		"	2007	56.5	.0445	1.53	23.5	7.69901	-.19		
		"	2511	56.3	.0172	1.03	23.6	7.69952	+.51		
		"	3015	56.3	.0169	1.30	23.6				
		29°C, 60V		54.9	.0190	0.22	24.2	7.69947	-.05	X	
2-4	376	25°C, 60V	Init.	54.0	.0260	0.94					
		125°C, 40V	Init.	55.9	.0176	2.85	23.7	7.71358			
		"	24	55.8	.0170	2.3	23.8	7.71342	-.16		
		"	115	55.3	.0622	1.85	24.0	7.71333	-.09		
		"	282	55.2	.0328	1.45	24.0	7.71335	+.02		
		"	500	55.2	.0193	1.25	24.0	7.71331	-.04		
		"	1192	55.5	.0208	1.20	23.9	7.71308	-.23		
		"	1505	55.0	.0229	0.65	24.1	7.71318	+.10		
		"	2007	55.0	.0200	1.15	24.1	7.71300	-.18		
		"	2511	54.9	.0194	0.81	24.2	7.71292	-.08		
		"	3015	54.9	.0186	0.92	24.2				
		29°C, 60V		53.2	.0260	0.25	24.9	7.71287	-.05	X	
2-5	377	25°C, 60V	Init.	54.6	.0275	0.32					
		125°C, 40V	Init.	56.3	.0153	1.9	23.6	7.64989			
		"	24	56.2	.0150	2.7	23.6	7.64974	-.15		
		"	115	56.1	.0201	2.4	23.6	7.64980	+.06		
		"	282	55.9	.0845	2.0	23.7	7.64974	-.06		
		"	500	56.0	.0859	2.2	23.7	7.64980	+.06		
		"	1192	56.1	.0213	1.25	23.6	7.64968	-.12		
		"	1505	55.8	.0252	2.1	23.8	7.64981	+.13		
		"	2007	55.8	.0505	0.88	23.8	7.64971	-.10		
		"	2511	55.8	.0159	0.71	23.8	7.64993	+.22		
		"	3015	55.5	.0165	0.77	23.9				
		29°C, 60V		54.2	.0182	0.12	24.4	7.64992	-.01	X	

LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	W $g \times 10^3$	ACCEPT	FAIL MODE
2-6	379	25°C,60V	Init.	55.1	.0328	0.09					
		125°C, 40V	Init.	56.9	.0220	1.75	23.6	7.49602			
		"	24	56.9	.0222	1.1	23.2	7.49600	-.02		
		"	115	56.8	.0420	0.85	23.3	7.49597	-.03		
		"	282	56.5	.1670	0.82	23.8	7.49603	+.06		
		"	500	56.7	.0220	0.73	23.4	7.49605	+.02		
		"	1192	56.9	.0212	1.35	23.3	7.49591	-.14		
		"	1505	56.3	.0701	0.68	23.6	7.49620	+.29		
		"	2007	56.3	.0400	0.55	23.6	7.49605	-.15		
		"	2511	56.2	.0230	0.48	23.6	7.49657	+.52		
		"	3015	55.9	.0226	0.46					
		29°C, 60V		54.3	.0265	0.038		7.49662	+.05	X	
2-7	380	25°C,60V	Init.	55.9	.0327	0.24					
		125°C,40V	Init.	57.5	.0140	2.85	23.2	7.74706			
		"	24	57.5	.0139	5.0	23.2	7.74708	+.02		
		""	115	57.3	.0173	2.1	23.3	7.74709	+.01		
		"	282	57.2	.3450	2.05	23.3	7.74714	+.05		
		"	500	57.2	.0194	2.05	23.2	7.74712	-.02		
		"	1192	57.3	.0178	18.0	23.1	7.74711	-.01		HighL
		"	1505	56.9	.0275	1.9	23.3	7.74728	+.17	L O.K	
		"	2007	56.9	.0195	1.38	23.3	7.74717	-.11		
		"	2511	56.8	.0180	1.70	23.3	7.74736	+.19		
		"	3015	56.8	.0184						
		29°C,60V		54.9	.0230	0.40		7.74738	+.02	X	
2-8	381	25 C 60V	Init.	56.3	.0250	0.25					
		125°C,40V	Init.	58.2	.0167	2.05	22.7	7.66941			
		"	24	58.1	.0158	1.65	22.8	7.66948	+.07		
		"	115	57.8	.0213	1.2	22.9	7.66946	-.02		
		"	282	57.8	.0189	0.92	22.9	7.66954	+.08		
		"	500	57.7	.0240	0.95	23.0	7.66952	-.02		
		"	1195	58.0	.0212	1.15	22.9	7.66927	-.25		
		"	1505	57.6	.0217	0.6	23.0	7.66941	+.14		
		"	2007	57.5	.085	1.40	23.1	7.66902	-.39		
		"	2511	57.4	.0180	0.51	23.1	7.66917	+.15		
		"	3015	57.1	.0186	0.65					
		29°C,60V		55.5	.0231	0.068		7.66903	-.14	X	

LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	W gx10^3	ACCEPT	FAIL MODE
2-9	382	25°C,60V	Init.	53.9	.0190	0.37					
		125°C, 40V	Init.	55.3	.0195	2.15	24.0	7.71259			
		"	24	55.3	.0183	1.75	24.0	7.71267	+.08		
		"	115	55.0	.0538	1.45	24.1	7.71267	0		
		"	282	55.0	.0273	3.2	24.1	7.76123	+.05		
		"	500	55.1	.0166	2.15	24.1	7.71269	-.04		
		"	1192	55.1	.0198	6.5	24.1	7.71273	+.04		
		"	1505	54.9	.0204	1.05	24.2	7.71280	+.07		
		"	2007	54.9	.0178	1.10	24.2	7.71272	-.08		
		"	2511	54.7	.0170	0.92	24.2	7.71275	+.03		
		"	3015	54.7	.0131	1.05	24.2				
		29°C,60V		53.2	.0180	0.26	24.9	7.71284	+.09	X	
2-10	383	25°C,60V	Init.	54.8	.0241	0.15					
		125°C,40V	Init.	56.5	.0145	2.1	23.5	7.58737			
		"	24	56.3	.0139	1.25	23.5	7.58745	+.08		
		"	115	56.2	.0152	0.86	23.6	7.58736	-.09		
		"	282	56.1	.0155	0.70	23.6	7.58756	+.20		
		"	500	56.2	.0157	0.70	23.6	7.58752	-.04		
		"	1192	56.2	.0188	1.1	23.6	7.58737	-.15		
		"	1505	55.8	.0189	0.44	23.8	7.58761	+.24		
		"	2007	55.8	.0178	0.76	23.8	7.58742	-.19		
		"	2511	55.6	.0178	0.55	23.8	7.58789	+.47		
		"	3015	55.4	.0168	0.55	23.9				
		29°C,60V		54.0	.0222	0.048	24.6	7.58802	+.13	X	
3-1	384	25°C,60V	Init.	54.2	.0230	0.66					
		125°C,40V	Init.	56.3	.0158	4.3	23.6	7.71946			
		"	24	56.2	.0153	2.25	23.6	7.71933	-.13		
		"	115	56.2	.0330	1.4	23.6	7.71918	-.15		
		"	282	56.0	.0150	0.94	23.7				Leak

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LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	W $gx10^3$	ACCEPT	FAIL MODE
3-2	386	25°C ,60V	Init.	54.2	.0179	0.13					
		125°C,40V	Init.	57.1	.0149	2.1	23.2	7.82913			
		"	24	57.1	.0158	1.45	23.2	7.82912	-.01		
		"	115	57.0	.0705	1.1	23.3	7.82898	-.14		
		"	282	56.9	.0222	0.90	23.3	7.82911	+.13		
		"	500	56.9	.0328	0.83	23.3	7.82908	-.03		
		"	1192	57.3	.0245	1.3	23.1	7.82917	+.08		
		"	1505	56.9	.0156	0.67	23.3	7.82913	-.04		
		"	2007	56.9	.0182	0.99	23.3	7.82912	-.01		
		"	2511	56.6	.0159	0.62	23.4	7.82924	+.12		
		"	3015	56.6	.0189	0.54	23.4				
		29°C,60V		55.0	.0193	0.071	24.1	7.82926	+.02	X	
3-3	387	25°C,60V	Init.	57.2	.0218	5.6					
		125°C,40V	Init.	59.1	.0165	9.6	22.4	7.74550			
		"	24	59.1	.0169	8.8	22.4	7.74553	+.03		
		"	115	59.0	.0181	4.0	22.5	7.74541	-.11		
		"	282	58.9	.0180	2.75	22.5	7.74554	+.13		
		"	500	59.0	.0187	1.7	22.5	7.74548	-.06		
		"	1192	59.1	.0258	2.25	22.4	7.74559	+.11		
		"	1505	58.5	.0198	1.22	22.7	7.74555	-.04		
		"	2007	58.5	.0282	1.40	22.7	7.74556	+.01		
		"	2511	58.3	.0211	0.96	22.7	7.74675	+.19		
		"	3015	58.3	.0253	0.81	22.7				
		29°C,60V		56.5	.0280	0.11	23.5	7.74580	+.05	X	
3-4	388	25°C,60V	Init.	56.9	.0269	1.45					
		125°C,40V	Init.	58.9	.0186	4.5	22.5	7.53222			
		"	24	58.8	.0181	4.0	22.5	7.53211	-.11		
		"	115	58.7	.0183	3.8	22.6	7.53188	-.23		
		"	282	58.2	.0204	3.2	22.8	7.53179	-.09		
		"	500	58.2	.0300	1.4	22.8	7.53152	-.27		Leak
		"		58.2	.0244	1.75	22.8	7.53106	-.46		X

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LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	ΔW $gx10^3$	ACCEPT	FAIL MODE
3-5	390	25°C, 60V	Init.	53.7	.0218	0.65					
		125°C, 40V	Init.	55.2	.0165	3.8	24.0	7.68717			
		"	24	55.1	.0167	3.5	24.1	7.68701	-.16		
		"	115	55.1	.0223	3.4	24.1	7.68673	-.28		
		"	282	54.9	.0368	1.6	24.2	7.68638	-.35		Leak
3-6	393	25°C, 60V	Init.	55.0	.0205	0.60	24.1				
		125°C, 40V	Init.	56.9	.0140	3.3	23.3	7.78502			
		"		56.8	.0141	4.0	23.3				Leak
3-7	394	25°C, 60V	Init.	55.0	.0224	0.22					
		125°C, 40V	Init.	56.9	.0190	3.1	23.3	7.74387			
		"	24	56.8	.0260	2.6	23.3	7.74393	+.06		
		"	115	56.7	.0560	2.45	26.9	7.74392	-.01		
		"	282	56.8	.0190	2.05	23.3	7.74392	0		
		"	500	56.7	.0375	1.8	23.4	7.74392	0		
		"	1192	56.9	.0800	2.7	24.1	7.74409	+.17		
		"	1505	56.3	.0528	1.75	23.8	7.74403	-.06		
		"	2007	56.3	.0372	1.95	23.6	7.74404	+.01		
		"	2511	56.2	.0200	1.45	23.6	7.74422	+.18		
		"	3015	55.9	.0418	3.0	23.9				
		29°C, 60V		54.5	.0305	0.23	24.3	7.74431	+.09	X	
3-8	395	25°C, 60V	Init.	55.7	.0215	0.42					
		125°C, 40V	Init.	57.2	.0152	3.4	23.2	7.77434			
		"	24	57.2	.0160	3.4	23.2	7.77426	-.08		
		"	115	57.2	.0163	2.1	23.2	7.77421	-.05		
		"	282	57.1	.0160	1.6	23.2	7.77429	+.08		
		"	500	57.1	.0462	1.55	23.5	7.77424	-.05		
		"		57.3	.0700	760.0	23.8	7.76256			Leak

LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	ΔW $gx10^3$	ACCEPT	FAIL MODE
3-9	396	25°C,60V	Init.	56.2	.0238	1.15					
		125°C,40V	Init.	57.9	.0182	2.3	22.9	7.65676			
		"	24	57.7	.0194	3.2	23.0	7.65679	+.03		
		"	115	57.8	.0208	1.9	23.4	7.65679	0		
		"	282	57.5	.0462	5.2	23.1	7.65676	-.03		
		"	500	57.3	.0980	7.7	23.2	7.65673	-.03		
		"	1192	58.0	.0242	1.6	22.9	7.65668	-.05		
		"	1505	57.3	.0204	0.71	23.1	7.65660	-.08		
		"	2007	57.3	.0345	0.95	23.1	7.65656	-.04		
		"	2511	57.1	.0216	0.54	23.2	7.65678	+.22		
		"	3015	57.1	.0232	0.58	23.2				
		29°C,60V		55.7	.0312	0.70	23.8	7.65676	-.02	X	
3-10	397	25°C,60V	Init.	55.1	.0248	0.28					
		125°C,40C	Init.	57.0	.0201	1.85	23.3	7.80238			
		"	24	56.9	.0240	1.55	23.3	7.80242	+.04		
		"	115	56.9	.0302	1.2	23.3	7.80251	+.09		
		"	282	56.9	.0250	1.05	23.3	7.80248	-.03		
		"	500	56.7	.0542	1.0	26.6	7.80247	-.01		
		"	1192	57.0	.0202	1.5	23.3	7.80251	+.04		
		"	1505	56.6	.0221	0.77	23.4	7.80256	+.05		
		"	2007	56.3	.059	1.15	23.6	7.80258	+.02		
		"	2511	56.2	.0188	0.71	23.6	7.80251	-.07		
		"	3015	56.0	.0240	0.71	23.7				
		29°C,60V		54.3	.0450	0.074	24.5	7.80255	+.04	X	
4-1	398	25°C 60V		56.5	.0208	1.65					
		125°C,40V		58.3	.0145	1.7	22.7	7.97193			
		"	24	58.2	.0141	1.25	22.8	7/97184	-.09		
		"	115	58.2	.0155	0.88	22.8	7.97198	+.14		
		"	282	56.2	.0335	29.0	23.6				Leak

NOTE: Readings of capacitors on Tray No. 4 were eratic after 3015 hours. All units not previously rejected due to electrolyte leakage were placed on a new tray and tested at 25°C, 60V, then replaced at 125°C. 40V and tested after 30 minutes stabilization.

