PAH75D48-5033

RELIABILITY DATA

POWER MODULE

DRAWING NO. : PA550-79-01			
DLJ QA	NLS R&D		
APPROVED	PREPARED	CHECKED	APPROVED
T. Murayama			
DATE : 7/Jul/00	DATE ISSUE : 7/7/00		

DENSEI-LAMBDA

INDEX

Note :- Test result are typical data. Nevertheless the following result are consider to be actual capability data because all units have nearly the same charateristics.

PAH75D48-5033

1. Calculated Values Of M.T.B.F

1 . Method of calculation

Calculated based on part count reliability projection of MIL-HDBK-217F.
Individual failure rate λ_G is given to each part, and MTBF is calculated by the count of each part.

Formula :

$$MTBF = \frac{1}{\lambda_{equip}}$$

$$= \frac{1}{\sum_{i=1}^{n} N_i (\lambda_G \pi_Q)_i} \times 10^6 \quad \text{Hours}$$

Where :

λ_{equip} : Total Equipment Failure Rate (Failure / 10^6 Hours)

λ_G : Generic Failure Rate for The ith Generic Part (Failure / 10^6 Hours)

N_i : Quantity of ith Generic Part

n : Number of Different Generic Part Categories

π_Q : Generic Quality Factor for The ith Generic Part (π_Q = 1)

2 . MTBF Values

G F : (GROUND, FIXED)
M T B F = 406,836 Hours

2. Component Derating

(1) Calculating Method

(a) Measuring Conditions

Input Voltage	:	48VDC
Output Current	:	Io5 = 5A, Io3.3 = 15A
Mounting Method	:	Standard Mounting Method (with Heatsink)
Ambient Temperature	:	25°C
Base-Plate Temperature	:	100°C

(b) Semiconductors

Compared with maximum junction temperature and actual one which is calculated based on case temperature, power dissipation and thermal impedance.

(c) IC, Resistors, Capacitors, etc.

Ambient temperature, operating condition, power dissipation, etc are within derating criteria.

(d) Calculating Method of Thermal Impedance

$$\theta_{j-c} = \frac{T_{j(max)} - T_c}{P_{(max)}} \qquad \theta_{j-a} = \frac{T_{j(max)} - T_a}{P_{(max)}}$$

