PAQ65D48 - *

RELIABILITY DATA

DWG. No. PA566-79-01			
QA APPROVED	APPROVED	CHECK	DRAWN
I Murayama			
6/9/02	6/9/02	6/9/02	06.9.12

DENSEI-LAMBDA

INDEX

* The following data are typical values. Nevertheless the following result are consider to be actual capability data because all units have nearly the same charateristics.

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

MODEL : PAQ65D48-5033

1 . Calculation Method

Calculated based on parts stress reliability projection of Tellcordia (*1).
Individual failure rate λ_{SS} is calculated by the electric stress and temperature rise of each device.

*1 : Tellcordia (Bellcore) "Reliability Prediction Procedure for Electronic Equipment".
(Document number TR-332, Issue 5)

$$MTBF = \frac{1}{\lambda equip} = \frac{1}{\pi_E \sum_{i=1}^{m} N_i \cdot \lambda_{SSi}} \times 10^9 \quad \text{hours}$$

$$\lambda_{SSi} = \lambda_{Gi} \cdot \pi_{Qi} \cdot \pi_{Si} \cdot \pi_{Ti}$$

Where :

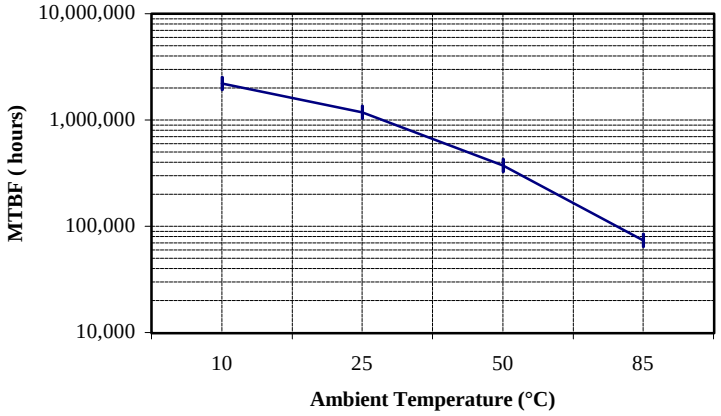
λ_{equip}	:	Total equipment failure rate (FITs = Failures in 10^9 hours).
λ_{Gi}	:	Generic failure rate for the ith device.
π_{Qi}	:	Quality factor for the ith device.
π_{Si}	:	Stress factor for the ith device.
π_{Ti}	:	Temperature factor for the ith device.
m	:	Number of different device types.
N_i	:	Quantity of ith device type.
π_E	:	Equipment environmental factor.

2 . MTBF Values

Conditions :
Vin = 48VDC
Air velocity = 2m/s
Environment G_B
(Ground, Fixed, Controlled)

M T B F = 1,178,599 hours

Ambient Temperature vs. MTBF



2. Component Derating

MODEL : PAQ65D48-5033

(1) Calculation Method

(a) Measuring Conditions

Input Voltage	:	48VDC
Output Current	:	Io1 = 6A, Io2 = 10.6A
Mounting Method	:	Standard Mounting Method
Ambient Temperature	:	85°C
Air Velocity	:	2m/s

(b) Semiconductors

The derating is derived by comparing the junction temperature with the device maximum rating temperature. The junction temperature, is calculated base on case temperature, power dissipation and thermal impedence.

(c) IC, Resistors, Capacitors, etc.

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

(d) Calculating Method of Thermal Impedance

$$\theta_{j-c} = \frac{T_{j(max)} - T_c}{P_{c(max)}} \qquad \theta_{j-a} = \frac{T_{j(max)} - T_a}{P_{c(max)}} \qquad \theta_{j-1} = \frac{T_{j(max)} - T_1}{P_{c(max)}}$$

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
T_1	=	Lead Temperature at Start Point of Derating, 25°C in General
$P_{(max)}$ ($P_{ch(max)}$)	=	Maximum Collector (Channel) Dissipation
$T_{j(max)}$ ($T_{ch(max)}$)	=	Maximum Junction (Channel) Temperature
θ_{j-c} (θ_{ch-c})	=	Thermal Impedance between Junction (Channel) and Case
θ_{j-a}	=	Thermal Impedance between Junction and Air
θ_{j-1}	=	Thermal Impedance between Junction and Lead