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LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	ΔW $gx10^3$	ACCEPT	FAIL MODE
4-2	399	25°C 60V	Init.	53.5	.0348	0.18					
		125°C,40V	Init.	55.1	.0192	2.65	24.1	7.66905			
		"	24	55.2	.0191	1.75	24.0	7.66900	-.05		
		"	115	55.0	.0190	1.9	24.1	7.66915	+.15		
		"	282	55.0	.0218	1.2	24.1	7.66916	+.01		
		"	500	55.0	.0244	1.4	24.1	7.66915	-.01		
		"	1192	55.2	.2050	1.7	24.5	7.66893	-.22		
		"	1505	54.8	.0217	0.93	24.2	7.66871	-.22		
		"	2007			1.15		7.66824	-.47		
		"	2511	55.2	.0470		24.3	7.66805	-.19		
		"	3015			0.51					
		29°C,60V		56.8	.0256		23.3				
		"		52.9	.0445	0.40	25.0	7.66893	-.12	X	
4-3	400	25°C 60V	Init.	55.0	.0277	0.13					
		125°C,40V	Init.	56.8	.0190	2.75	23.3	7.65283			
		"	24	56.5	.0235	1.6	23.5	7.65276	-.07		
		"	115	56.6	.103	1.1	23.5	7.65294	+.18		
		"	282	54.5	1.42	0.78	42.1	7.65293	-.01		
		"	500	56.5	.0205	0.90	23.5	7.65295	+.02		
		"	1192	56.7	.2050	1.25	23.8	7.65296	+.01		
		"	1505	56.2	.159	0.53	23.9	7.65292	-.04		
		"	2007			0.80		7.65292	0		
		"	2511			0.93		7.65305	+.13		
		"	3015			0.30					
		29°C,60V		55.8	.0210	10.5	23.8				
		"		57.0	.0183	43.0	23.3	7.65325	+.20		High L
4-4	402	25°C,60V	Init.	55.1	.0450	0.11					
		125°C,40V	Init.	57.1	.0237	1.8	23.2	7.54387			
		"	24	57.0	.0239	1.4	23.3	7.54376	-.11		
		"	115	56.9	.0272	1.9	23.3	7.54383	+.07		
		"	282	56.2	.0260	1.15	23.6	7.54387	+.04		
		"	500	56.9	.0262	1.15	23.3	7.54388	+.01		
		"	1192	56.9	.0337	1.4	23.3	7.54388	0		
		"	1505	56.3	.0278	0.75	23.6	7.54391	+.03		
		"	2007	56.3	.0380	0.84	23.6	7.54391	0		

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LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	ΔW $g \times 10^3$	ACCEPT	FAIL MODE
4-4	402	125°C, 40V									
		"	2511	56.9	.0322	0.96	23.3	7.54407	+.16		
		"	3015	56.2	.0300	0.47	23.6				
		29°C, 60V		57.6	.0319		23.0				
		"		54.0	.0470	0.035	24.6	7.54420	+.13		
		"		56.2	.0293	0.34	23.6			X	
4-5	404	25°C, 60V	Init.	54.2	.0196	0.21					
		125°C, 40V	Init.	56.1	.0145	2.9	23.6	7.98722			
		"	24	56.1	.0140	4.9	23.6	7.98703	-.19		
		"	115	55.9	.0142	4.0	23.7	7.98707	-.04		
		"	282	55.8	.0197	1.3	23.8	7.98700	-.07		
		"	500	55.8	.0162	1.4	23.8	7.98695	-.05		
		"	1192	56.2	.0200	1.85	23.6	7.98670	+.05		
		"	1505	55.8	.0175	0.82	23.8	7.98655	-.15		
		"	2007	55.8	.0190	0.81	23.8	7.98657	+.02		
		"	2511	56.4	.0222	0.98	23.5	7.98683	+.26		
		"	3015	55.3	.0272	0.62	24.0				
		29°C, 60V		57.2	.0215		23.2				
		" "		53.9	.0193	0.65	24.6	7.98687	+.04		
		"		55.7	.0178	0.40	23.8			X	
4-6	406	25°C, 60V	Init.	57.4	.0303	56.0					
		125°C, 40V	Init.	59.3	.0164	6.0	22.4	7.73060			
		"	24	59.1	.0165	2.3		7.72973	-.87		Leak
4-7	407	25°C, 60V	Init.	54.0	.0303	0.28					
		125°C, 40V	Init.	55.8	.0170	3.4	23.8	7.67097			
		"	24	55.7	.0171	2.2	23.8	7.67089	-.08		
		"	115	55.4	.0179	1.8	23.9	7.67086	-.03		
		"	282	55.6	.0202	5.0	24.0	7.67096	+.10		
		"	500	55.0	.0182	1.55	24.0	7.67089	-.07		
		"	1192	55.6	.0320	1.8	23.8	7.67089	0		
		"	1505	55.1	.0175	1.6	24.1	7.67082	-.07		
		"	2007	55.0	.0201	1.67	24.1	7.67095	+.13		
		"	2511	55.8	.0230	1.54	23.8	7.67124	+.29		
		""	3015	55.0	.0170	0.73	24.1				
		29°C, 60V		56.8	.0235		23.3				
		"		53.2	.0265	0.022	24.9				
		"		54.9	.0175	0.43	24.2	7.67138	+.14	X	

LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	ΔW gx10^3	ACCEPT	FAIL MODE
4-8	410	25°C,60V	Init.	53.8	.0204	0.31					
		125°C,40V	Init.	55.3	.0160	5.3	24.0	7.61017			
		"	24	55.3	.0160	3.2	24.0	7.61013	-.04		
		"	115	55.2	.0141	2.3	24.0	7.61007	-.06		
		"	282	55.1	.0169	1.85	24.1	7.61011	+.04		
		"	500	55.2	.0182	2.6	24.0	7.61006	-.05		
		"	1192	55.3	.0204	1.8	24.0	7.61006	0		
		"	1505	55.0	.0162	1.1	24.1	7.61002	-.04		
		"	2007	55.0	.0262	1.55	24.1	7.61014	+.12		
		"	2511	55.8	.0215	1.56	23.8	7.61009	-.05		
		"	3015	54.9	.0160	0.78	24.2				
		29°C,60V		56.6	.0185		23.4				
		"		53.2	.0299	0.096	24.9	7.61021	+.12		
		"		54.9	.0195	0.40	24.2			X	
4-9	411	25°C,60V	Init.	57.9	.0298	0.92					
		125°C,40V	Init.	60.0	.0175	2.9	22.1	7.69578			
		"	24	59.8	.0171	2.5	22.2	7.69568	-.10		
		"	115	59.9	.0183	2.35	22.1	7.69555	-.13		
		"	282	59.8	.0230	1.8	22.2	7.69567	+.12		
		"	500	59.7	.0193	2.3	22.2	7.69566	-.01		
		"	1192	59.8	.2780	2.1	23.0	7.69566	0		
		"	1505	59.4	.0192	1.33	22.3	7.69551	-.15		
		"	2007	59.4	.0562	1.28	22.3	7.69520	-.31		
		"	2511			1.77		7.69571	+.51		
		"	3015	59.2	.0176	1.15	22.4				
		29°C,60V		62.1	.0258						
				57.6	.0189	0.92	23.0	7.69580	+.09		
				54.2	.0185	0.54	24.4			X	
4-10	415	25°C,60V	Init.	52.2	.0200	0.60					
		125°C,40V	Init.	54.1	.0145	3.0	24.5	7.85616			
		"	24	54.0	.0140	3.1	24.6	7.85613	-.03		
		"	115	54.0	.0162	4.1	24.6	7.85600	-.13		
		"	282	43.0	3.83	28.0	122.1	7.85611	+.11		
		"	500	54.0	.1890	1.2	25.0	7.85607	-.04		
		"	1192	54.0	.0287	1.55	24.6	7.85600	-.07		
		"	1505	54.5	.300	0.76	25.2	7.85588	-.12		

LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	ΔW gx10^3	ACCEPT	FAIL MODE
4-10	415	125°C,40V									
		"	2007			1.33		7.85605	+.17		
		"	2511	54.2	0.13	1.38	24.6	7.85621	+.16		
		"	3015		0.29						
		25°C,60V		56.2	.0299		23.6				
		29°C,60V		51.7	.1515	0.025	25.9	7.85628	+.07		
		"		53.4	.0170	0.46	24.9			X	
5-1	416	25°C,60V	Init.	58.3	.0183	0.18					
		125°C,40V	Init.	60.5	.0157	2.55	21.9	7.68581			
		"	24	60.3	.0150	1.9	22.0	7.68571	-.10		
		"	115	60.2	.0160	1.55	22.0	7.68571	0		
		"	282	60.0	.0179	1.25	22.1	7.68574	+.03		
		"	500	60.0	.0162	1.05	22.1	7.68569	-.05		
		"	1192	60.0	.0215	1.7	22.0	7.68575	+.06		
		"	1505	59.8	.0308	0.71	22.2	7.68571	-.04		
		"	2007	59.6	.0278	8.9	22.2	7.68571	0		
		"	2511	59.5	.0205	0.88	22.3	7.68604	+.27		
		"	3015	59.3	.0286	0.88	22.4				
		29°C,60V		57.3	.0257	0.074	23.2	7.68636	+.32	X	
5-2	417	25°C,60V	Init.	54.2	.0208	0.14					
		125°C,40V	Init.	56.1	.0134	1.7	23.6	7.81446			
		"	24	56.0	.0133	1.3	23.7	7.81434	-.12		
		"	115	55.9	.0140	1.1	23.7	7.81433	-.01		
		"	282	56.0	.0203	1.0	23.7	7.81435	+.02		
		"	500	56.0	.0152	0.92	23.7	7.81418	-.17		
		"	1192	56.2	.0282	1.7	23.6	7.81415	-.03		
		"	1505	55.8	.0146	0.90	23.8	7.81403	-.12		
		"	2007	55.8	.0183	0.96	23.8	7.81393	-.10		
		"	2511	55.6	.0168	0.63	23.8	7.81361	-.32		
		"	3015	55.3	.0172	0.71	24.0				X
		29°C,60V		53.6	.0194	0.12	24.7	7.81328	-.43		Leak
5-3	418	25°C,60V	Init.	53.9	.0237	1.35					
		125°C,40V	Init.	55.8	.0212	5.0	23.8	7.81576			
		"	24	55.5	.0202	3.9	23.9	7.81551	-.25		
		"	115	55.7	.0180	4.2	23.8	7.81536	-.15		

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LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	Δ W gx10^3	ACCEPT	FAIL MODE
5-3	418	125°C,40V	282	55.2	.0196	4.4	24.0	7.81527	-.09		
		"	500	55.2	.0219	5.4	24.0	7.81512	-.15		
		"	1192	55.8	.0202	82.0	23.8	7.81494	-.18		
		"	1505	55.1	.0189	5.0	24.1	7.81478	-.16		High L
		"	2007	55.2	.0196	15.8	24.0	7.81478	0		
		"	2511	55.0	.232	2.2	24.7	7.81388	-.90		
		"	3015	55.0	.282	20.0	25.2				High L
		29°C,60V		53.4	.0245	0.54	24.8	7.81178	-.210		X Δ W
5-4	421	25°C,60V	Init.	54.0	.0410	0.09					
		125°C,40V	Init.	56.0	.0181	2.2	23.7	7.74994			
		"	24	55.8	.0180	1.45	23.8	7.74977	-.17		
		"	115	55.8	.0172	1.2	23.8	7.74970	-.07		
		"	282	55.7	.0240	1.0	23.8	7.74969	-.01		
		"	500	55.6	.0186	1.05	23.8	7.74975	+.06		
		"	1192	56.0	.0235	1.7	23.7	7.74969	-.06		
		"	1505	55.3	.0241	0.95	24.0	7.74969	0		
		"	2007	55.3	.0250	0.84	24.0	7.74972	+.03		
		"	2511	55.0	.0234	0.66	24.1	7.74973	+.01		
		"	3015	54.8	.0230	0.66	24.2				
		29°C,60V		52.8	.0297	0.15	25.1	7.73623	-.01350 g		Δ W X
5-5	422	25°C,60V	Init.	54.7	.0179	0.12					
		125°C,40V	Init.	56.3	.0143	1.7	23.6	7.70103			
		"	24	56.2	.0141	1.45	23.6	7.70087	-.16		
		"	115	56.2	.0143	1.4	23.6	7.70084	-.03		
		"	282	56.2	.0171	1.3	23.6	7.70091	+.07		
		"	500	56.2	.0150	1.2		7.70008			Leak

LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	Δ W gx10^3	ACCEPT	FAIL MODE
5-6	423	25°C,60V	Init.	59.1	.0216	0.75					
		125°C,40V	Init.	61.2	.0160	11.0	21.7	7.71835			
		"	24	61.0	.0145	11.5	21.7	7.71845	+.10		
		"	115	61.0	.0182	10.0	21.7	7.71847	+.02		
		"	282	61.0	.0160	30.0	21.7	7.71851	+.04		High L
		"	500	60.9	.0200	60.0	21.8	7.71853	+.02		
		"	1192	61.0	.0267	1.9	21.7	7.71822	-.31		
		"	1505	60.5	.0213	1.28	21.9	7.71808	-.14		
		"	2007	60.5	.0195	0.87	21.9	7.71801	-.07		
		"	2511	60.2	.0730	0.65	22.6	7.71756	-.45		
		"	3015	60.0	.0200	0.58	22.1				
		29°C,60V		57.8	.0237	3.8	22.9	7.71751	0.05		High L X
5-7	424	25°C,60V	Init.	54.8	.0220	1.15					
		125°C,40V	Init.	56.3	.0210	2.6	23.6	7.66449			
		"		56.2	.0172	1.70	23.6				Leak
5-8	425	25°C,60V	Init.	54.2	.0231	0.11					
		125°C,40V	3 PM	56.2	.0158	1.95	23.6	7.68832			
		"	24	56.2	.0158	1.60	23.6	7.68848	+.16		
		"	115	56.1	.0209	1.4	23.6	7.68843	-.05		
		"	282	56.1	.0211	1.7	23.6	7.68835	-.08		
		"	500	55.9	.0219	1.4	23.7	7.68822	-.13		
		"	1192	56.2	.0265	1.95	23.6	7.68762	-.60		
		"	1505	55.8	.0200	0.95	23.8	7.68734	-.28		
		"	2007	55.8	.0410	1.83	23.8	7.68717	-.17		
		"	2511	55.3	.0280	1.47	24.0	7.68720	+.03		
		"	3015	55.3	.0320	1.28	24.0				
		29°C,60V		53.9	.0270	0.094	24.6	7.68722	+.02	X	

LIFE TEST

TRAY No.	CAP. No.	CONDITION	TIME Hrs.	C uf	D	L ua	Z ohm	W g	ΔW gx10^3	ACCEPT	FAIL MODE
5-9	426	25°C,60V	Init.	55.5	.0260	0.18					
		125°C,40V	Init.	57.2	.0181	2.0	23.2	7.78408			
		"	24	57.1	.0176	1.45	23.2	7.78438	+.30		
		"	115	57.2	.0172	1.15	23.2	7.78441	+.03		
		"	282	57.0	.0198	1.05	23.3	7.78440	-.01		
		"	500	57.0	.0197	0.88	23.3	7.78432	-.08		
		"	1192	57.2	.0274	1.55	23.2	7.78426	-.06		
		"	1505	56.9	.0210	0.76	23.3	7.78422	-.04		
		"	2007	56.9	.0199	0.94	23.3	7.78428	+.06		
		"	2511	56.8	.0203	0.67	23.3	7.78452	+.24		
		"	3015	56.6	.0308	0.59	23.4				
		29°C, 60V		55.0	.0214	0.066	24.1	7.78487	+.37	X	
5-10	427	25°C,60V	Init.	55.0	.0217	0.27					
		125°C,40V	Init.	56.9	.0160	2.0	23.2	7.67952			
		"	24	56.9	.0161	1.4	23.3	7.67985	+.33		
		"	115	56.8	.0169	1.0	23.3	7.67990	+.05		
		"	282	56.8	.0197	1.05	23.3	7.67987	-.03		
		"	500	56.5	.0363	0.78	23.5	7.67989	+.02		
		"	1192	56.8	.0268	1.65	23.3	7.67973	-.16		
		"	1505	56.2	.0208	0.69	23.6	7.67959	-.14		
		"	2007	56.2	.0232	0.69	23.6	7.67962	+.03		
		"	2511	56.0	.0246	0.56	23.7	7.67984	+.22		
		"	3015	55.8	.0206	0.48	23.8				
		29°C.,60V		54.1	.0270	0.17	24.5	7.68014	+.30	X	

APPENDIX C

Reverse Voltage Tolerance Test Data

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V,25°C	TIME Hrs.	C µf	△ C %	D	L µ a	W g	ACCEPT	FAIL Mode
8-1	292		0	53.0	0	.330	1.80	7.54927		
		-1.0V	24	53.0	0	.0340	0.75			
		"	100	53.0	0	.0338	0.59			
		"	244	53.2	+0.38	.0318	0.85			
		"	524	53.1	+0.19	.0300	0.55			
		"	1007	53.2	+0.4	.0340	0.10			
		Note 1	1511	53.0	0	.0365	0.57			
		Note 2	1511							
		-1.5V	1679	53.2	+0.38	.0348	3.0			High L
		Note 3	2039	53.2	+0.38	.0352	2.7			
		-2.0V	2183	54.0	+1.9	.0298	40.0			
		"	2519	53.7	+1.3	.0357	22.5			
		"	3000	53.8		.0355	19.0	7.55021		
		Soak:+60V	18	53.5		.0341	3.5			X

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.5V
3. On -2.0V after test

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V, 25°C	TIME Hrs.	C µf	Δ C %	D	L µ a	W g	ACCEPT	FAIL Mode
8-2	294		0	53.2		.0208	0.50	7.76000		
		-1.0V	24	53.3	+0.19	.0255	1.20			
		"	100	53.2	0	.0222	2.0			
		"	244	53.5	+0.6	.0225	6.6			High L
		"	524	53.8	+1.1	.0210	7.8			"
		"	1007	53.7	+0.9	.0200	9.0			
		Note 1	1511	53.5	+0.6	.0214	8.0			
		Note 2	1511							
		-1.5V	1679	54.0	+1.5	.0200	7.4			
		Note 3	2039	54.0	+1.5	.0195	5.2			
		-2.0V	2183	54.2	+1.7	.0198	5.4			
		"	2519	53.9	+1.3	.0208	2.8			
		"	3000	54.0		.0185	1.5			
		Soak@+60V	18	53.8		.0168	.9	7.76089		X
8-3	295		0	56.7		.0202	0.29	7.84436		
		-1.0V	24	56.8	+0.18	.0215	0.29			
		"	100	56.7	0	.0195	0.30			
		"	244	56.8	+0.2	.0185	3.4			High L
		"	524	56.9	+0.4	.0301	1.25			
		"	1007	56.8	+0.2	.0202	2.6			
		Note 1	1511	56.8	+0.2	.0188	2.7			
		Note 2	1511							
		-1.5V	1679	56.9	+0.4	.0188	2.6			
		Note 3	2039	56.9	+0.4	.0196	2.8			
		-2.0V	2183	57.3	+1.1	.0218	5.0			
		"	2519	57.3	+1.1	.0172	10.5			
		"	3000	57.3		.0214	3.1			
		Soak@+60V	18	57.2		.0208	3.2	7.84495		X
8-4	296		0	55.3		.0293	1.45	7.69367		
		-1.0V	24	55.3	0	.0273	1.35			
		"	100	55.2	-0.18	.0313	1.05			
		"	244	55.3	0	.0296	0.81			
		"	524	55.8	+0.9	.0301	0.75			
		"	1007	55.6	+0.6	.0298	0.63			
		Note 1	1511	55.4	+0.2	.040	0.35			
		Note 2	1511							
		-1.5V	1679	55.2	+1.6	.033	1.07			
		Note 3	2039	56.3	+1.8	.0258	1.07			
		-2.0V	2183	56.2	+1.6	.0226	0.73			
		"	2519	56.2	+1.6	.0260	0.68			
		"	3000	56.2		.0318	0.79			
		Soak@+60V	18	55.9		.0320	0.30	7.69458	X	

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On-1.5V
3. On-2.0V after test

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V, 25°C	TIME Hrs.	C µf	Δ C %	D	L µa	W g	ACCEPT	FAIL Mode
8-5	297		0	55.7		.0308	0.38	7.71903		
		-1.0V	24	55.8	+0.18	.0338	0.64			
		"	100	55.8	+0.18	.0302	1.15			
		"	244	55.9	+0.4	.0290	2.8			High L
		"	524	56.0	+0.6	.0255	3.0			
		"	1007	56.0	+0.6	.0298	4.4			
		Note 1	1511	55.9	+0.4	.0312	3.3			
		Note 2	1511							
		-1.5V	1679	56.2	+0.9	.0284	3.1			
		Note 3	2039	56.3	+1.1	.0262	3.6			
		-2.0V	2183	56.6	+1.6	.0229	2.6			High L
		"	2519	56.7	+1.8	.0185	1.1			L o.k.
		"	3000	56.6		.0235	1.1			
		Soak+60V	18	56.3		.0203	0.9	7.71960		X
8-6	298	-1.0V	0	55.0		.0200	0.33	7.89602		
		"	24	54.9	-0.18	.0241	0.80			
		"	100	54.9	-0.18	.0218	0.56			
		"	244	55.0	0	.0260	0.63			
		"	524	55.0	0	.0281	0.75			High L
		"	1007	55.0	0	.0222	2.3			
		Note 1	1511	55.0	0	.0190	1.8			
		Note 2	1511							
		-1.5V	1679	55.3	+0.6	.016	1.8			
		Note 3	2039	55.3	+0.6	.0158	2.6			High L
		-2.0V	2183	55.5	+0.9	.0152	2.3			
		"	2375	-	-	-	-			Leak
8-7	300	-1.0V	0	52.2		.0183	0.41	7.77697		
		"	24	52.2	0	.0175	0.38			
		"	100	52.2	0	.0168	0.41			
		"	244	52.2	0	.0169	0.55			
		"	524	52.2	0	.0168	0.66			
		"	1007	52.4	+0.38	.0182	0.69			
		Note 1	1511	52.3	-0.2	.0169	0.64			
		Note 2	1511							
		-1.5V	1679	52.7	+1.0	.0165	1.08			
		Note 3	2039	52.7	+1.0	.0158	1.5			
		-2.0V	2183	52.8	+1.2	.0162	1.05			
		"	2519	52.8	+1.2	.0198	1.25			
		"	3000	52.8		.0189	1.25			
		Soak +60V	18	52.5		.0180	0.77	7.77784	X	

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.5V
3. On -2.0V after test

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V, 25°C	TIME Hrs.	C µf	Δ C %	D	L µ a	W g	ACCEPT	FAIL Mode
8-8	301		0	55.9		.0235	0.37	7.76905		
		-1.0V	24	55.8	-0.18	.0237	2.0			
		"	100	56.0	+0.18	.0205	3.0			High L
		"	244	56.1	+0.4	.0205	7.2			
		"	524	56.2	+0.6	.0191	5.0			
		"	1007	56.2	+0.6	.0240	2.5			
		Note 1	1511	56.2	+0.6	.0239	0.90			
		Note 2	1511							
		-1.5	1679	56.2	+0.6	.0242	4.2			
		Note 3	2039	56.5	+1.1	.0235	18			
		-2.0V	2183	56.8	+1.6	.0216	180			
		"	2519	56.7	+1.4	.0190	320			
		"	2832	–	–	–	–			Leak X
8-9	302		0	55.1		.0200	0.61	7.94544		
		-1.0V	24	55.1	0	.0213	0.78			
		"	100	55.2	+0.18	.0213	0.90			
		"	244	55.2	+0.18	.0200	1.25			
		"	524	55.3	+0.4	.0205	1.95			
		"	1007	55.3	+0.4	.0210	2.4			High L
		Note 1	1511	55.3	+0.4	.0190	2.2			
		Note 2	1511							
		-1.5V	1679	55.9	+1.4	.0178	2.4			
		Note 3	2039	55.8	+1.2	.0159	2.4			
		-2.0V	2183	55.9	+1.4	.0147	4.0			
		"	2519	55.8	+1.2	.0322	59			
		"	3000	55.8		.0335	30.1			
		Soak@60V	18	55.5		.0352	5.3	7.94500		X
8-10	303		0	53.3		.0191	2.6	7.77810		High L
		-1.0V	24	53.2	-0.19	.0189	4.2			
		"	100	53.2	-0.19	.0190	2.7			
		"	244	53.5	+0.4	.0183	2.0			L o.k.
		"	524	53.5	+0.4	.0186	1.85			
		"	1007	53.5	+0.4	.0197	1.92			
		Note 1	1511	53.4	+0.2	.0194	1.40			
		Note 2	1511							
		-1.5V	1679	53.5	+0.4	.0197	9.0			High L
		Note 3	2039	53.7	+0.7	.0198	7.8			
		-2.0V	2183	54.1	+1.5	.0221	15			
		"	2519	54.1	+1.5	.0270	165			
		"	3000	53.5		.0502	300			X
		Soak@+60V	18	53.8		.0415	265			Leak