T_c = Case Temperature at Start Point of Derating, 25°C in General

T_a = Ambient Temperature at Start Point of Derating, 25°C in General

$P_{(max)}$ = Maximum Power Dissipation

$T_{j(max)}$ = Maximum Junction Temperature

θ_{j-c} = Thermal Impedance between Junction and Case

θ_{j-a} = Thermal Impedance between Junction and Air

2. Temperature Derating

Model :- PAH75D48-5033

Condition :- Vin = 48 VDC
Load = Io1 (5A) Io2 (15A)
Tp = 100°C

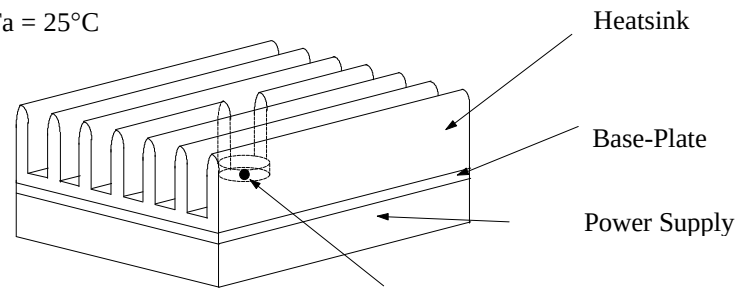
Symbol	Parts Name	Catalog No	Tj max (°C)	Actual Tj (°C)	Derating factor (%)
Q1	CHIP MOSFET	2SK1334BY-TL	150	104.0	69.33
Q2	CHIP TRANSISTOR	2SC2712Y-TE85L	125	99.6	79.68
Q3	CHIP TRANSISTOR	2SA1162Y-TE85L	150	95.90	63.93
A1	CHIP IC	NL21C001	150	123.0	82.00
A2	CHIP IC	ZR431LF01	150	91.5	61.00
A3	CHIP IC	IR2110STR	150	125.0	83.33
A4	CHIP IC	UCC2813DTR-3	150	116.9	77.93
A5	CHIP IC	TA75S393F-TE85L	125	101.5	81.20
A6	CHIP IC	TA75S01F-TE85L	125	101.9	81.52
A7	CHIP IC	ZR431LF01	150	91.6	61.06
D1	CHIP DIODE, U-LLD	D1FL20U-4063	150	103.9	69.26
D2	CHIP DIODE	1SS184-TE85L	150	111.5	74.33
D3	CHIP DIODE, U-LLD	D1FL20U-4063	150	100.2	66.80
D4	CHIP DIODE	1SS184-TE85L	150	113.5	75.67
ZD1	CHIP ZENER	02CZ18Y-TE85L	150	106.6	71.07
ZD2	CHIP ZENER	02CZ2.2X-TE85L	150	104.4	69.60
ZD3	CHIP ZENER	02CZ13Z-TE85L	150	97.3	64.87
PC1	CHIP PHOTO COUPLER	TLP181GRH-TPL	150	93.1	62.06
PC2	CHIP PHOTO COUPLER	TLP181GRH-TPL	150	88.6	59.07
Q101	CHIP MOSFET	2SK2099-01S	150	113.0	75.33
Q102	CHIP MOSFET	2SK2226-01S	150	106.0	70.67
Q103	CHIP MOSFET	TRC8003-TE12L	150	122.6	81.73
Q104	CHIP MOSFET	TRC8003-TE12L	150	124.4	82.93
D101	CHIP S.B.D	DF30SC3ML	150	123.6	82.40
D102	CHIP S.B.D	DE10S3L	150	129.6	86.40
ZD101	CHIP ZENER	02CZ18Y-TE85L	150	100.5	67.00

3. Main Components Temperature Rise DT List

MODEL : PAH75D48-5033

Location	Parts Name	Catalog No.	ΔT_{C-P} (°C)
Q101	CHIP MOSFET	2SK2099-01S	5.5
Q102	CHIP MOSFET	2SK2226-01S	3.4
Q103	CHIP MOSFET	TPC8003-TE12L	18.3
Q104	CHIP MOSFET	TPC8003-TE12L	20.1
D101	CHIP S.B.D	DF30SC3ML-4072	12.8
D102	CHIP S.B.D	DE10S3L	8.8
ZD101	CHIP ZENER	02CZ18Y-TE85L	0.5
C102	CHIP CAP.,CERAMIC	CY55Y5U2A685S-TE12L	3.0
C103	CHIP CAP.,CERAMIC	GHM1530X7R473K250PT	3.6
C106	CHIP CAP.,CERAMIC	CY55Y5U1C107S-TE12L	3.8
L101	CHIP COIL	R-12T766DC	5.1
L102	CHIP POWER INDUCTOR	S6LH-M41	9.0
C25	CHIP CAP., POSCAP	10TPB220M	-2.2
T101	COIL (SEC)		4.6
T102	COIL (SEC)		-0.2