(2) Temperature Derating

MODEL : PAQ65D48-5033

Condition :- Vin = 48 VDC
Load = Io1 (6A) Io2 (10.6A)
Ta = 85°C
Air flow = 2m/s

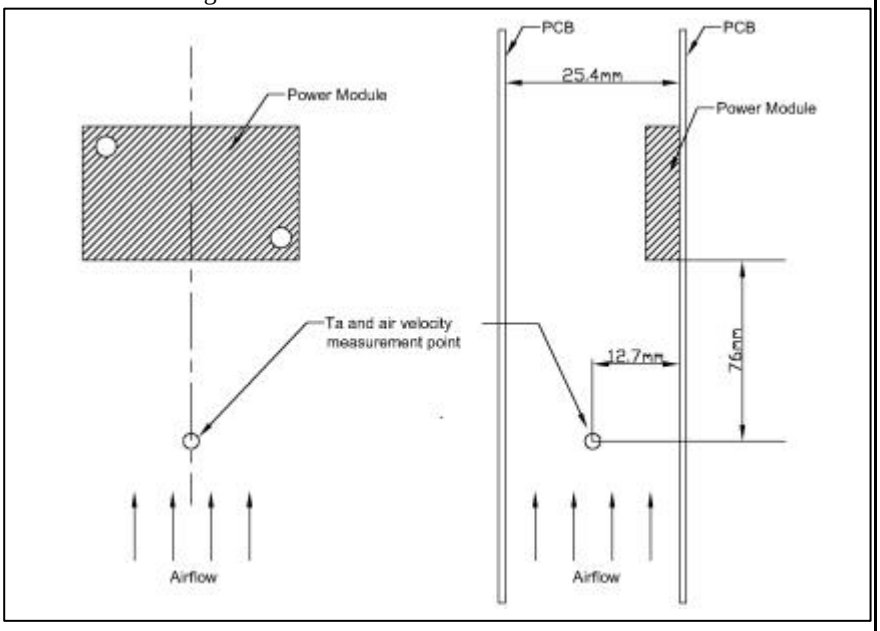
Symbol	Parts Name	Catalog No	Tj max (°C)	Actual Tj (°C)	Derating factor (%)
Q2	CHIP MOSFET	2SK3474-01	150	121.7	81.12
Q9	CHIP MOSFET	UPA2701G-E1	150	126.2	84.16
Q12	CHIP MOSFET	UPA2701G-E1	150	125.56	83.71
Q15	CHIP MOSFET	UPA2701G-E1	150	129.0	86.00
Q16	CHIP MOSFET	UPA2701G-E1	150	126.2	84.10
Q27	CHIP MOSFET	UPA2701G-E1	150	115.8	77.20
A3	CHIP IC	UCC2813PWTR-4	150	120.8	80.56
A4	CHIP IC	UCC25702PWTR	150	120.6	80.40
PC2	CHIP PHOTO COUPLER	PS2801-1-F3(P)	150	108.9	72.60

3. Main Components Temperature Rise ΔT List

MODEL : PAQ65D48-5033

Location	Parts Name	Catalog No.	ΔT_{C-a} (°C)
Q2	CHIP MOSFET	2SK3474-01	35.6
Q9	CHIP MOSFET	UPA2701G-E1	38.8
Q12	CHIP MOSFET	UPA2701G-E1	39.8
Q15	CHIP MOSFET	UPA2701G-E1	43.2
TH1	CHIP THERMISTOR	NSM2104J-425J3R	23.9
L5	CHOKE COIL	IHLP-5050CE-01 1uH	39