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.5V
3. On -2.0V after test

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V, 25°C	TIME Hrs.	C µf	Δ C %	D	L µ a	W g.	ACCEPT	FAIL Mode
9-1	304		0	56.1		.0237	0.34	7.79636		
		-1.0V	24	56.1	0	.0200	0.37			
		"	100	56.1	0	.0221	0.37			
		"	244	56.1	0	.0188	0.43			
		"	524	56.2	+0.2	.0213	0.23			
		"	1007	56.3	+0.4	.0230	0.46			
		Note 1	1511	56.3	+0.4	.0218	11.0			High L
		Note 2	1511							
		-1.0V	1679	56.2	+0.2	.0217	10.5			
		"	2039	56.2	+0.2	.0195	9.5			
		"	2183	56.2	+0.2	.0184	9.6			
		"	2519	56.2	+0.2	.0208	9.5			
		"	3000	56.2		.0335	8.0			
		Soak@+60V	18	55.8		.0183	2.7	7.79759		X
9-2	312		0	55.4		.0215	1.35	7.72718		
		-1.0V	24	55.3	-0.18	.0180	2.0			
		"	100	55.3	-0.18	.0181	1.8			
		"	244	55.6	+0.4	.0181	0.79			
		"	524	55.6	+0.4	.0179	0.48			
		"	1007	55.3	-0.2	.0233	0.63			
		Note 1	1511	55.3	-0.2	.0192	0.65			
		Note 2	1511							
		-1.0V	1679	55.6	+0.4	.0195	0.80			
		"	2039	55.4	0	.0195	0.70			
		"	2183	55.5	-0.2	.0195	0.70			
		"	2519	55.4	0	.0195	0.66			
		"	3000	55.4		.0208	0.56			
		Soak@+60V	18	55.1		.0198	0.74	7.72775	X	
9-3	314		0	54.1		.0229	2.0	7.74372		
		01.0V	24	54.1	0	.0205	3.6			High L
		"	100	54.1	0	.0203	8.0			
		"	244	54.2	+0.18	.0190	12.0			
		"	524	54.3	+0.4	.0191	9.0			
		"	1007	54.4	+0.6	.0196	10.0			
		Note 1	1511	54.2	+0.2	.0195	10.0			
		Note 2	1511							
		-1.0V	1679	54.3	+0.4	.0223	9.7			
		"	2039	54.2	+0.2	.0213	9.0			
		"	2183	54.2	+0.2	.0194	8.0			
		"	2519	54.2	+0.2	.0219	9.5			
		"	3000	54.2		.0206	8.0			
		Soak@+60V	18	54.0		.0206	7.8	7.74440		X

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.0V

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V,25°C	TIME Hrs.	C µf	Δ C %	D	L µ a	W g	ACCEPT	FAIL Mode
9-4	316		0	54.9		.0200	0.24	8.03585		
		-1.0V	24	54.8	-0.18	.0179	0.29			
		"	100	54.9	0	.0181	0.34			
		"	244	55.0	+0.2	.0163	0.50			
		"	524	55.0	+0.2	.0163	0.14			
		"	1007	54.9	0	.0171	0.46			
		Note 1	1511	54.9	0	.0162	1.30			
		Note 2	1511							
		-1.0V	1679	54.9	0	.0166	1.6			
		"	2039	54.9	0	.0170	0.30			
		"	2183	54.9	0	.0162	0.4			
		"	2519	54.9	0	.0305	0.275			
		"	3000	54.9		.0236	1.6			
		Soak@+60V	18	54.7		.0167	0.5	8.93640	X	
9-5	320		0	54.5		.0330	0.63	7.75882		
		-1.0V	24	54.7	+0.4	.0254	0.82			
		"	100	54.8	+0.6	.0290	1.25			
		"	244	54.8	+0.6	.0301	4.6			
		"	524	54.8	+0.6	.0260	5.0			
		"	1007	54.8	+0.6	.0267	4.2			
		Note 1	1511	54.7	+0.4	.0279	2.9			
		Note 2	1511							
		-1.0V	1679	54.8	+0.6	.0269	1.65			
		"	2039	54.8	+0.6	.0255	2.3			
		"	2183	54.6	+0.2	.0298	1.9			
		"	2519	54.6	+0.2	.0308	1.5			
		"	3000	54.6		.0305	1.5			X
		Soak @ +60V	18	54.6		.0275	8.0	7.75910		High L
9-6	321		0	56.2		.0235	0.36	7.77582		
		-1.0V	24	56.3	+0.18	.0222	0.60			
		"	100	56.3	+0.2	.0212	0.65			
		"	244	56.5	+0.6	.0255	0.66			
		"	524	56.5	+0.6	.0258	0.37			
		"	1007	56.6	+0.4	.0252	0.77			
		Note 1	1511	56.5	+0.8	.0228	1.50			
		Note 2	1511							
		-1.0V	1679	56.5	+0.8	.0246	1.03			
		"	2039	56.4	+0.4	.0565	0.95			
		"	2183	56.3	+0.2	.0255	1.1			
		"	2519	56.5	+0.6	.0420	0.96			
		"	3000	56.3		.0288	0.74			
		Soak @ +60V	18	56.2		.0223	0.82	7.77657	X	

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.0V

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V, 25°C	TIME Hrs.	C µf	△ C. %	D	L µa	W g	ACCEPT	FAIL Mode
9-7	322		0	55.5		.0238	0.23	7.82186		
		-1.0V	24	55.0	-0.90	.0212	0.24			
		"	100	55.0	-0.90	.0210	0.25			
		"	244	55.0	-0.90	.0200	0.30			
		"	524	55.0	-0.90	.0212	0.13			
		"	1007	54.9	-1.1	.0258	0.35			
		Note 1	1511	54.9	-1.1	.0342	0.22			
		Note 2	1511							
		-1.0V	1679	55.0	-0.9	.0230	0.37			
		"	2039	54.9	-1.1	.0339	0.25			
		"	2183	54.9	-1.1	.0270	0.34			
		"	2519	54.9	-1.1	.0340	0.38			
		"	3000	54.9		.128	0.40			
		Soak@+60V	18	54.8		.0220	0.08	7.82225	X	
9-8	324		0	53.7		.0175	0.24	7.78014		
		-1.0V	24	53.8	+0.19	.0189	6.5			High L
		"	100	53.8	+0.19	.0189	11.0			
		"	244	53.8	+0.19	.0185	12.5			
		"	524	53.9	+0.4	.0190	7.0			
		"	1007	53.8	+0.2	.0212	10.2			
		Note 1	1511	53.8	+0.2	.0204	10.5			
		Note 2	1511							
		-1.0V	1679	53.9	+0.4	.0212	9.0			
		"	2039	53.8	+0.2	.0360	8.5			
		"	2183	53.8	+0.2	.0201	7.0			
		"	2519	53.8	+0.2	.0230	8.0			
		"	3000	53.8		.0234	7.0			
		Soak@+60V	18	53.4		.0198	1.7	7.78073	X	
9-9	326		0	54.8		.0228	12.0	7.84283		High L
		-1.0V	24	54.8	0	.0180	14.0			"
		"	100	54.8	0	.0173	2.2			"
		"	244	54.8	0	.0170	1.6			"
		"	524	54.8	0	.0170	2.55			"
		"	1007	54.8	0	.0212	1.53			L o.k.
		Note 1	1511	54.8	0	.0178	1.30			
		Note 2	1511							
		-1.0V	1679	54.9	+0.18	.0176	1.75			
		"	2039	54.8	0	.0181	1.63			
		"	2183	54.8	0	.0180	1.78			
		"	2519	54.8	0	.0206	1.70			
		"	3000	54.8		.0208	1.5			X
		Soak@+60V	18	54.5		.0187	6.0	7.84294		High L

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.0V

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REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V, 25°C	TIME Hrs.	C μf	Δ C %	D	L μa	W g	ACCEPT	FAIL Mode
9-10	327		0	54.4		.0202	0.63	7.64143		
		-1.0V	24	54.2	-0.37	.0173	0.65			
		"	100	54.2	-0.37	.0231	0.80			
		"	244	54.3	-0.2	.0143	1.1			
		"	524	54.1	-0.6	.0220	0.55			
		"	1007	54.2	-0.4	.0254	1.3			
		Note 1	1511	54.2	-0.4	.0188	0.82			
		Note 2	1511							
		-1.0	1679	54.2	-0.4	.0200	1.12			
		"	2039	54.2	-0.4	.0270	0.98			
		"	2183	54.2	-0.4	.0190	1.20			
		"	2519	54.2	-0.4	.0265	1.20			
		"	3000	54.2		.045	1.0			
		Soak@+60V	18	53.9		.0247	0.20	7.64176	X	
10-1	329		0	55.3		.0236	0.40	7.78642		
		-1.0V	24	55.3	0	.0190	0.39			
		"	100	55.6	+0.54	.0193	0.22			
		"	244	55.5	+0.4	.0197	0.21			
		"	524	55.8	+0.9	.0190	0.19			
		"	1007	55.4	+0.2	.0252	0.165			
		Note 1	1511	55.4	+0.2	.0235	0.125			
		Note 2	1511							
		-1.5V	1679	55.8	+0.9	.0193	3.0			High L
		Note 3	2039	55.8	+0.9	.0188	2.9			
		-2.0V	2183	56.2	+1.6	.0222	4.9			
		"	2519	55.9	+1.1	.0225	3.5			
		"	3000	55.8		.0245	44.0			
		Soak@+60V	18	55.8		.0227	7.8	7.78720		X
10-2	330		0	58.2		.0190	0.59	7.98832		
		-1.0V	24	58.1	-0.17	.0183	0.53			
		"	100	58.2	0	.0171	0.38			
		"	244	58.2	0	.0180	0.36			
		"	524	58.3	+0.2	.0155	0.22			
		"	1007	58.3	+0.2	.0185	0.20			
		Note 1	1511	58.3	+0.2	.0182	0.150			
		Note 2	1511							
		-1.5V	1679	58.6	+0.7	.0150	4.6			High L
		Note 3	2039	58.6	+0.7	.0152	3.0			
		-2.0V	2183	-	-	-	-			Leak X

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.5V
3. On -2.0V after test

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V.25°C	TIME Hrs.	C µf	Δ C %	D	L µ a	W g	ACCEPT	FAIL Mode
10-3	331		0	53.3		.0225	0.48	7.79688		
		-1.0V	24	53.5	+0.18	.0240	0.47			
		"	100	53.2	-0.2	.0236	0.25			
		"	244	53.3	0	.0239	0.27			
		"	524	53.3	0	.0230	0.22			
		"	1007	53.3	0	.0242	0.20			
		Note 1	1511	53.3	0	.0235	0.155			
		Note 2	1511							
		-1.5V	1679	53.9	+1.1	.0230	0.95			
		Note 3	2039	54.0	+1.3	.0202	1.4			
		-2.0V	2183	54.1	+1.5	.0358	6.4			High L
		"	2519	54.2	+1.7	.0290	4.1			
		"	3000	54.1		.0368	3.2			
		Soak @60V	18	-	-	-	2.95	7.79759		X
10-4	333		0	58.2		.0192	0.90	7.86466		
		-1.0V	24	57.9	-0.52	.0208	1.07			
		"	100	58.0	-0.52	.0198	0.80			
		"	244	58.0	-0.3	.0198	0.68			
		"	524	58.0	-0.3	.0180	0.48			
		"	1007	58.2	0	.0193	0.44			
		Note 1	1511	58.0	-0.3	.0199	0.35			
		Note 2	1511							
		-1.5V	1679	58.3	+0.2	.0190	0.76			
		Note 3	2039	58.4	+0.4	.0163	1.2			
		-2.0	2183	58.5	+0.5	.0165	1.7			
		"	2519	58.9	+1.2	.0240	4.8			High L
		"	3000	58.3		.0296	1.85			L o.k.
		Soak@60V	18	58.3		.0339	1.05	7.86488	X	
10-5	334		0	54.9		.0229	0.70	7.78060		
		-1.0V	24	54.9	0	.0236	0.59			
		"	100	54.9	0	.0218	0.39			
		"	244	55.0	-0.18	.0237	0.39			
		"	524	55.0	-0.18	.0221	0.32			
		"	1007	54.9	0	.0225	0.26			
		Note 1	1511	54.9	0	.0224	0.265			
		Note 2	1511							
		-1.5V	1679	55.4	+1.0	.0195	7.8			High L
		Note 3	2039	55.4	+1.0	.0176	9.0			
		-2.0	2183	55.5	+1.1	.0263	6.0			
		"	2519	55.6	+1.3	.0262	3.1			
		"	3000	55.3		.0305	2.3			
		Soak@60V	18	55.1		.0462	4.8	7.78114		X

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.5V
3. On -2.0V after test

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V,25°C	TIME Hrs.	C uf	△ C %	D	L µ a	W g	ACCEPT	FAIL Mode
10-6	335		0	54.2		.0214	0.38	7.87004		
		+1.0V	24	54.2	0	.0228	0.50			
		"	100	54.2	0	.0201	0.28			
		"	244	54.2	0	.0212	0.25			
		"	524	54.4	+0.37	.0210	0.26			
		"	1007	54.2	0	.0215	0.55			
		Note 1	1511	54.2	0	.0230	0.175			
		Note 2	1511							
		-1.5V	1679	54.9	+1.3	.0215	1.12			
		Note 3	2039	54.9	+1.3	.0211	3.8			High L
		-2.0V	2183	54.9	+1.3	.0223	2.2			
		"	2519	54.9	+1.3	.0183	1.7			
		"	3000	54.9		.0205	1.9			
		Soak@60V	18	54.6		.0302	2.2	7.87026		X
10-7	338		0	53.8		.0200	0.36	7.74514		
		+1.0V	24	53.8	0	.0198	3.0			
		"	100	53.8	0	.0195	0.47			
		"	244	53.9	+0.19	.0179	0.41			
		"	524	53.9	+0.19	.0177	0.30			
		"	1007	53.8	0	.0186	0.205			
		Note 1	1511	53.8	0	.0176	0.130			
		Note 2	1511							
		-1.5V	1679	54.2	+0.8	.0192	0.37			
		Note 3	2039	54.2	+0.8	.0152	15			High L
		-2.0V	2183	54.5	+1.3	.0160	12.5			
		"	2375	–	–	–	–			Leak X
10-8	339		0	55.0		.0174	0.60	7.69163		
		+1.0V	24	55.0	0	.0180	0.47			
		"	100	55.0	0	.0195	0.45			
		"	244	55.0	0	.0200	0.57			
		"	524	55.0	0	.0178	0.44			
		"	1007	55.0	0	.0200	0.34			
		Note 1	1511	55.0	0	.0195	0.32			
		Note 2	1511							
		-1.5V	1679	55.5	+1.00	.0185	0.25			
		Note 3	2039	55.6	+1.18	.0195	5.0			High L
		-2.0V	2183	55.6	+1.18	.0190	3.8			
		"	2519	55.7	+1.4	.0192	9.0			
		"	3000	55.4		.0240	2.1			
		Soak@60V	18	55.3		.0208	0.7	7.69236	X	L o.k.