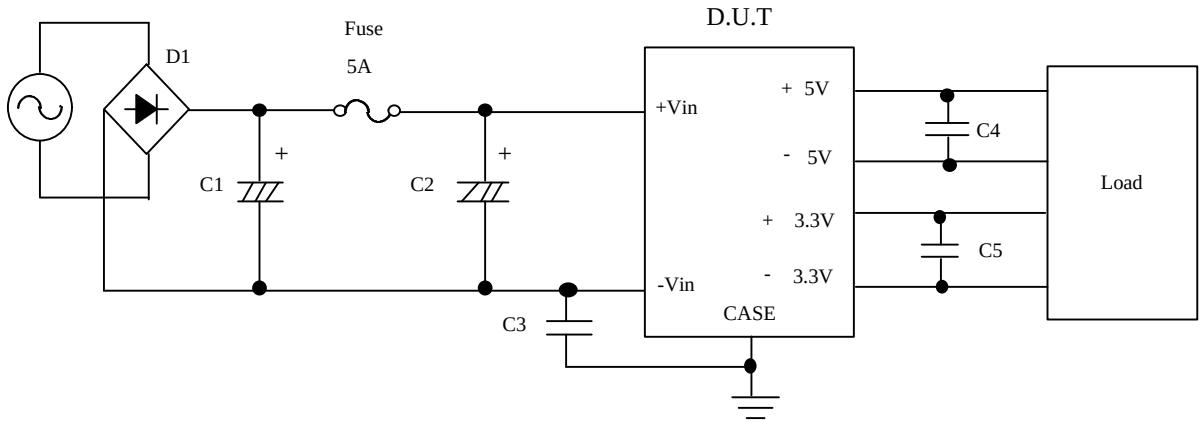
Measuring Conditions

Mounting Method	Standard Mounting Method (with Heatsink) Ta = 25°C 
Input Voltage	48VDC
Output Voltage	Vo1 = 5 V, Vo2 =3.3 V
Output Current	Io1 = 5 A , Io2 =15 A

ΔT_{C-P} : Differential temperature between component and base-plate; with power supply fitted with heatsink, baseplate temperature = 100°C and ambient temperature = 25°C.

4. Abnormal Test

MODEL : PAH75D48-5033



(1) Test Condition and Circuit

Input Voltage	*76VDC*	Output Current	*Io1 = 5A, Io2 = 15A*
Base-Plate Temperature	*25°C*	Fuse	*5A*
Bridge Rectifier (D1)	*D10XB60H*	Electrolytic Cap. (C1)	*200V 1000uF x 10pcs*
Electrolytic Cap. (C2)	*100V 33uF*	Ceramic Cap. (C3)	*AC400V 4700pF*
Ceramic Cap.(C4)	*25V 33uF*	Ceramic Cap. (C5)	*25V 33uF*

(2) Test Results

No.	Test Position		Test Mode		Test Results												
	LOCATION	TEST POINT	SHORT	OPEN	1 FIRE	2 SMOKE	3 BURST	4 SMELL	5 RED HOT	6 DAMAGE	7 FUSE BLOW	8 O.C.P.	9 O.V.P.	10 NO OUTPUT	11 NO CHANGE	12 OTHER	NOTE
1	Q1	D-G	●							●				●			Q1, R27, A1 Damage
2		D-S	●							●				●			R30, Q1, A1 Damage
3		G-S	●											●			
4		D		●										●			
5		S												●			
6		G		●										●			

No.	Test Position		Test Mode		Test Results												
	LOCATION	TEST POINT	SHORT	OPEN	1 FIRE	2 SMOKE	3 BURST	4 SMELL	5 RED HOT	6 DAMAGE	7 FUSE BLOW	8 O.C.P.	9 O.V.P.	10 NO OUTPUT	11 NO CHANGE	12 OTHER	NOTE
7	Q3	E-B	●												●		
8		E-C	●											●			
9		B-C	●											●			
10		B		●											●		
11		C		●											●		
12		E		●											●		
13	A4	1-2	●										●	●			
14		2-3	●													●	5V O/P remain. 3.3V O/P low
15		3-4	●										●	●			
16		5-6	●													●	5V O/P remain. 3.3V no O/P
17		6-7	●													●	5V O/P remain. 3.3V O/P low
18		7-8	●											●			
19		1		●												●	5V O/P remain. 3.3V O/P low
20		2		●												●	5V O/P remain. 3.3V O/P low
21		3		●												●	5V O/P remain. 3.3V O/P low
22		4		●												●	5V O/P remain. 3.3V no O/P
23		5		●										●			
24		6		●												●	5V O/P remain. 3.3V no O/P
25		7		●												●	5V O/P remain. 3.3V no O/P
26		8		●												●	5V O/P remain. 3.3V no O/P
27	D1		●							●	●			●			Q101, Q102 A2 Damage
28				●											●		Efficiency Low
29	D2		●												●		
30				●										●			
31	D3		●											●			
32				●										●			
33	D4		●												●		
34				●										●			
35	D5	1-2	●												●		
36		1-3	●												●		
37		2-3	●												●		
38		1		●											●		
39		2		●											●		
40		3		●											●		
41	D6		●												●		
42				●											●		
43	D7		●													●	5V O/P remain. 3.3V no O/P
44				●												●	5V O/P remain. 3.3V no O/P