Measuring Conditions

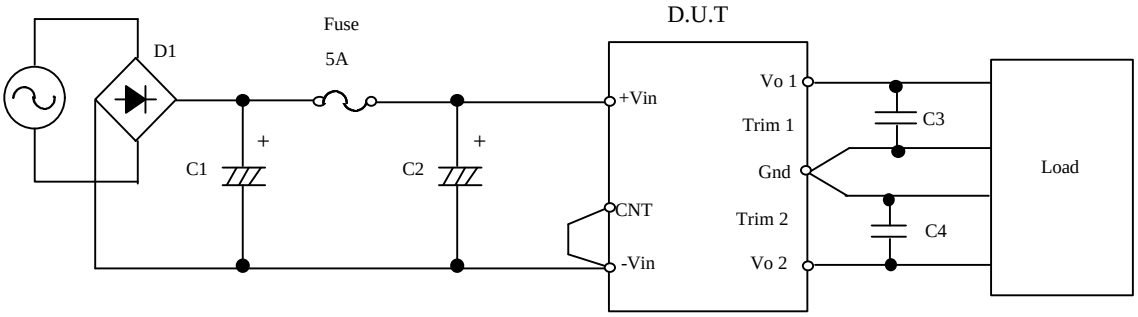
Mounting Method	Standard Mounting Method 
Input Voltage	48VDC
Output Voltage	Vo1 = 5 V, Vo2 =3.3 V
Output Current	Io1 = 6 A , Io2 =10.6 A

ΔT_{C-a} : Differential temperature between component and ambient temperature.
(Condition: Ta = 85°C and 2m/s at ambient temperature and air velocity measuring point)

4. Abnormal Test

MODEL : PAQ65D48-5033

(1) Test Condition and Circuit



Input Voltage	:	76VDC	Output Current	:	Io1 = 6.5A, Io2 = 8A
Ambient Temperature	:	25°C	Additional Fuse	:	5A
Bridge Rectifier (D1)	:	D10XB60H	Electrolytic Cap. (C1)	:	200V 1000uF x 8pcs
Ceramic Cap. (C2)	:	160V 33uF	Ceramic Cap. (C3)	:	6.3V 22uF
Air Velocity	:	2m/s	Ceramic Cap. (C4)	:	6.3V 22uF

(2) Test Results

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

No.	Test Position		Test Mode		Test Results												NOTE
	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	
7	Q2	G		●						●				●			Da: Q2, R7, R8, R9, R10, D4 A1,A2,fuse
8		S		●										●			
9		D		●										●			
10		D-S	●							●				●			Da:R7,R8,R9,R10,fuse
11		G-S	●											●			
12		D-G	●							●				●			Da:R7,R8,R9,R10,Q2,A2 D13,fuse
13	Q3	G		●										●			
14		S		●										●			
15		D		●										●			
16		D-S	●							●				●			Da: R13, R98. A3
17		G-S	●											●			
18		D-G	●												●		
19	Q7	E		●												●	(Efficiency Down)
20		C		●												●	(Efficiency Down)
21		B		●												●	(Efficiency Down)
22		B-E	●											●			
23		C-E	●												●		
24		B-C	●											●			
25	Q8	E		●										●			
26		C		●										●			
27		B		●										●			
28		B-E	●											●			
29		C-E	●							●				●			Da:Q7,D17
30		B-C	●							●				●			Da:Q7,D17
31	Q9	G		●										●			
32		S		●												●	(Efficiency Down)
33		D		●												●	(Efficiency Down)
34		D-S	●											●			
35		G-S	●							●				●			Da:Q11
36		D-G	●											●			
37	Q11	G		●											●		
38		S		●										●			
39		D		●						●				●			Da:Q10
40		D-S	●												●		
41		G-S	●												●		
42		D-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
43	Q12	G		●											●		
44		S		●											●		
45		D		●											●		
46		D-S	●											●			
47		G-S	●							●				●			Da:D17,Q7
48		D-G	●											●			
49	Q14	G		●										●			
50		S		●												●	(Efficiency Down)
51		D		●											●		
52		D-S	●											●			
53		G-S	●											●			
54		D-G	●											●			
55	Q16	G		●										●			
56		S		●											●		
57		D		●											●		
58		D-S	●											●			
59		G-S	●											●			
60		D-G	●											●			
61	Q21	E		●												●	Vo1 increase Vo2 no output
62		C		●												●	Vo low
63		B		●												●	Vo1 increase Vo2 no output
64		B-E	●													●	Vo low
65		C-E	●											●			
66		B-C	●							●				●			Da:ZD6
67	Q22	G		●										●			
68		S		●										●			
69		D		●										●			
70		D-S	●											●			
71		G-S	●											●			
72		D-G	●											●			
73	D1			●												●	(Efficiency Down)
74			●													●	(Efficiency Down)
75	D3			●												●	(Efficiency Down)
76			●													●	(Efficiency Down)
77	D5			●										●			
78			●												●		
79	D6			●										●			
80			●												●		