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.5V
3. On -2.0V after test

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V,25°C	TIME Hrs.	C µf	Δ C %	D	L µ a	W g	ACCEPT	FAIL Mode
10-9	340		0	56.1		.0183	0.27	7.70689		
		-1.0V	24	56.1	0	.0183	0.25			
		"	100	56.1	0	.0180	0.15			
		"	244	56.1	0	.0180	0.15			
		"	524	56.2	+0.2	.0169	0.11			
		"	1007	56.2	+0.2	.0174	0.10			
		Note 1	1511	56.2	+0.2	.0178	0.073			
		Note 2	1511							
		-1.5V	1679	56.4	+0.5	.0167	0.18			
		Note 3	2039	56.4	+0.5	.0173	.32			
		-2.0V	2183	56.9	+1.4	.0160	.86			
		"	2519	56.9	+1.4	.0170	1.3			
		"	3000	56.8		.0185	.53			
		Soak@+60V	18	56.5		.0273	.57	7.70729	X	
10-10	342		0	56.2		.0303	0.62	7.79611		
		-1.0V	24	56.3	+0.18	.0300	4.4			High L
		"	100	56.3	+0.18	.0239	4.6			
		"	244	56.3	+0.18	.0223	0.42			L o.k.
		"	524	56.7	+0.9	.0240	0.32			
		"	1007	56.5	+0.6	.0214	0.32			
		Note 1	1511	56.3	+0.2	.0213	0.24			
		Note 2	1511							
		-1.5V	1679	56.7	+0.9	.0189	1.05			
		Note 3	2039	56.8	+1.1	.0180	1.9			
		-2.0V	2183	56.9	+1.3	.0204	1.7			
		"	2519	56.9	+1.3	.0208	3.8			High L
		"	3000	56.8		.0268	150			
		Soak@+60V	18	56.7		.0268	0.9	7.79707	X	L o.k.

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On -1.5
3. On -2.0V after test

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V, 25°C	TIME Hrs.	C µf	Δ C %	D	L µ a	W g	ACCEPT	FAIL Mode
11-1	345		0	54.0		.0249	0.22	7.70574		
		+1.0V	24	54.0		.0223	0.14			
		"	100	54.1	+0.18	.0221	0.10			
		"	244	54.1		.0219	0.13			
		"	524	54.1		.0218	0.13			
		"	1007	54.1		.0212	0.092			
		Note 1	1511	54.1		.0216	0.055			
		Note 2	1511							
		+1.0V	1679	54.1		.0216	0.051			
		"	2039	54.1		.0219	0.058			
		"	2183	54.0		.0225	0.048			
		"	2519	54.0		.0229	0.058			
		"	3000	53.9		.0238	0.023			
		Soak@60V	18	53.7		.0234	0.014	7.70669	X	
11-2	347		0	57.7		.0265	0.30	7.63340		
		+1.0V	24	57.8	+0.17	.0183	0.19			
		"	100	57.8		.0182	0.12			
		"	244	57.8		.0203	0.16			
		"	524	58.0		.0170	0.16			
		"	1007	57.8		.0223	0.12			
		Note 1	1511	57.8		.0226	0.075			
		Note 2	1511							
		+1.0V	1679	57.8		.0184	0.080			
		"	2039	57.8		.0178	0.138			
		"	2183	57.8		.0201	0.088			
		"	2519	57.8		.0210	0.240			
		"	3000	57.7		.0182	0.12			
		Soak@60V	18	57.5		.0194	0.036	7.63433	X	
11-3	348		0	55.8		.0262	0.28	7.79355		
		+1.0V	24	55.8		.0242	0.17			
		"	100	55.8		.0229	0.13			
		"	244	55.9	+0.17	.0230	0.18			
		"	524	55.9		.0218	0.15			
		"	1007	55.9		.0221	0.14			
		Note 1	1511	55.8	-0.17	.0224	0.080			
		Note 2	1511							
		+1.0V	1679	55.8		.0219	0.076			
		"	2039	55.8		.0230	0.080			
		"	2183	55.8		.0230	0.780			
		"	2519	55.8		.0250	0.080			
		"	3000	55.7		.0258	0.040			
		Soak@60V	18	55.3		.0225	0.068	7.79472	X	

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On +1.0V

REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V,25°C	TIME Hrs.	C µf	Δ C %	D	L µ a	W g	ACCEPT	FAIL Mode
11-4	349		0	54.9		.0280	0.76	7.76546		
		+1.0V	24	55.0	+0.18	.0240	0.77			
		"	100	54.9	-0.18	.0220	0.41			
		"	244	55.0	+0.18	.0228	0.43			
		"	524	55.0		.0213	0.43			
		"	1007	55.0		.0222	0.43			
		Note 1	1511	55.0		.0210	0.40			
		Note 2	1511							
		+1.0V	1679	55.0		.0218	0.47			
		"	2039	55.0		.0245	0.52			
		"	2183	55.0		.0220	0.48			
		"	2519	55.0		.0220	0.56			
		"	3000	54.9		.0229	0.34			
		Soak@ 60V	18	54.8		.0222	0.60	7.76644	X	
11-5	350		0	54.7		.0233	0.45	7.77915		
		+1.0V	24	54.5		.0212	0.39			
		"	100	54.4		.0199	0.22			
		"	244	54.7		.0192	0.22			
		"	524	54.8	+0.6	.0190	0.20			
		"	1007	54.7		.0201	0.16			
		Note 1	1511	54.6		.0218	0.12			
		Note 2	1511							
		+1.0V	1679	54.6		.0213	0.125			
		"	2039	54.6		.0236	0.14			
		"	2183	54.3	-0.7	.0220	0.36			
		"	2519	54.6		.0290	0.15			
		"	3000	54.2		.0218	0.078			
		Soak@ 60V	18	54.2		.0210	0.11	7.78015	X	
11-6	351		0	55.2		.0279	2.45	7.79496		High L
		+1.0V	24	55.3		.0218	3.1			
		"	100	55.2	-0.18	.0203	2.3			
		"	244	55.3		.0214	1.3			
		"	524	55.7	+1.0	.0206	1.7			
		"	1007	55.3		.0201	1.65			
		Note 1	1511	55.6		.0200	5.4			High L
		Note 2	1511							
		+1.0V	1679	55.3		.0200	0.59			L o.k.
		"	2039	55.3		.0200	0.54			
		"	2183	55.3		.0203	0.44			
		"	2519	55.3		.0200	0.47			
		"	3000	55.3		.0201	0.29			
		Soak @60V	18	55.1		.0201	0.34	7.79558	X	

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On +1.0V

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REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V, 25°C	TIME Hrs.	C µf	Δ C %	D	L µa	W g	ACCEPT	FAIL Mode
11-7	352		0	54.7		.0290	0.27	7.79527		
		+1.0V	24	54.5	-0.37	.0250	0.17			
		"	100	54.8	+0.2	.0249	0.14			
		"	244	54.8	+0.2	.0250	0.18			
		"	524	54.8	+0.2	.0243	0.16			
		"	1007	54.7	0	.0244	0.135			
		Note 1	1511	54.7	0	.0249	0.083			
		Note 2	1511							
		+1.0V	1679	54.7	0	.0267	0.086			
		"	2039	54.7	0	.0269	0.089			
		"	2183	54.7	0	.0266	0.074			
		"	2519	54.7	0	.0278	0.084			
		"	3000	54.6		.0260	0.055			
		Soak @60V	18	54.2		.0258	0.68	7.79637	X	
11-8	354		0	53.9		.0219	0.44	7.78166		
		+1.0V	24	53.9	0	.0176	0.31			
		"	100	53.9	0	.0174	0.19			
		"	244	54.0	+0.19	.0178	0.21			
		"	524	54.0	+0.19	.0166	0.19			
		"	1007	54.0	+0.19	.0170	0.15			
		Note 1	1511	53.9	0	.0180	0.094			
		Note 2	1511							
		+1.0V	1679	53.9	0	.0172	0.112			
		"	2039	53.9	0	.0179	0.138			
		"	2183	53.9	0	.0184	0.13			
		"	2519	53.9	0	.0188	0.20			
		"	3000	53.8		.0188	0.13			
		Soak @60V	18	53.5		.0180	0.095	7.78275	X	
11-9	359		0	55.6		.0296	0.83	7.87935		
		+1.0V	24	55.7	+0.18	.0302	0.43			
		"	100	55.5	-0.2	.0241	0.24			
		"	244	55.5	-0.2	.0232	0.24			
		"	524	55.7	+0.2	.0515	0.21			
		"	1007	55.5	-0.2	.0372	0.17			
		Note 1	1511	55.6	0	.0612	0.105			
		Note 2	1511							
		+1.0V	1679	55.6	0	.0234	.092			
		"	2039	55.5	-0.2	.0260	.098			
		"	2183	55.4	-0.4	.0262	.082			
		"	2519	55.5	-0.2	.0279	0.10			
		"	3000	55.3		.0442	0.05			
		Soak @60V	18	55.3		.0249	0.35	7.88081	X	

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On +1.0V

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REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION Test @ 60V,25°C	TIME Hrs.	C µf	Δ C %	D	L µa	W g	ACCEPT	FAIL Mode
11-10	360		0	56.2		.0201	1.2	7.76952		
		+1.0V	24	56.3	+0.2	.0170	0.54			
		"	100	56.2	0	.0184	1.0			
		"	244	56.2	0	.0173	0.45			
		"	524	56.4	+0.4	.0163	0.37			
		"	1007	56.3	+0.2	.0182	0.30			
		Note 1	1511	56.3	+0.2	.0182	0.225			
		Note 2	1511							
		+1.0V	1679	56.3	+0.2	.0175	0.22			
		"	2039	56.3	+0.2	.0180	0.22			
		"	2183	56.3	+0.2	.0175	0.20			
		"	2519	56.3	+0.2	.0169	0.22			
		"	3000	56.2		.0170	0.155			
		Soak @60V	18	56.2		.0172	0.72	7.77110	X	

Note: 1. Off 27 hrs-Revise source for -1.5V
2. On +1.0V

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REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION 25°C	TIME	C uf	Δ C %	D	I ua	W g	ACCEPT	FAIL Mode
6-1	252	+60V -10V	Init. 1 hr.	54.2		.0442	1.55	7.74784		Fuse
6-2	253	+60V -10V	Init. 30 sec	54.6		.0165	0.42	7.97802		Case Bulged
6-3	256	+60V -10V	Init. 1 hr.	52.1		.0270	0.21	7.70109		Fuse
6-4	257	+60V -10V	Init. 40 sec.	54.1		.0239	0.65	7.73121		Leak
6-5	258	+60V -10V	Init. 60 sec.	53.4		.0238	0.19	7.73761		Fuse
6-6	259	+60V -10V	Init. 60 sec.	52.8		.0291	1.05	7.68040		Short
6-7	260	+60V -10V	Init. 60 sec.	53.1		.0239	0.39	7.77600		Short
6-8	264	+60V -10V	Init. 1 hr.	53.8		.0249	0.21	7.74440		Fuse
6-9	266	+60V -10V	Init. 1 hr.	52.8		.0223	0.39	7.77433		Fuse
6-10	268	+60V -10V	Init. 1 hr.	54.5		.0307	1.05	7.76743		Fuse

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REVERSE VOLTAGE TOLERANCE TEST

TRAY No.	CAP No.	CONDITION 25°C	TIME	C uf	Δ C %	D	L ua	W g	ACCEPT	FAIL Mode
7-1	270	+ 60V - 5V	Init. 60 sec	55.3		.0248	0.24	7.77540		Leak
7-2	272	+ 60V - 5V	Init. 1 hr.	52.6		.0250	0.20	7.65832		Bulge, Fuse, Lk.
7-3	273	+ 60V - 5V	Init. 10 min.	54.1		.0272	0.25	7.67188		Fuse
7-4	275	+ 60V - 5V	Init. 2 min.	52.6		.0179	1.20	7.79193		Bulge, Leak
7-5	276	+ 60V - 5V	Init. 2 min.	54.1		.0252	0.41	7.74326		Bulge, Leak
7-6	250	+ 60V - 5V	Init. 1 hr.	54.2		.0134	0.32	7.79097		Bulge, Fuse
7-7	282	+ 60V - 5V	Init. 1 hr.	53.8		.0260	0.40	7.73779		Bulge, Fuse
7-8	283	+ 60V - 5V	Init. 1 hr.	54.9		.0231	0.23	7.66534		Bulge, Fuse
7-9	284	+ 60V - 5V	Init. 60 sec.	54.2		.0202	0.20	7.87522		Leak
7-10	286	+ 60V - 5V	Init. 1 hr.	53.2		.0180	0.16	7.72901		Lo. Voltage