No.	Test Position		Test Mode		Test Results												
	LOCATION	TEST POINT	SHORT	OPEN	1 FIRE	2 SMOKE	3 BURST	4 SMELL	5 RED HOT	6 DAMAGE	7 FUSE BLOW	8 O.C.P.	9 O.V.P.	10 NO OUTPUT	11 NO CHANGE	12 OTHER	NOTE
45	ZD1		●												●		Efficiency Low
46				●											●		
47	ZD2		●													●	Output Low
48				●											●		
49	ZD3		●											●			
50				●											●		
51	PC1	1-3	●										●				
52		4-6	●											●			
53		1		●									●				
54		3		●									●				
55		4		●									●				
56		6		●									●				
57	PC2	1-3	●												●		
58		4-6	●											●			
59		1		●											●		
60		3		●											●		
61		4		●											●		
62		6		●											●		
63	C4		●													●	Output High
64				●									●	●			
65	C5		●												●		
66				●											●		
67	C9		●											●			
68				●										●			
69	C12		●											●			
70				●										●			
71	C26		●											●			
72				●											●		
73	C28		●											●			
74				●											●		
75	T1	1-3	●											●			
76		6-7	●											●			
77		1		●										●			
78		3		●										●			
79		6		●										●			
80		7		●										●			

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No.	Test Position		Test Mode		Test Results												
	LOCATION	TEST POINT	SHORT	OPEN	1 FIRE	2 SMOKE	3 BURST	4 SMELL	5 RED HOT	6 DAMAGE	7 FUSE BLOW	8 O.C.P.	9 O.V.P.	10 NO OUTPUT	11 NO CHANGE	12 OTHER	NOTE
81	Q101	D-G	●									●					
82		D-S	●									●					
83		G-S	●												●		Efficiency Low
84		D		●											●		Efficiency Low
85		S		●											●		Efficiency Low
86		G		●											●		Efficiency Low
87	Q102	D-G	●							●	●			●			Q102 Damange
88		D-S	●								●			●			
89		G-S	●											●			
90		D		●										●			
91		S		●										●			
92		G		●										●			
93	Q103	D-G	●							●				●			Q103, R106, A4 Damage
94		D-S	●							●				●			Q103, R106, A4 Damage
95		G-S	●													●	5V O/P remain. 3.3V no O/P
96		D		●										●			5V O/P remain. 3.3V no O/P
97		S		●										●			5V O/P remain. 3.3V no O/P
98		G		●										●			5V O/P remain. 3.3V no O/P
99	Q104	D-G	●							●							Q104, R107, A4 Damage
100		D-S	●							●							Q104, R107, A4 Damage
101		G-S	●													●	5V O/P remain. 3.3V no O/P
102		D		●										●			5V O/P remain. 3.3V no O/P
103		S		●										●			5V O/P remain. 3.3V no O/P
104		G		●										●			5V O/P remain. 3.3V no O/P
105	D101	T101	●											●			
106				●												●	5V & 3.3V Output Low
107		T102	●											●			
108				●												●	5V & 3.3V Output Low
109	D102		●											●			
110				●												●	5V O/P remain. 3.3V O/P low
111	ZD101		●											●			
112				●											●		
113	C102		●											●			
114				●												●	Output drop to zero
115	C103		●											●			Efficiency Low
116				●											●		Efficiency Low
117	C105		●							●				●			R103, R104, R107 Damage
118				●											●		
119	L102		●											●			
120				●												●	5V O/P remain. 3.3V O/P low