No.	Test Position		Test Mode		Test Results												
					1	2	3	4	5	6	7	8	9	10	11	12	
	LOCATION	TEST POINT	SHORT	OPEN	FIRE	SMOKE	BURST	SMELL	RED HOT	DAMAGE	FUSE BLOW	O.C.P.	O.V.P.	NO OUTPUT	NO CHANGE	OTHER	NOTE
81	D11			●											●		
82			●							●				●			Da:R99,Q21
83	D13			●											●		
84			●											●			
85	D14			●											●		
86			●											●			
87	D15			●											●		
88			●												●		
89	D16			●											●		
90			●												●		
91	D17			●											●		
92			●											●			
93	ZD2			●											●		
94			●												●		
95	ZD3			●											●		
96			●												●		
97	ZD6			●											●		
98			●											●			
99	Inverse Input Connection									●				●			Da:R7,R8,R9,R10,fuse
100																	

5. Vibration Test

MODEL : PAQ65D48-5033

(1) Vibration Test Class

Frequency Variable Endurance Test

(2) Equipment Used

Controller : F-400-BM-E47 (EMIC CORP.)

Vibrator : 905-FN (EMIC CORP.)

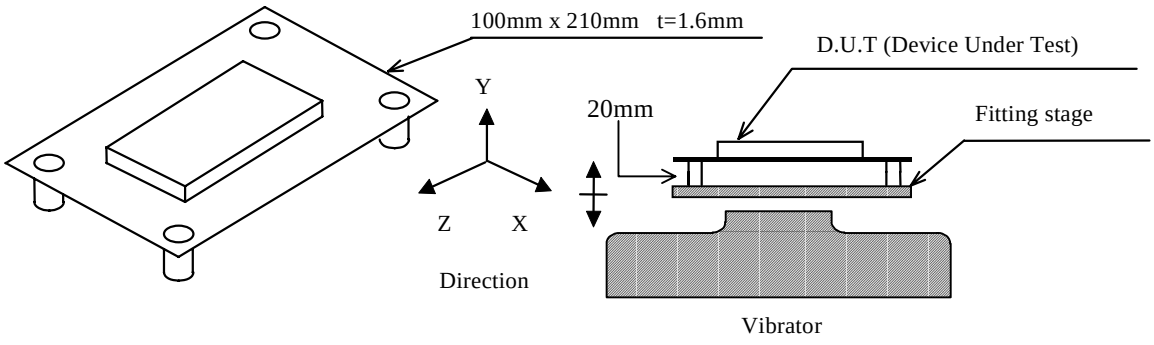
(3) The Number of D.U.T. (Device Under Test)

1 unit

(4) Test Conditions

Sweep Frequency	:	10-55Hz	Direction	:	X, Y, Z
Sweep Time	:	1 min.	Test Time	:	1 hour each axis
Amplitude	:	(0.825mm) const.			

(5) Test Method



Fix 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

Test Conditions : - Vin = 48VDC Load Condition :-
Ambient Temperature = 25°C Io1=6.5A
Air Velocity = 2m/s Io2=8A

Check Item		Output Voltage (V)		Ripple & noiseVoltage (mVp-p)		D.U.T. State
		Vo1(5V)	Vo2(3.3V)	Vo1(5V)	Vo2(3.3V)	
Before Test		4.994	3.277	47.2	51.0	OK
After Test	X	4.993	3.275	43.2	48.9	OK
	Y	4.994	3.278	44.1	39.2	OK
	Z	4.992	3.278	41.3	44.1	OK