APPENDIX D

Incremental Ambient Step Stress Test Data

INCREMENTAL AMBIENT STEP STRESS

TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	Δ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
13-1	154	60V	25°C		Init.	54.9		.0106	0.90			
		40V	125°C		Init.					7.82452		
		40V	125°C	135°C	192	56.5	+23.7	.0170	2.6			
		40V	135°C	145°C	360	56.2		.0425	2.6			
		40V	145°C	155°C	528	54.8		.0726	2.87			Leak
		40V	155°C	165°C	696	53.5		.0955	5.0			
		40V	165°C	175°C	864	51.6	-6.0	.150	5.4			
		40V	175°C	185°C	1032	0.2		2.4	7.9			
		40V	185°C	195°C	1200	0.2		3.15	11.5	7.29081		
		60V	27°C			0		10+	39			
												X
13-2	155	60V	25°C		Init.	52.5		.0152	0.30			
		40V	125°C		Init.					7.75289		
		40V	125°C	135°C	192	54.1		.0168	13.5			
		40V	135°C	145°C	360	54.8		.0160	7.0			
		40V	145°C	155°C	528	54.8		.0193	2.35			
		40V	155°C	165°C	696	54.9	+4.6	.0203	13.5			
		40V	165°C	175°C	864	53.7		.042	5.9			Leak
		40V	175°C	185°C	1032	52.2	-.06	.056	9.3			
		40V	185°C	195°C	1200	.25		3.6	11.1	7.26587		
		60V	27°C			0		10	2.4			
												X
13-3	158	60V	25°C		Init.	51.8		.0108	0.29			
		40V	125°C		Init					7.76799		
		40V	125°C	135°C	192	53.2		.0186	1.3			
		40V	135°C	145°C	360	53.9		.0159	1.75			
		40V	145°C	155°C	528	54.1	+4.4	.0172	2.10			
		40V	155°C	165°C	696	53.9		.0238	4.4			
		40V	165°C	175°C	864	53.6		.0248	5.7			
		40V	175°C	185°C	1032	52.7		.0220	7.9			
		40V	185°C	195°C	1200	51.2		.0258	11.2			
		40V	195°C		1368	49.3	-4.8	.0260	15.3	7.76617		
		60V	27°C			46.2	-10.8	.0245	0.10		X	
13-4	160	60V	25°C		Init.	52.2		.0261	1.05			
		40V	125°C		Init.					7.72738		
		40V	125°C	135°C	192	53.8		.0182	2.1			
		40V	135°C	145°C	360	54.2		.1449	2.5			

INCREMENTAL AMBIENT STEP STRESS

TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	Δ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
13.4	160	40V	145°C	155°C	528	54.5	+ 4.4	.0208	2.18			
		40V	155°C	165°C	696	54.1		.0210	3.8			
		40V	165°C	175°C	864	54.0		.0260	6.05			
		40V	175°C	185°C	1032	52.8		.0295	8.2			Leak
		40V	185°C	195°C	1200	51.5		.0288	11.7			
		40V	195°C		1368	49.3	- 5.6	.0328	16.0	7.47120		
		60V	27°C			45.8	-12.5	.0482	0.37			
												X
13-5	161	60V	25°C		Init.	53.0		.0271	3.1			
		40V	125°C		Init.					7.78903		
		40V	125°C	135°C	192	54.0		.0196	2.8			
		40V	135°C	145°C	360	54.5		.0212	3.4			
		40V	145°C	155°C	528	54.7	+ 3.2	.0211	3.45			
		40V	155°C	165°C	696	54.7		.0313	4.8			
		40V	165°C	175°C	864	54.5		.0290	5.9			
		40V	175°C	185°C	1032	53.2		.0296	8.4			
		40V	185°C	195°C	1200	51.8		.0295	11.7			
		40V	195°C		1368	50.0	-5.7	.0295	16.2	7.78361		
		60V	27°C			46.5	-12.3	.0290	3.0			Hi L
												X
12-1	120	60V	25°C		Init.	51.5		.0245	.042			
		40V	125°C		Init.					7.79272		
		40V	125°C	135°C	192	53.0	+2.9	.0168	2.7			
		40V	135°C	145°C	360	53.2		.0196	2.65			
		40V	145°C	155°C	528	53.6	+4.1	.0217	3.6			
		40V	155°C	165°C	696	53.5		.0275	5.9			
		40V	165°C	175°C	864	53.3		.0266	6.6			Leak
		40V	175°C	185°C	1032	52.5		.0292	9.3			
		40V	185°C	195°C	1200	51.2		.0410	11.9			
		40V	195°C		1368	49.7	-3.5	.0305	9.1			
		60V	27°C			45.9		.0338	0.31	7.65581		
							-10.9					X
12-2	131	60V	25°C		Init.	52.2		.0338	.005			
		40V	125°C		Init.					7.72017		
		40V	125°C	135°C	192	53.8	+3.1	.0189	0.72			
		40V	135°C	145°C	360	54.0		.0204	0.80			
		40V	145°C	155°C	528	54.2		.0200	1.27			
		40V	155°C	165°C	696	54.2		.0229	2.3			

INCREMENTAL AMBIENT STEP STRESS

TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	Δ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
12-2	131	40V	165°C	175°C	864	54.2	+3.8	.0275	3.7			
		40V	175°C	185°C	1032	53.2		.0272	7.0			
		40V	185°C	195°C	1200	52.2		.062	11.3			
		40V	195°C		1368	50.4	-3.4	.0280	8.35	7.71965		
		60V	27°C			47.3	-9.4	.0295	0.021		X	
12-3	135	60V	25°C		Init.	52.8		.0245	.011			
		40V	125°C		Init.					7.70214		
		40V	125°C	135°C	192	54.2	+2.7	.0181	1.0			
		40V	135°C	145°C	360	54.5		.0227	1.0			
		40V	145°C	155°C	528	54.8		.0225	1.53			
		40V	155°C	165°C	696	54.8	+3.8	.0325	2.7			
		40V	165°C	175°C	864	54.5		.0280	4.4			
		40V	175°C	185°C	1032	53.5		.0315	7.3			
		40V	185°C	195°C	1200	52.1		.0385	10.3			Leak
		40V	195°C		1368	50.4	-4.5	.0375	8.6	7.51490		
		60V	27°C			46.2	-12.5	.0507	.081			
												X
12-4	138	60V	25°C		Init.	51.8		.0270	.080			
		40V	125°C		Init.					7.75486		
		40V	125°C	135°C	192	53.3	+2.9	.0170	5.0			
		40V	135°C	145°C	360	53.5		.0193	38.0			Hi.L
		40V	145°C	155°C	528	53.7	+3.7	.0225	32.0			
		40V	155°C	165°C	696	53.4		.0249	74.0			
		40V	165°C	175°C	864	53.4		.0232	100.0			
		40V	175°C	185°C	1032	52.5		.0278	74.0			
		40V	185°C	195°C	1200	50.5		.040	68.0			Leak
		40V	195°C		1368	49.0	-5.4	.043	18.9	7.45107		
		60V	27°C			44.3	-14.5	.0572	6.6			
												X
12-5	140	60V	25°C		Init.	54.0		.0261	.010			
		40V	125°C		Init.					7.76600		
		40V	125°C	135°C	192	55.7	+3.1	.0175	1.0			
		40V	135°C	145°C	360	55.9		.0201	1.15			
		40V	145°C	155°C	528	56.1	+3.9	.0223	1.34			
		40V	155°C	165°C	696	55.7		.0275	3.2			Leak
		40V	165°C	175°C	864	54.8		.0462	5.0			
		40V	175°C	185°C	1032	53.6		.0480	7.6			
		40V	185°C	195°C	1200	50.5		.094	11.7			
		40V	195°C		1368	48.9	-9.1	.086	10.5	7.34591		

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TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	△ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
12-5	140	60V	27°C			38.2	-29.3	0.276	.066			
												X
12-6	141	60V	25°C		Init.	51.5		.1000	.018			
		40V	125°C		Init.					7.37680		
		40V	125°C	135°C	192	52.9	+2.7	.0565	1.25			
		40V	135°C	145°C	360	53.1		.0640	1.2			
		40V	145°C	155°C	528	53.3	+3.5	.0890	1.57			
		40V	155°C	165°C	696	53.2		.0875	2.75			
		40V	165°C	175°C	864	53.2		.0850	4.3			
		40V	175°C	185°C	1032	52.2		.091	6.5			
		40V	185°C	195°C	1200	50.8		.093	9.9			
		40V	195°C		1368	48.2	-6.4	0.149	9.2	7.30798		Leak
		60V	27°C			37.2	-27.8	0.436	44.0			
												X
12-7	142	60V	25°C		Init.	52.1		.0256	0.10			
		40V	125°C		Init.					7.75228		
		40V	125°C	135°C	192	53.5	+2.7	.0155	0.87			
		40V	135°C	145°C	360	53.9		.1790	1.2			
		40V	145°C	155°C	528	54.1		.0183	1.7			
		40V	155°C	165°C	696	54.1	+3.8	.0196	2.65			
		40V	165°C	175°C	864	54.0		.0260	4.2			Leak
		40V	175°C	185°C	1032	52.8		.031	7.0			
		40V	185°C	195°C	1200	51.6		.0298	10.0			
		40V	195°C		1368	50.1	-3.8	.0258	10.2	7.66401		
		60V	27°C			46.8	-10.2	.0250	0.090			
												X
12-8	145	60V	25°C		Init.	54.0		.0258	.009			
		40V	125°C		Init.					7.76998		
		40V	125°C	135°C	192	55.5	+2.9	.0175	0.90			
		40V	135°C	145°C	360	55.8		.0185	1.05			
		40V	145°C	155°C	528	56.1	+3.9	.0201	1.63			
		40V	155°C	165°C	696	56.0		.0221	3.5			
		40V	165°C	175°C	864	55.8		.0240	4.6			
		40V	175°C	185°C	1032	54.9		.0228	7.1			
		40V	185°C	195°C	1200	53.5		.0295	11.1			
		40V	195°C		1368	51.5	-4.6	.0278	10.5			Leak
		60V	27°C			48.3	-10.6	.0312	0.040	7.73968		
												X

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TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	Δ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
12-9	146	60V	25°C		Init	54.9		.0219	.029			
		40V	125°C		Init					7.75927		
		40V	125°C	135°C	192	56.5	+3.1	.0160	2.45			
		40V	135°C	145°C	360	56.8		.0259	3.4			
		40V	145°C	155°C	528	56.9	+3.6	.0212	3.25			
		40V	155°C	165°C	696	56.9		.0210	6.2			Leak
		40V	165°C	175°C	864	56.6		.0232	7.4			
		40V	175°C	185°C	1032	55.5		.0240	9.6			
		40V	185°C		1200	0.1	-99.8	1.63	14.0	7.18962		X
12-10	148	60V	25°C		Init	52.0		.0248	.023			
		40V	125°C		Init					7.79431		
		40V	125°C	135°C	192	53.3	+2.1	.0163	0.92			
		40V	135°C	145°C	360	53.8		.0190	1.15			
		40V	145°C	155°C	528	54.0	+3.8	.0185	1.69			
		40V	155°C	165°C	696	53.2		.0298	3.3			Leak
		40V	165°C	175°C	864	53.2		.0262	4.6			
		40V	175°C	185°C	1032	51.8		.0405	7.3			
		40V	185°C	195°C	1200	49.7		.062	10.8			
		40V	195°C		1368	46.3	-9.6	.105	11.6	7.36538		
		60V	27°C			37.2	-28.5	.53	8.8			
												X
15-1	199	60V	25°C		Init	55.0		.0258	0.37			
		20V	125°C		Init					7.73481		
		20V	125°C	135°C	192	56.9	+3.5	.0197	96.0			Hi.L
		20V	135°C	145°C	360	57.3		.0219	43.0			
		20V	145°C	155°C	528	58.2		.0330	130.0			
		20V	155°C	165°C	696	59.2		.0355	146.0			
		20V	165°C	175°C	864	60.8		.084	108.0			
		20V	175°C	185°C	1032	62.8		.056	37.0			
		20V	185°C	195°C	1200	65.2		.077	2.80			
		20V	195°C		1368	68.2	+24.0	.065	16.5	7.71863		X
		60V	27°C			57.3	+4.2	.0305	0.49			
15-2	201	60V	25°C		Init	53.0		.0204	0.25			
		20V	125°C		Init					7.83253		
		20V	125°C	135°C	192	54.9	+3.5	.0164	0.52			