No.	Test Position		Test Mode		Test Results												
	LOCATION	TEST POINT	SHORT	OPEN	1 FIRE	2 SMOKE	3 BURST	4 SMELL	5 RED HOT	6 DAMAGE	7 FUSE BLOW	8 O.C.P.	9 O.V.P.	10 NO OUTPUT	11 NO CHANGE	12 OTHER	NOTE
121	T101	1-2	●													●	Output Low
122		3-4	●													●	Output Low
123		1		●												●	Output Low
124		2		●												●	Output Low
125		3		●												●	Output Low
126		4		●												●	Output Low
127	T102	1-2	●													●	Output Low
128		3-4	●													●	Output Low
129		1		●												●	Output Low
130		2		●												●	Output Low
131		3		●												●	Output Low
132		4		●												●	Output Low
133	Reverse Input Voltage										●			●			

5. Vibration Test

(1) Vibration Test Class

Frequency Variable Endurance Test

(2) Equipment Used

Controller : F-400-BM-DCS-7800 (EMIC CORP.)

Vibrator : 905-FN (EMIC CORP.)

(3) Test Conditions

Sweep Frequency : 10-55Hz

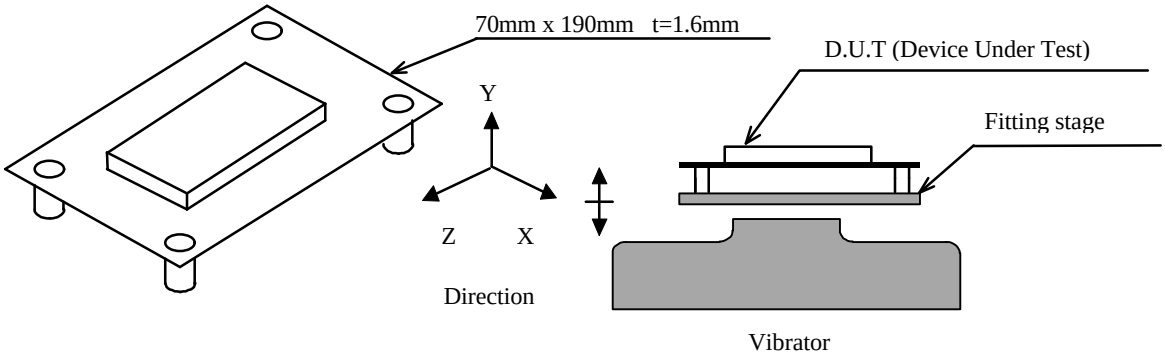
Sweep Time : 1 min.

Amplitude : (0.825mm) const.

Direction : X, Y, Z

Test Time : 1 hour each

(5) Test Method



Put the D.U.T. on the universal circuit board (soldering Input Output signal terminals and fixing by four M3-tapped-holes) and fit it on the fitting-stage.

(6) Test Results

Check Item		Output Voltage (V)		Ripple Voltage (mVp-p)		D.U.T. State
		Vo1(5V)	Vo2(3.3V)	Vo1(5V)	Vo2(3.3V)	
Before Test		4.936	3.328	58.8	37.5	OK
After Test	X	4.955	3.274	50.9	38.9	OK
	Y	4.955	3.276	60.6	35.3	OK
	Z	4.955	3.274	66.5	37.2	OK

6. Resistance To Soldering Heat Test

(1) Machine Used

Automatic Dip Soldering Machine (OSAKA ASAHI KAGAKU)

(2) Model

PAH75D48-5033

(3) The Number Of D.U.T. (Device Under Test)

1 Unit

(4) Test Conditions

Dip Soldering temperature : 260°C Dip time : 10 Seconds

Pre-heating temperature : 60 Seconds

(5) Test Method

Check if there is no abnormal output before test. Then put the D.U.T. on a circuit board, transfer to flux-dipping, pre-heat and solder in the automatic dip soldering machine. Leave it for 1 hour at the room temperature, then check if there is no abnormal output.