6. Noise Simulation Test

MODEL : PAQ65D48-5033

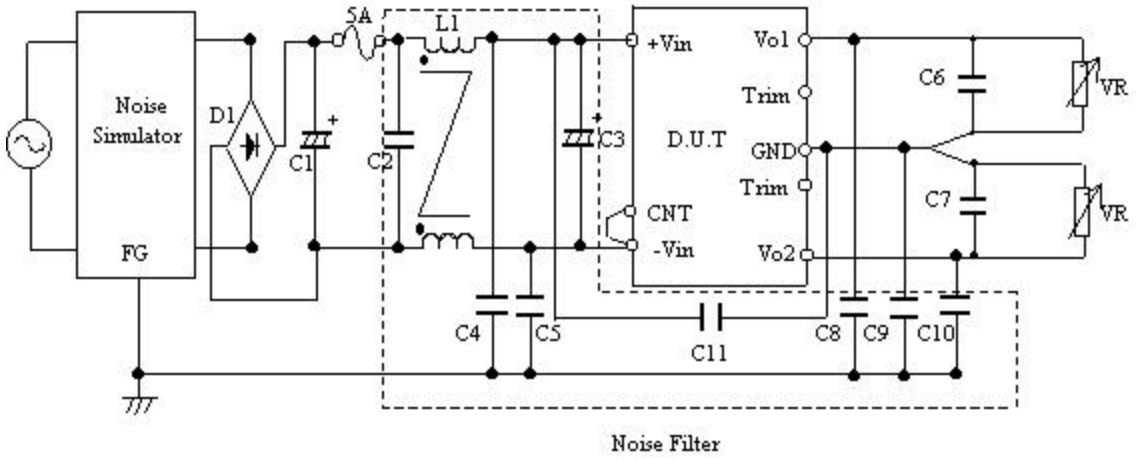
(1) Equipment Used

Noise Simulator	:	INS-4420 (Noise Laboratory Co.,LTD.)

(2) Test Conditions

Input voltage	:	48Vdc	Noise level	:	0V - 2kV
Output voltage	:	Rated	Phase shift	:	0° - 360°
Output current	:	0%, 100%	Polarity	:	+, -
Base-plate temperature	:	25°C	Mode	:	NORMAL, COMMON
Pulse width	:	50ns - 1000ns	Trig Select	:	LINE
Air Velocity	:	2m/s			

(3) Test Circuit and Equipment



Bridge Rectifier (D1)	:	D10XB60H (SHINDENGEN)
Electrolytic Cap. (C1)	:	200V, 1000µF x 10pcs
Film Cap. (C2)	:	100V, 1.5µF
Electrolytic Cap. (C3)	:	100V, 470µF
Film Cap. (C4, C5)	:	0.068uF
Ceramic Cap. (C6,C7)	:	10V, 22µF
Film Cap. (C8 to C10)	:	0.033uF
Ceramic Cap. (C11)	:	3kV,4700pF

(3) Acceptable Conditions

1. Nothing broken
2. Outputs do not shut down
3. No other out of orders

(4) Test Result - OK

7. Resistance To Soldering Heat Test

MODEL : PAQ65D48-5033

(1) Machine Used

Automatic Dip Soldering Machine (OSAKA ASAHI KAGAKU)

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

1 Unit

(3) Test Conditions

Dip Soldering temperature : 260°C
Pre-heating temperature : 110°C
Dip time : 6 seconds
Pre-heating Time : 40 seconds

(4) Test Method

Check to make sure there is no abnormal output before test. Then fix 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 to make sure there is no abnormal output.