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TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	Δ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
15-2	201	20V	135°C	145°C	360	55.3		.0185	0033			
		20V	145°C	155°C	528	56.2		.0240	0.40			
		20V	155°C	165°C	696	57.1		.0322	0.86			
		20V	165°C	175°C	864	58.5		0.172	0.50			
		20V	175°C	185°C	1032	60.6		.0532	0.87			
		20V	185°C	195°C	1200	63.5		.077	1.98			
		20V	195°C		1368	66.2	+24.9	.075	1.08	7.63869		Leak
		60V	27°C			55.0	+ 3.8	.0320	0.235			
												X
15-3	204	60V	25°C		Init.	52.2		.0290	0.32			
		20V	125°C		Init.					7.73681		
		20V	125°C	135°C	192	54.1		.0261	22.0			
		20V	135°C	145°C	360	54.8		.0228	5.2			
		20V	145°C	155°C	528	55.3		.0294	6.0			
		20V	155°C	165°C	696	56.3		.0360	8.2			
		20V	165°C	175°C	864	57.8		0.278	9.9			
		20V	175°C	185°C	1032	60.0		.055	8.6			
		20V	185°C	195°C	1200	63.0		0.380	2.35			
		20V	195°C		1368	65.8	+26.1	.065	3.65	7.72049		Leak
		60V	27°C			54.9	+5.2	.0268	0.34			
												X
15-4	206	60V	25°C		Init	52.6		.0195	0.30			
		20V	125°C		Init					7.85643		
		20V	125°C	135°C	192	55.6		.0153	1.0			
		20V	135°C	145°C	360	56.1		.0180	0.26			
		20V	145°C	155°C	528	56.8	+ 6.1	.0229	0.44			
		20V	155°C	165°C	696	57.5		.0360	0.85			
		20V	165°C	175°C	864	59.0		.0865	0.48			
		20V	175°C	185°C	1032	61.0		.055	0.84			
		20V	185°C	195°C	1200	63.3		0.108	1.87			
		20V	195°C		1368	66.0	+27.4	.0625	5.5	7.85611		
		60V	27°C			56.1	+6.7	.0203	0.29		X	
15-5	211	60V	25°C		Init	52.8		.0210	0.72			
		20V	125°C		Init					7.82040		
		20V	125°C	135°C	192	54.9		.0169	14.0			
		20V	135°C	145°C	360	55.2		.0200	4.8			
		20V	145°C	155°C	528	56.0		.0362	7.2			

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TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	Δ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
15-5	211	20V	155°C	165°C	696	56.9		.0327	5.6			
		20V	165°C	175°C	864	58.5		0.102	14.0			
		20V	175°C	185°C	1032	60.6		.0530	7.9			
		20V	185°C	195°C	1200	63.5		.0665	4.5			
		20V	195°C		1368	66.3	+25.6	.0625	4.2	7.81562		Leak
		60V	27°C			55.2	+4.5	.0255	0.58			
												X
14-1	167	60V	25°C		Init.	51.9		.0780	0.51			
		20V	125°C		Init.					7.79319		
		20V	125°C	135°C	192	53.9		.0286	1.05			
		20V	135°C	145°C	360	54.5		.0300	0.50			
		20V	145°C	155°C	528	55.0		.0327	1.20			
		20V	155°C	165°C	696	55.9		.0398	0.81			
		20V	165°C	175°C	864	57.2		.0236	1.13			
		20V	175°C	185°C	1032	59.0		.103	1.45			
		20V	185°C	195°C	1200	61.5		.320	1.43			
		20V	195°C		1368	64.1	+23.5	.081	2.72	7.78362		Leak
		60V	27°C			54.2	+4.4	.0265	0.255			
												X
14-2	168	60V	25°C		Init.	55.0		.0305	0.36			
		20V	125°C		Init.					7.86703		
		20V	125°C	135°C	192	57.2		.0204	0.39			
		20V	135°C	145°C	360	57.9		.0211	0.56			
		20V	145°C	155°C	528	58.5		.0251	0.50			
		20V	155°C	165°C	696	59.5		.0319	0.75			
		20V	165°C	175°C	864	60.9		.0472	0.45			
		20V	175°C	185°C	1032	63.0		.054	0.81			
		20V	185°C	195°C	1200	65.2		.098	1.52			
		20V	195°C		1368	70.6	+35.3	.41	3.15	7.86596		
		60V	27°C			57.8	+5.1	.0240	0.14		X	
14-3	184	60V	25°C		Init.	54.2		.0211	0.20			
		20V	125°C		Init.					7.69601		
		20V	125°C	135°C	192	55.9		.0240	1.35			
		20V	135°C	145°C	360	56.2		.0280	1.65			
		20V	145°C	155°C	528	55.7		.0418	3.20			Leak
		20V	155°C	165°C	696	56.8		.0505	1.05			
		20V	165°C	175°C	864	57.8		.062	1.67			

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TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	Δ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
14-3	184	20V	175°C	185°C	1032	59.9		.0695	3.40			
		20V	185°C	195°C	1200	63.0		.0875	2.33			
		20V	195°C		1368	66.2	+22.1	.089	2.82	7.42195		
		60V	27°C			55.7	+ 2.8	.059	0.33			
												X
14-4	185	60V	25°C		Init	55.3		.0190	0.52			
		20V	125°C		Init					7.84033		
		20V	125°C	135°C	192	57.5		.0200	2.0			
		20V	135°C	145°C	360	57.9		.0319	2.35			
		20V	145°C	155°C	528	58.6		.0235	1.08			
		20V	155°C	165°C	696	59.6		.0350	2.70			
		20V	165°C	175°C	864	61.0		0.102	1.95			
		20V	175°C	185°C	1032	63.0		0.057	2.85			
		20V	185°C	195°C	1200	65.2		.0705	2.72			
		20V	195°C		1368	67.6	+22.2	.0945	3.55	7.56742		Leak
		60V	27°C			56.8	+ 2.7	.0699	0.90			
												X
14-5	187	60V	25°C		Init	53.8		.0219	0.15			
		20V	125°C		Init					7.81459		
		20V	125°C	135°C	192	55.9		.0164	.09			
		20V	135°C	145°C	360	56.5		.0200	0.17			
		20V	145°C	155°C	528	56.8		.0235	0.165			
		20V	155°C	165°C	696	58.0		.0308	0.33			Leak
		20V	165°C	175°C	864	59.4		0.444	0.42			
		20V	175°C	185°C	1032	61.4		0.114	0.65			
		20V	185°C	195°C	1200	64.2	+19.3	.092	1.33			
		20V	195°C		1368				14.2	7.79009		
		60V	27°C			56.9	+ 5.8	.0235	0.32			
												X
14-6	188	60V	25°C		Init	53.3		.0270	0.19			
		20V	125°C		Init					7.63624		
		20V	125°C	135°C	192	55.1		.0190	28.5			Hi.L
		20V	135°C	145°C	360	55.7		.0225	24.0			
		20V	145°C	155°C	528	56.3		.0307	30.0			
		20V	155°C	165°C	696	57.0		.0340	18.5			
		20V	165°C	175°C	864	58.4		.0422	27.5			
		20V	175°C	185°C	1032	60.2		.345	32.0			
		20V	185°C	195°C	1200	62.8		.0600	2.8			Lo.k

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TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	Δ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
14-6	188	20V	195°C		1368	65.2	+22.3	.084	3.8	7.63617		
		60V	27°C			55.3	+ 3.8	.0305	0.235			
											X	
14-7	190	60V	25°C		Init.	55.2		.0223	0.14			
		20V	125°C		Init.					7.66373		
		20V	125°C	135°C	192	57.5		.0167	1.05			
		20V	135°C	145°C	360	58.0		.0197	0.37			
		20V	145°C	155°C	528	58.7		.0246	0.38			
		20V	155°C	165°C	696	59.5		.0450	0.54			Leak
		20V	165°C	175°C	864	61.0		0.188	1.10			
		20V	175°C	185°C	1032	62.7	+13.6	.0582	1.80			
		20V	185°C	195°C	1200	51.0	- 7.6	.0446	1.63			
		20V	195°C		1368	.15		2.05	2.78	7.14846		
		60V	27°C			.15		10+	0.33			
												X
14-8	191	60V	25°C		Init.	52.9		.0251	0.36			
		20V	125°C		Init.					7.70378		
		20V	125°C	135°C	192	54.9		.0190	14.5			
		20V	135°C	145°C	360	55.2		.0218	1.8			
		20V	145°C	155°C	528	55.9		.0258	1.7			
		20V	155°C	165°C	696	56.9		.0407	1.1			
		20V	165°C	175°C	864	58.2		.0855	2.0			
		20V	175°C	185°C	1032	59.8		.060	3.8			
		20V	185°C	195°C	1200	62.3		.065	2.15			
		20V	195°C		1368	64.8	+22.5	.089	2.95	7.70386		
		60V	27°C			54.9	+3.8	.0312	20.0			Hi.L X
14-9	195	60V	25°C		Init.	53.8		.0221	0.33			
		20V	125°C		Init.					7.76369		
		20V	125°C	135°C	192	55.9		.0166	1.1			
		20V	135°C	145°C	360	56.3		.0217	0.46			
		20V	145°C	155°C	528	56.9		.0281	0.300			
		20V	155°C	165°C	696	57.2		.0720	0.71			Leak
		20V	165°C	175°C	864	58.5		.0998	0.65			
		20V	175°C	185°C	1032	60.4		.288	1.07			
		20V	185°C	195°C	1200	62.8		.187	1.45			
		20V	195°C		1368	66.2	+23.0	.115	2.73	7.36398		
		60V	27°C			52.7	-2.0	.295	0.34			X

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INCREMENTAL AMBIENT STEP STRESS

TRAY No.	CAP. No.	CONDITION Volts V	Temp. °C Read at	Raise to	TIME Hrs.	C uf	Δ C % Max.	D	L ua	W g	ACCEPT	FAIL MODE
14-10	198	60V	25°C		Init.	52.8		.0255	0.13			
		20V	125°C		Init.					7.70926		
		20V	125°C	135°C	192	54.9		.0180	0.28			
		20V	135°C	145°C	360	55.2		.0201	0.30			
		20V	145°C	155°C	528	56.0		.0289	0.275			
		20V	155°C	165°C	696	56.9		.0778	0.55			
		20V	165°C	175°C	864	58.2		.0965	0.64			Leak
		20V	175°C	185°C	1032	59.9		.076	0.78			
		20V	185°C	195°C	1200	62.8		.0695	1.37			
		20V	195°C		1368	65.5	+24.1	.089	2.67	7.50212		
		60V	27°C			54.2	+2.7	.047	0.20			
												X

APPENDIX E

Temperature Cycling and Immersion

FANSTEEL, INC. Electronic Materials Lab. NASA 12-2004

TEMPERATURE CYCLING & IMMERSION TEST

MEASUREMENT CONDITIONS		ACCEPTANCE CRITERIA				
		TEMP. °C	C %	Z ohm	ESR ohm	L ua
Step 1	25°C, 60V	- 55	- 32	50.	6	
2	-55°C, 60V	+ 25	+ 5			2.04
4	125°C, 40V	+125	+ 16			16.3
5	25°C, 60V					
After Immersion	25°C, 60V					

TRAY No.	CAP. No.	CYCLE	STEP	C uf	Δ C max %	D	L ua	ESR ohm	Z ohm	ACCEPT	FAIL MODE
16-1	246	Init.	1	53.0		.0385	0.25	.962			
		1	2	48.8		.565	3.4		31.3		
			4	54.9		.0222	2.25	.536			
			5	53.6		.0320	0.15	.792			
		2	2	48.5	-8.5	.570	2.0		31.5		
			4	55.0		.0215	1.75	.518			
			5	53.4		.0352	0.10	.873			
		3	2	49.4		.555	1.25		30.7		
			4	55.0		.0210	1.45	.506			
			5	53.2		.0370	0.10	.923			
		4	2	49.2		.560	3.2		30.9		
			4	54.9		.0305	4.9	.737			
			5	53.5		.0460	0.09	1.141			
		5	2	49.2		.565	2.3		30.9		
			4	54.8		.0305	5.2	.738			
			5	53.4		.0380	0.22	.943			
		After	Imm.	53.2		.0418	0.16	1.042		X	

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TEMPERATURE CYCLING & IMMERSION TEST

TRAY No.	CAP. No.	CYCLE	STEP	C uf	ΔC max %	D	L ua	ESR ohm	Z ohm	ACCEPT	FAIL MODE
16-2	249	Init.	1	52.2		.0251	0.73	.637			
		1	2	48.0		.432	0.11		30.1		
			4	54.0		.0180	2.1	.442			
			5	52.8		.0221	0.54	.555			
		2	2	48.1	− 8.4	.431	0.22		30.0		
			4	54.0		.0176	2.2	.432			
			5	52.8		.0238	0.38	.598			
		3	2	47.8		.440	0.27		30.3		
			4	54.0		.0175	1.25	.430			
			5	52.5		.0239	0.28	.604			
		4	2	48.0		.430	0.15		30.1		
			4	53.8		.0290	2.0	.714			
			5	52.8		.0445	0.35	1.118			
		5	2	48.2		.429	0.18		30.0		
			4	53.9		.0182	2.1	.448			
			5	52.8		.0334	0.45	.839			
		After	Imm.	52.4		.0235	0.27	.595		X	
16-3	428	Init.	1	52.4		.0208	0.09	.526			
		1	2	49.3		.340	.045		28.3		
			4	54.1		.0153	1.05	.375			
			5	53.0		.0168	0.10	.420			
		2	2	49.1	− 6.2	.345	0.40		28.6		
			4	54.1		.0145	9.2	.355			
			5	52.9		.0180	.065	.451			
		3	2	49.1		.370	0.20		28.8		
			4	54.1		.0150	0.82	.368			
			5	52.9		.0217	0.06	.544			
		4	2	49.3		.330	0.04		28.4		
			4	54.0		.0240	1.05	.590			
			5	53.0		.0202	0.05	.505			
		5	2	49.2		.365	0.32		28.6		
			4	53.9		.0147	1.25	.362			
			5	53.0		.0212	0.07	.530			
		After	Imm.	52.8		.0267	0.08	.671		X	