(6) Test Result

Test Conditions :- Vin = 48 VDC Load Condition :-

Base-Plate Temperature = 25°C Io1 - 5A, Io2 - 15A

Vo1

Check Items	Before Test	After Test
Output Voltage	4.992V	4.98V
Ripple Voltage	60.9mV	64.7mV
Line Regulation	1.2mV	1.6mV
Load Regulation	15.9mV	11.8mV
Isolation Resistance	OK	OK
Withstand Voltage	OK	OK
Appearnce	OK	OK

Vo2

Check Items	Before Test	After Test
Output Voltage	3.27V	3.254V
Ripple Voltage	42.9mV	33.5mV
Line Regulation	4mV	2mV
Load Regulation	18.9mV	11.7mV
Isolation Resistance	OK	OK
Withstand Voltage	OK	OK
Appearnce	OK	OK

Final Result : OK

7. Thermal Shock Test

(1) Equipment Used

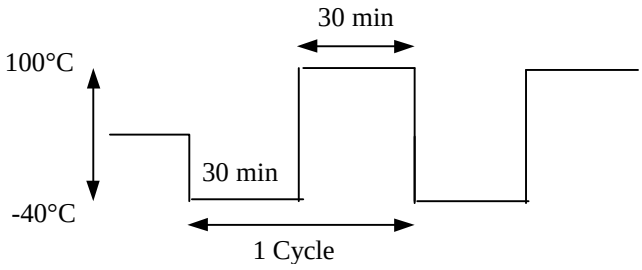
Thermal Shock Chamber TSV-40 (TABAI ESPEC CORP.)

(2) The Number Of D.U.T. (Device Under Test)

3 Units

(4) Test Conditions

- Ambient Temperature : -40°C~100°C
- Test Time : 500 Hours
- Test Cycle : 500 Cycles
- Not Operating



(5) Test Method

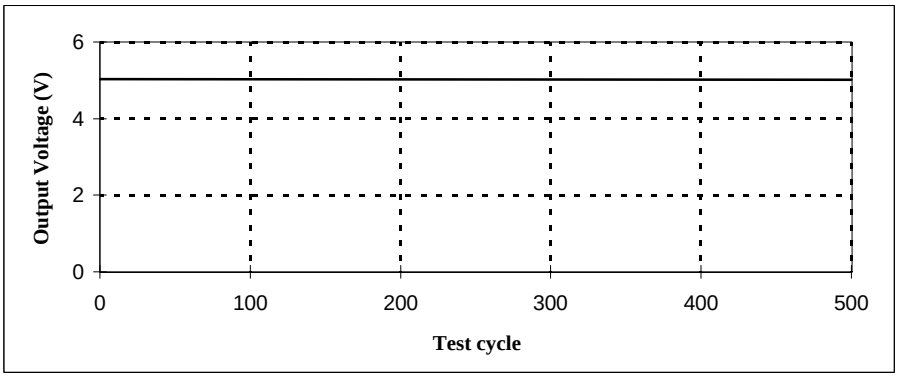
Before testing, check if there is no abnormal output, then put the D.U.T. in testing chamber, and test it according to the above cycle. After 500 cycles later, leave it for 1 hour at room temperature. then check if there is no abnormal output.