(5) Test Result - OK

Test Conditions :- Vin = 48 VDC Load Condition :-
Ambient Temperature = 25°C Io1 = 6.5A
Air Velocity = 2m/s Io2 = 8.0A

Check Items	Before Test		After Test	
	Vo1	Vo2	Vo1	Vo2
Output Voltage	4.965 V	3.270 V	4.963 V	3.269 V
Ripple Voltage	28 mV	10 mV	32 mV	14 mV
Line Regulation	1 mV	0 mV	1 mV	1 mV
Load Regulation	7 mV	4 mV	9 mV	5 mV
Isolation Resistance	OK	OK	OK	OK
Withstand Voltage	OK	OK	OK	OK
Appearance	OK	OK	OK	OK

8. Thermal Shock Test

(1) Equipment Used

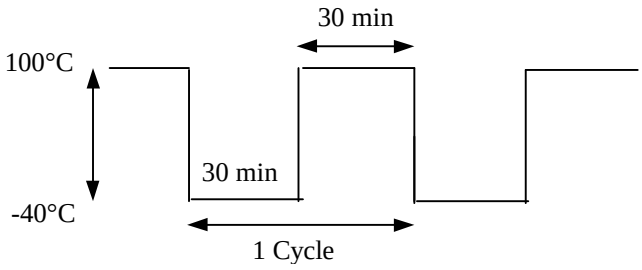
Thermal Shock Chamber TSV-40 (TABAI ESPEC CORP.)

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

3 Units (PAQ65D48-5033)

(4) Test Conditions

- Ambient Temperature : -40°C~+100°C
- Test Time : 30min.~30min.
- Test Cycle : 100,200 Cycles
- Not Operating

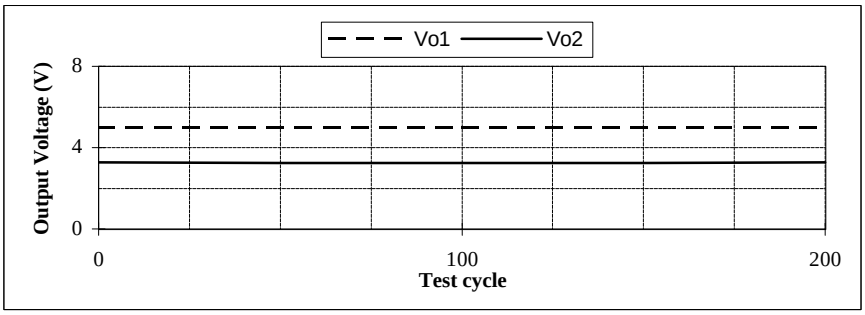


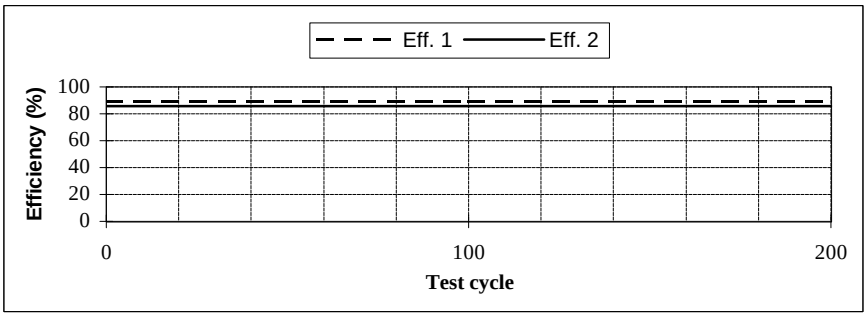
(5) Test Method

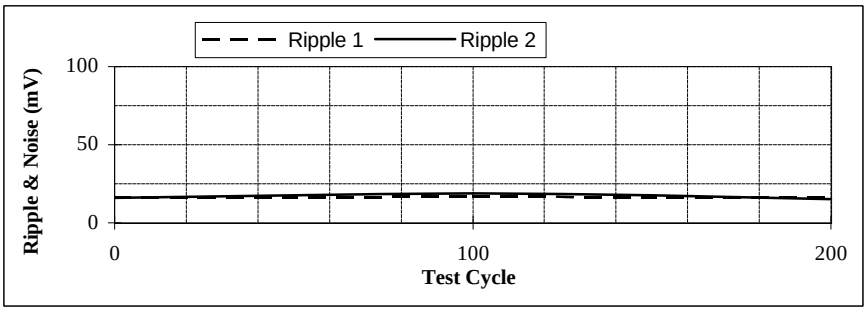
Before testing, check to make sure there is no abnormal output, then put the D.U.T. in testing chamber, and test it according to the above cycle. After 200 cycles later, leave it for 1 hour at room temperature. then check to make sure there is no abnormal output.