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TEMPERATURE CYCLING & IMMERSION TEST

TRAY No.	CAP. No.	CYCLE	STEP	C uf	ΔC max %	D	L ua	ESR ohm	Z ohm	ACCEPT	FAIL MODE
16-4	430	Init.	1	57.5		.0240	0.10	.553			
		1	2	54.1		.400	0.61		26.3		
			4	59.5		.0173	1.15	.385			
			5	58.2		.0198	0.12	.451			
		2	2	54.2		.395	0.50		26.2		
			4	59.5		.0165	1.0	.367			
			5	58.2		.0220	.072	.501			
		3	2	54.2	-6.0	.410	0.32		26.5		
			4	59.6		.0160	0.90	.356			
			5	58.1		.0305	0.75	.696			
		4	2	54.2		.390	0.33		26.2		
			4	59.1		.0277	1.1	.621			
			5	58.2		.0229	0.06	.522			
		5	2	54.3		.425	0.40		26.6		
			4	59.5		.0169	1.05	.376			
			5	58.1		.0215	0.14	.491			
		After	Imm.	58.2		.0204	0.10	.465		X	
16-5	431	Init.	1	54.1		.0228	0.46	.559			
		1	2	51.0		.355	0.60		27.5		
			4	55.9		.0160	2.05	.380			
			5	54.8		.0190	0.39	.460			
		2	2	51.1		.343	0.75		28.1		
			4	56.0		.0161	2.1	.382			
			5	54.8		.0190	0.26	.460			
		3	2	51.2		.340	0.82		27.9		
			4	55.9		.0160	1.8	.380			
			5	54.8		.0205	0.22	.496			
		4	2	50.8	-6.1	.360	0.74		27.8		
			4	55.9		.0273	2.4	.648			
			5	54.6		.0195	0.22	.473			
		5	2	51.1		.340	0.58		27.4		
			4	56.0		.0200	2.2	.474			
			5	54.7		.0220	0.25	.534			
		After	Imm.	54.7		.0202	0.23	.490		X	

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TEMPERATURE CYCLING & IMMERSION TEST

TRAY No.	CAP. No.	CYCLE	STEP	C uf	ΔC max %	D	L ua	ESR ohm	Z ohm	ACCEPT	FAIL MODE
16-6	433	Init.	1	55.7		.0240	2.3	.571			
		1	2	53.0	- 4.8	.325	0.42		26.4		
			4	57.3		.0160	4.8	.370			
			5	56.2		.0181	1.6	.427			
		2	2	53.0		.330	0.70		26.4		
			4	57.2		.0150	10.6	.348			
			5	56.2		.0200	2.0	.472			
		3	2	53.2		.310	0.90		26.2		
			4	57.3		.0146	8.8	.338			
			5	56.1		.0200	1.25	.473			
		4	2	53.1		.320	0.54		26.3		
			4	57.1		.0225	10.5	.522			
			5	56.1		.0200	1.70	.473			
		5	2	53.2		.325	1.10		26.3		
			4	57.2		.0246	11.2	.571			
			5	56.1		.0322	5.5	.761			
		After	Imm.	56.1		.0450	5.8	1.064			Hi L X
16-7	437	Init.	1	53.1		.0215	0.18	.538			
		1	2	49.8	-6.2	.375	0.13		28.5		
			4	54.9		.0142	1.35	.343			
			5	53.8		.0160	0.16	.394			
		2	2	49.9		.340	0.15		28.2		
			4	55.0		.0140	1.15	.337			
			5	53.6		.0169	0.10	.418			
		3	2	49.9		.365	0.11		28.3		
			4	55.0		.0152	1.05	.366			
			5	53.4		.0191	0.10	.474			
		4	2	49.8		.360	0.13		28.4		
			4	54.9		.0214	1.6	.517			
			5	53.5		.0200	0.09	.403			
		5	2	50.0		.355	0.12		28.2		
			4	54.9		.0188	1.32	.454			
			5	53.4		.0170	0.11	.422			
		After	Imm.	53.5		.0178	0.12	.442		X	

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TEMPERATURE CYCLING & IMMERSION TEST

TRAY No.	CAP. No.	CYCLE	STEP	C uf	ΔC max %	D	L ua	ESR ohm	Z ohm	ACCEPT	FAIL MODE
16-8	440	Init.	1	57.2		.0250	5.7	.580			Hi L
		1	2	54.7		.321	4.4		25.5		
			4	59.1		.0185	6.4	.415			
			5	57.8		.0212	1.75	.486			
		2	2	54.8		.315	2.1		25.4		
			4	59.2		.0170	2.25	.381			
			5	57.8		.0236	1.95	.541			
		3	2	54.8		.320	1.4		25.4		
			4	59.1		.0170	14.5	.381			
			5	57.8		.0238	0.65	.546			
		4	2	54.6	-4.5	.340	1.8		25.6		
			4	59.0		.0250	7.9	.562			
			5	57.6		.0277	0.57	.638			
		5	2	54.6		.335	1.2		25.6		
			4	59.1		.0198	4.8	.444			
			5	57.7		.0260	0.56	.598			
16-9	442	After	Imm.	57.7		.0260	0.53	.598		X L o.k.	
		Init.	1	54.1		.0305	0.20	.748			
		1	2	50.2	-7.2	.440	7.6		28.6		
			4	55.9		.0199	1.65	.473			
			5	54.6		.0785	0.15	1.905			
		2	2	50.5		.430	3.2		28.6		
			4	56.1		.0154	1.25	.364			
			5	54.7		.0490	0.12	1.188			
		3	2	50.4		.435	1.8		28.7		
			4	56.1		.0150	1.1	.355			
			5	54.7		.0222	0.10	.539			
		4	2	50.3		.445	1.45		29.0		
			4	55.4		.0317	7.5	.758			
			5	54.8		.0240	0.22	.581			
		5	2	50.4		.430	0.20		28.6		
			4	55.8		.0287	0.18	.682			
			5	54.7		.0246	0.14	.597			
		After	Imm.	54.7		.0245	0.12	.595		X	

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TEMPERATURE CYCLING & IMMERSION TEST

TRAY No.	CAP. No.	CYCLE	STEP	C uf	ΔC max %	D	L ua	ESR ohm	Z ohm	ACCEPT	FAIL MODE
16-10	445	Init.	1	55.3		.0291	0.33	.698			
		1	2	51.8		.405	5.2		27.6		
			4	57.2		.0181	2.65	.420			
			5	56.0		.0240	0.48	.568			
		2	2	51.9		.400	4.8		27.6		
			4	57.2		.0168	3.5	.390			
			5	55.9		.0259	0.46	.615			
		3	2	51.9		.410	3.9		27.6		
			4	57.2		.0175	4.2	.406			
			5	55.9		.0250	0.42	.595			
		4	2	51.7	-6.5	.415	2.7		27.8		
			4	57.1		.0266	6.2	.617			
			5	56.0		.0260	0.44	.514			
		5	2	51.7		.405	2.4		27.7		
			4	57.1		.0242	5.1	.561			
			5	56.0		.0225	0.45	.533			
		After	Imm.	56.0		.0220	0.30	.521		X	

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TEMPERATURE CYCLING & IMMERSION TEST

TRAY No.	CAP. No.	CYCLE	STEP	C uf	ΔC max %	D	L ua	ESR ohm	Z ohm	ACCEPT	FAIL MODE
17-1	446	Int.		53.3		.0258	0.20	.642			
		Final		53.3		.0260	0.13	.647		X	
17-2	447	Int.		54.2		.0207	0.20	.506			
		Final		54.1		.0270	0.15	.662		X	
17-3	448	Int.		55.0		.0210	0.26	.506			
		Final		55.0		.0246	0.17	.598		X	
17-4	455	Int.		58.2		.0184	0.19	.419			
		Final		58.3		.0184	0.13	.418		X	
17-5	458	Int.		54.9		.0175	0.32	.423			
		Final		54.9		.0262	0.25	.633		X	
17-6	460	Int.		54.7		.0218	0.90	.529			
		Final		54.9		.0216	0.42	.522		X	
17-7	462	Int.		56.0		.0184	0.65	.436			
		Final		56.1		.0195	0.34	.461		X	
17-8	464	Int.		55.8		.0210	0.75	.499			
		Final		56.0		.0201	0.32	.476		X	
17-9	467	Int.		55.9		.0286	0.36	.679			
		Final		55.9		.0225	0.27	.534		X	
17-10	468	Int.		55.8		.0195	0.60	.463			
		Final		55.9		.0218	0.40	.518		X	

APPENDIX F

Surge Voltage Test Data

FANSTEEL,INC. Electronic Materials Lab. NASA 12-2004

SURGE TEST

TRAY No.	CAP. No.	CONDITION	CYCLE	C uf	Δ C %	D	L ua	ESR ohm	W gm	Δ W g x 10^3	ACCEPT	FAIL MODE
18-1	214	25°C,60V	Init.	53.9		.0269	0.25	.662	7.70190	+.05		
		25°C,60V	1000	54.6	+1.3	.0230	0.20	.558	7.70195	+.03	X	
18-2	217	25°C,60V	Init.	52.8		.0200	0.56	.502	7.84124			
		25°C.60V	1000	53.2	+ .7	.0183	0.15	.456	7.84140	+.16	X	
18-3	218	25°C,60V	Init.	53.0		.0215	0.14	.538	7.72835			
		25°C,60V	1000	53.4	+ .7	.0300	0.13	.744	7.72835	0	X	
18-4	220	25°C,60V	Init.	54.8		.0250	0.96	.605	7.75370			
		25°C.60V	1000	55.7	+1.6	.0217	0.21	.517	7.75390	+.20	X	
18-5	221	25°C,60V	Init.	52.8		.0359	0.10	.902	7.69139			
		25°C,60V	1000	53.4	+1.1	.0290	0.14	.720	7.69174	+.35	X	
18-6	222	25°C,60V	Init.	52.2		.0280	0.68	.711	7.63661			
		25°C.60V	1000	53.0	+1.6	.0270	0.17	.675	7.63672	+ .11	X	
18-7	223	25°C,60V	Init.	52.8		.0251	0.70	.631	7.73874			
		25°C,60V	1000	53.2	+ .8	.0228	0.18	.568	7.73885	+ .11	X	
18-8	225	25°C,60V	Init.	53.9		.0226	0.31	.557	7.83636			
		25°C,60V	1000	54.3	+ .7	.0241	0.26	.589	7.83636	0	X	
18-9	227	25°C,60V	Init.	53.9		.0220	0.23	.542	7.78749			
		25°C,60V	1000	54.7	+1.5	.0211	0.16	.512	7.78784	+ .35	X	
18-10	228	25°C,60V	Init.	52.3		.0181	1.0	.459	7.70482			
		25°C,60V	1000	53.1	+1.5	.0189	0.19	.472	7.70488	+ .06	X	
19-1	229	25°C,60V	Init.	53.9		.0518	1.35	1.276	7.50883			X
		25°C,60V	1000	53.9	0	.0450	2.2	1.108	7.50901	+ .18		Hi.L
19-2	230	25°C,60V	Init.	53.8		.0278	0.18	.685	7.73319			
		25°C,60V	1000	53.9	+ .2	.0257	0.60	.633	7.73327	+ .08	X	

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SURGE TEST

TRAY No.	CAP. No.	CONDITION	CYCLE	C uf	$\Delta_{\%}$C	D	L ua	ESR ohm	W gm	Δ W g. x 10^3	ACCEPT	FAIL MODE
19-3	231	25°C,60V	Init.	51.0		.0305	0.29	.794	7.66703			
		25°C,60V	1000	51.2	+ .4	.0278	0.43	.720	7.66567	- 1.36	X	
									7.66471	- 1.96	X	
19-4	234	25°C,60V	Init.	53.8		.0262	0.19	.645	7.70046			
		25°C,60V	1000	53.9	+ .2	.0246	0.15	.606	7.70053	+ .07	X	
19-5	236	25°C,60V	Init.	54.9		.0243	0.40	.587	7.71659			
		25°C,60V	1000	55.0	+ .2	.0231	0.98	.557	7.71675	+ .16	X	
19-6	238	25°C,60V	Init.	52.8		.0271	1.05	.681	7.65146			
		25°C,60V	1000	52.9	+ .2	.0250	0.57	.626	7.65180	+ .34	X	
19-7	239	25°C,60V	Init.	52.4		.0215	0.20	.544	7.92285			
		25°C,60V	1000	52.6	+ .4	.0173	0.28	.436	7.92302	+ .17	X	
19-8	242	25°C,60V	Init.	52.5		.0201	0.27	.508	7.90415			
		25°C,60V	1000	52.6	+ .2	.0172	0.29	.433	7.90421	+ .06	X	
19-9	243	25°C,60V	Init.	54.8		.0288	1.3	.697	7.66046			
		25°C,60V	1000	54.8	0	.0285	2.0	.690	7.66042	- .04	X	
19-10	244	25°C,60V	Init.	54.1		.0270	2.2	.662	7.75557			
		25°C,60V	1000	54.1	0	.0241	22.5	.591	7.75599	+ .42		X Hi.L

APPENDIX G

New Technology

After a diligent review of the work performed under this contract, no new innovation, discovery, improvement or invention was made.