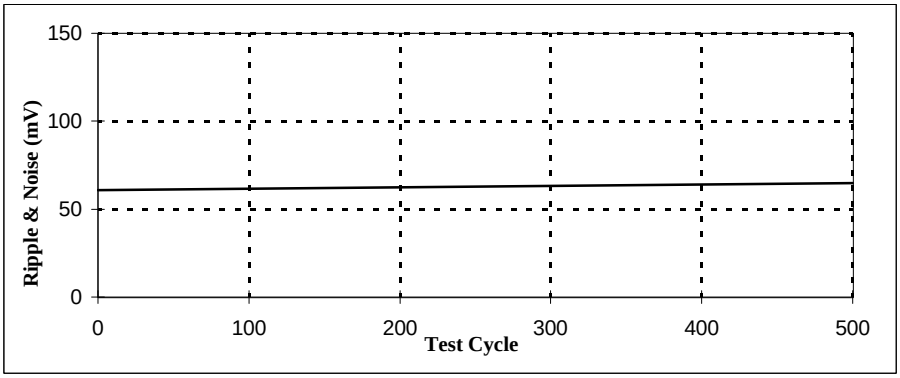
(6) Test results

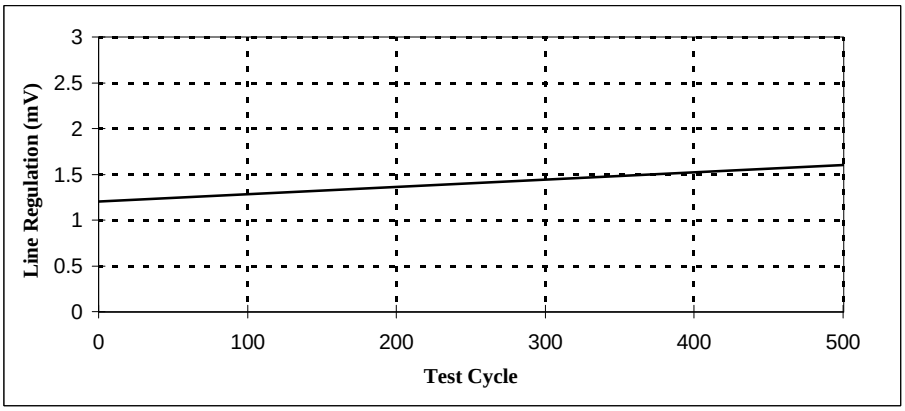
Final Result : OK.

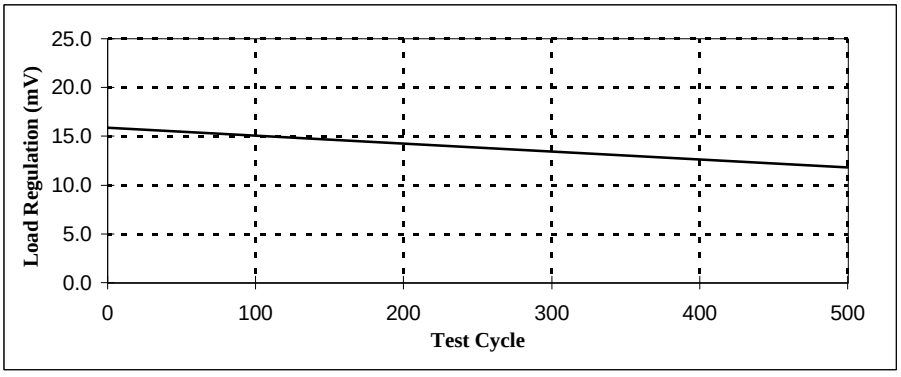
Refer to next page for measuring data.

Vo1 (5V)