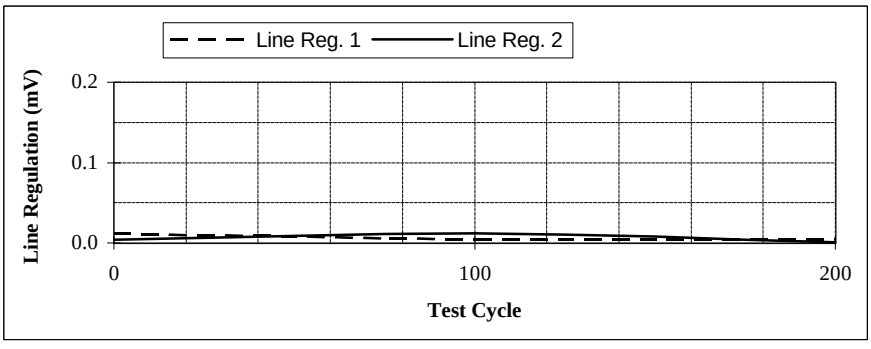
(6) Test results - OK

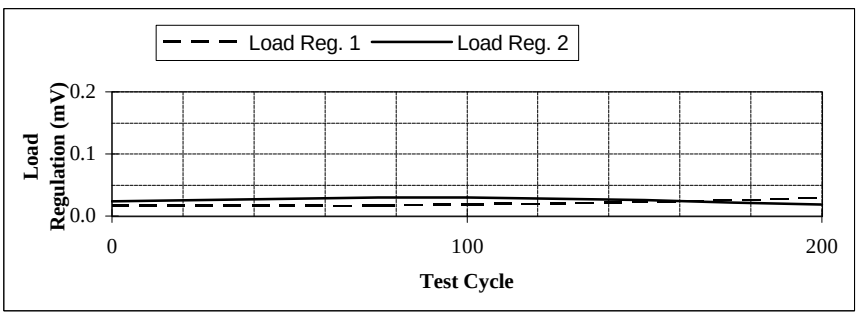
Refer to next page for measuring data.


Vo1
Vo2
Output Voltage (V)
8
4
0
0
100
200
Test cycle


Eff. 1
Eff. 2
Efficiency (%)
100
80
60
40
20
0
0
100
200
Test cycle


Ripple 1
Ripple 2
Ripple & Noise (mV)
100
50
0
0
100
200
Test Cycle


Line Reg. 1
Line Reg. 2
Line Regulation (mV)
0.2
0.1
0.0
0
100
200
Test Cycle


Load Reg. 1
Load Reg. 2
Load Regulation (mV)
0.2
0.1
0.0
0
100
200
Test Cycle

9. High Temperature Storage Test

MODEL : PAQ65D48-5033

(1) Equipment Used

MODEL : F-400-BM-E47 (EMIC CORP.)

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

2 Units

(3) Test Conditions

Ambient Temperature : 100°C
Test Time : 100 Hours
Not Operating

(4) Test Method

Check to make sure there is no abnormal output before test. Then fix the D.U.T. in testing chamber, and the chamber temperature is gradually increased from 25°C to 100°C. Leave the D.U.T. for 100 hours at 100°C and for 1 hour at the room temperature, then check to make sure there is no abnormal output.

(5) Test results - OK

Test Condition :- Vin = 48 VDC
Ambient temperature = 85°C
Air Velocity = 2m/s

Load Condition :-
Io1 = 6.5A
Io2 = 8.0A

Check Items	No. 1				No. 2			
	Before Test		After Test		Before Test		After Test	
	Vo1	Vo2	Vo1	Vo2	Vo1	Vo2	Vo1	Vo2
Output Voltage	4.986 V	3.270 V	4.984 V	3.280 V	4.971 V	3.263 V	4.969 V	3.263 V
Ripple Voltage	17.9 mV	18.9 mV	11.4 mV	11.8 mV	20 mV	20.4 mV	18.2 mV	17.5 mV
Line Regulation	9 mV	7 mV	7 mV	8 mV	9 mV	4 mV	5 mV	6 mV
Load Regulation	19 mV	19 mV	mV	21 mV	17 mV	20 mV	2 mV	8 mV
Isolation Resistance	OK	OK	OK	OK	OK	OK	OK	OK
Withstand Voltage	OK	OK	OK	OK	OK	OK	OK	OK
Appearance	OK	OK	OK	OK	OK	OK	OK	OK

10. Low Temperature Storage Test

MODEL : PAQ65D48-5033

(1) Equipment Used

MODEL : F-400-BM-E47 (EMIC CORP.)

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

2 Units

(3) Test Conditions

Ambient Temperature : -40°C
Test Time : 100 Hours
Not Operating

(4) Test Method

Check to make sure there is no abnormal output before test. Then fix the D.U.T. in testing chamber, and the chamber temperature is gradually decreased from 25°C to -40°C. Leave the D.U.T. for 100 hours at -40°C and for 1 hour at the room temperature, then check to make sure there is no abnormal output.

(5) Test results - OK

Test Conditions :- Vin = 48 VDC
Ambient Temperature = 25 °C
Air Velocity = 2m/s

Load Condition :-
Io1 = 6.5A
Io2 = 8.0A

Check Items	No. 1				No. 2			
	Before Test		After Test		Before Test		After Test	
	Vo1	Vo2	Vo1	Vo2	Vo1	Vo2	Vo1	Vo2
Output Voltage	4.991 V	3.273 V	4.994 V	3.278 V	4.971 V	3.269 V	4.974 V	3.269 V
Ripple Voltage	10.8 mV	10.2 mV	10.4 mV	10.0 mV	11.2 mV	12.2 mV	11 mV	11.8 mV
Line Regulation	7	7 mV	4 mV	5 mV	6 mV	4 mV	8 mV	3 mV
Load Regulation	15 mV	11 mV	3 mV	9 mV	9 mV	6 mV	15 mV	10 mV
Isolation Resistance	OK	OK	OK	OK	OK	OK	OK	OK
Withstand Voltage	OK	OK	OK	OK	OK	OK	OK	OK
Appearance	OK	OK	OK	OK	OK	OK	OK	OK

11. High Temperature and High Humidity Operation Test

MODEL : PAQ65D48-5033

(1) Equipment Used

MODEL : F-400-BM-E47 (EMIC CORP.)

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

2 Units

(3) Test Conditions

Ambient Temperature	: 85°C	Output Voltage	: Vo1 = 5V
Input Voltage	: 48VDC		: Vo2 = 3.3V
Output Current	: 0A (0%)	Humidity	: 95%RH
Test Time	: 500 Hours	Not Operating	

(5) Test Method

Check to make sure there is no abnormal output before test. Then fix the D.U.T. in testing chamber, and the chamber temperature is gradually increased from 25°C to 85°C. Operate the D.U.T. for 500 hours according to above condition and leave D.U.T for 1 hour at the room temperature, then check to make sure there is no abnormal output.

(6) Test results - OK

Test Condition :- Vin = 48 VDC
Ambient temperature = 25°C

Load Condition :-
Io1 = 6.5A
Io2 = 8.0A

Check Items	No. 1				No. 2			
	Before Test		After Test		Before Test		After Test	
	Vo1	Vo2	Vo1	Vo2	Vo1	Vo2	Vo1	Vo2
Output Voltage	4.989 V	3.270 V	4.986 V	3.263 V	4.979 V	3.266 V	4.838 V	3.17 V
Ripple Voltage	15.9 mV	15.9 mV	12.5 mV	14.5 mV	16.8 mV	16.8 mV	14.5 mV	15.5 mV
Line Regulation	9 mV	4 mV	7 mV	6 mV	8 mV	6 mV	6 mV	4 mV
Load Regulation	17 mV	24 mV	23 mV	23 mV	17 mV	20 mV	14 mV	18 mV
Isolation Resistance	OK	OK	OK	OK	OK	OK	OK	OK
Withstand Voltage	OK	OK	OK	OK	OK	OK	OK	OK
Appearance	OK	OK	OK	OK	OK	OK	OK	OK