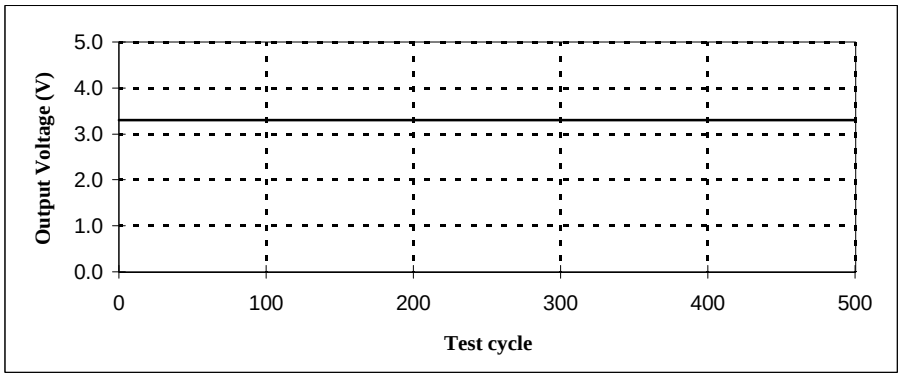

Output Voltage (V)
6
4
2
0
0
100
200
300
400
500
Test cycle

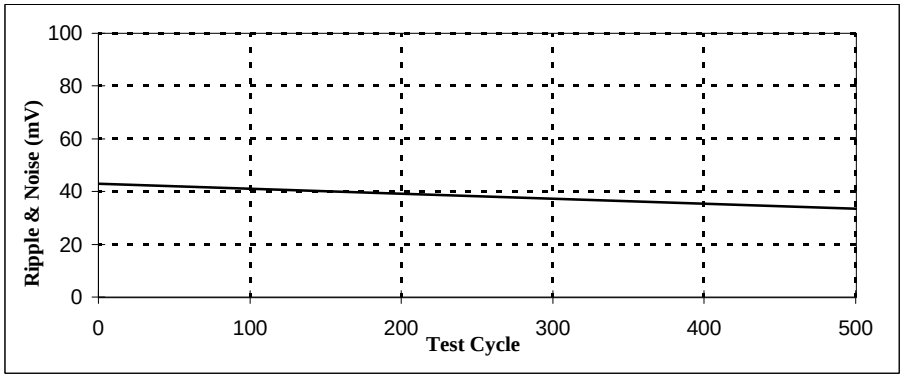

Ripple & Noise (mV)
150
100
50
0
0
100
200
300
400
500
Test Cycle

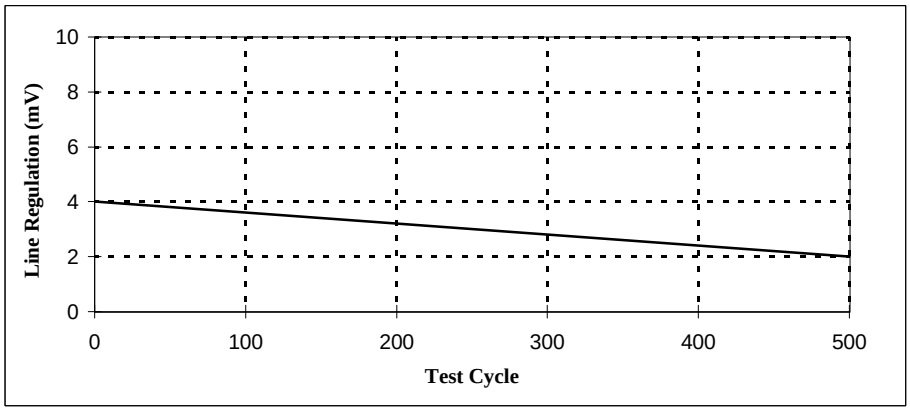

Line Regulation (mV)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
Test Cycle

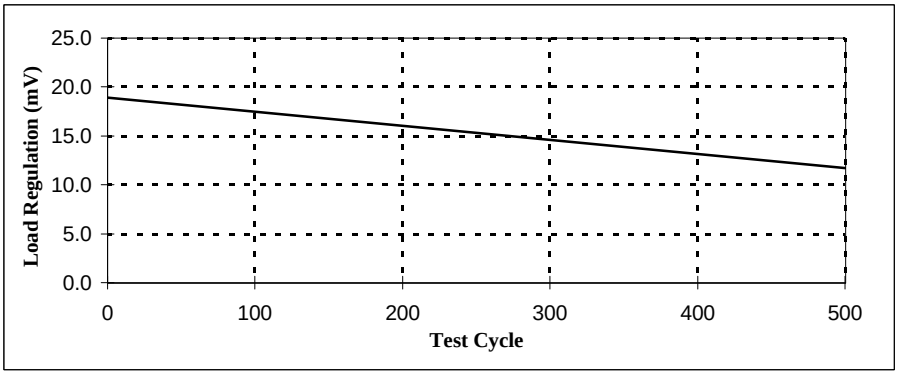

Load Regulation (mV)
25.0
20.0
15.0
10.0
5.0
0.0
0
100
200
300
400
500
Test Cycle

Vo2 (3.3V)


Output Voltage (V)
5.0
4.0
3.0
2.0
1.0
0.0
0
100
200
300
400
500
Test cycle


Ripple & Noise (mV)
100
80
60
40
20
0
0
100
200
300
400
500
Test Cycle


Line Regulation (mV)
10
8
6
4
2
0
0
100
200
300
400
500
Test Cycle


Load Regulation (mV)
25.0
20.0
15.0
10.0
5.0
0.0
0
100
200
300
400
500
Test Cycle