DLP-PU/EJ

RELIABILITY DATA

DWG No. CA738-57-01/EJ		
APPD	CHK	DWG
15-Mar;04	8/Mar/04	8/Mar/04

I N D E X

∗ The above data is typical value. As all units have nearly the same characteristics, the data to be considered as ability value.

1. CALCULATED VALUES OF MTBF

MODEL : DLP-PU/EJ

(1) Calculating method

Calculated based on part count reliability projection of JEITA (RCR-9102).

Individual failure rates λ_G is given to each part and MTBF is calculated by the count of each part.

<Formula> :

$$\mathrm{MTBF} = \frac{1}{\lambda_{\mathrm{equip}}} = \frac{1}{\sum_{i=1}^{n} N_i (\lambda_G \pi_Q)_i} \times 10^6 \ (\mathrm{Hours})$$

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)

MTBF = 369,055 (Hours)

2. COMPONENT DERATING

MODEL : DLP-PU/EJ

(1) Calculating Method

(a) Measuring Conditions

Input	:	24VDC	• Ambient temperature	:	60°C
Output	:	23.5V 20A(100%)	• Mounting method	:	Standard Mounting

(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 and so on are within derating criteria.

(d) Calculating Method of Thermal Impedance

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

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_l : Lead Temperature at Start Point of Derating ; 25°C in General

$P_{c(max)}$ $(P_{ch(max)})$: 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-l} : Thermal Impedance between Junction and Lead

(2) Component Derating List

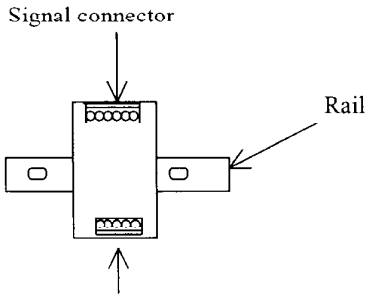
Location No.	Vin = 24VDC Load = 100% Ta = 60°C
D1 S30SC4M SHINDENGEN	Tjmax = 150 °C, θ j-c = 1.0 °C/W, Pd = 5.5W, Δ Tc = 28.4 °C, Tc = 88.4 °C Tj = Tc + ((θ j-c) × Pd) = 93.9°C D.F. = 62.6%
D2 S30SC4M SHINDENGEN	Tjmax = 150 °C, θ j-c = 1.0 °C/W, Pd = 5.5 W, Δ Tc = 28.6 °C, Tc = 88.6 °C Tj = Tc + ((θ j-c) × Pd) = 94.1 °C D.F. = 62.7%
D3 S30SC4M SHINDENGEN	Tjmax = 150 °C, θ j-c = 1.0 °C/W, Pd = 5.5 W, Δ Tc = 28.6 °C, Tc = 88.6 °C Tj = Tc + ((θ j-c) × Pd) = 94.1 °C D.F. = 62.7%
D4 S30SC4M SHINDENGEN	Tjmax = 150 °C, θ j-c = 1.0 °C/W, Pd = 5.5W, Δ Tc = 28.4 °C, Tc = 88.4 °C Tj = Tc + ((θ j-c) × Pd) = 93.9°C D.F. = 62.6%
D101 1SS294-TE85L TOSHIBA	Tjmax = 125 °C, θ j-a = 667 °C/W, P (max) = 150 mW, Pd = 1 mW, Δ Ta = 28.6 °C, Ta = 88.6 °C Tj = Ta + ((θ j-a) × Pd) = 89.3 °C D.F. = 71.4%
D102 1SS294-TE85L TOSHIBA	Tjmax = 125 °C, θ j-a = 667 °C/W, P (max) = 150 mW, Pd = 1 mW, Δ Ta = 24.2 °C, Ta = 84.2 °C Tj = Ta + ((θ j-a) × Pd) = 84.9 °C D.F. = 67.9%
D103 1SS184-TE85L TOSHIBA	Tjmax = 150 °C, θ j-a = 833°C/W, P (max) = 150 mW, Pd = 0 mW, Δ Ta = 27.5 °C, Ta = 87.5 °C Tj = Ta + ((θ j-a) × Pd) = 87.5 °C D.F. = 58.3%
D104 1SS184-TE85L TOSHIBA	Tjmax = 150 °C, θ j-a = 833 °C/W, P (max) = 150 mW, Pd = 0 mW, Δ Ta = 26.6 °C, Ta = 86.6 °C Tj = Ta + ((θ j-a) × Pd) = 86.6 °C D.F. = 57.7%
D105 1SS294-TE85L TOSHIBA	Tjmax = 125 °C, θ j-a = 667 °C/W, P (max) = 150 mW, Pd = 1 mW, Δ Ta = 24.2 °C, Ta = 84.2 °C Tj = Ta + ((θ j-a) × Pd) = 84.9 °C D.F. = 67.9%
Z101 02CZ15-Y-TE85L TOSHIBA	Tjmax = 150 °C, θ j-a = 625 °C/W, Pd(max) = 200 mW, Pd = 0 mW, Δ Ta = 26.7 °C, Ta = 86.7 °C Tj = Ta + ((θ j-a) × Pd) = 86.7 °C D.F. = 57.8%
Z102 02CZ15-Y-TE85L TOSHIBA	Tjmax = 150 °C, θ j-a = 625 °C/W, Pd(max) = 200 mW, Pd = 0 mW, Δ Ta = 28.7 °C, Ta = 88.7 °C Tj = Ta + ((θ j-a) × Pd) = 88.7 °C D.F. = 59.1%
Z103 02CZ15-Y-TE85L TOSHIBA	Tjmax = 150 °C, θ j-a = 625 °C/W, Pd(max) = 200 mW, Pd = 0 mW, Δ Ta = 29.4 °C, Ta = 89.4 °C Tj = Ta + ((θ j-a) × Pd) = 89.4°C D.F. = 59.6%
Z104 02CZ15-Y-TE85L TOSHIBA	Tjmax = 150 °C, θ j-a = 625 °C/W, Pd(max) = 200 mW, Pd = 0 mW, Δ Ta = 29.2 °C, Ta = 89.2 °C Tj = Ta + ((θ j-a) × Pd) = 89.2 °C D.F. = 59.5%
Z105 02CZ11-Y-TE85L TOSHIBA	Tjmax = 150 °C, θ j-a = 625 °C/W, Pd(max) = 200 mW Pd = 39 mW, Δ Ta = 34.2 °C, Ta = 94.2 °C Tj = Ta + ((θ j-a) × Pd) = 118.6 °C D.F. = 79.1%
Z106 02CZ11-Y-TE85L TOSHIBA	Tjmax = 150 °C, θ j-a = 625 °C/W, Pd(max) = 200 mW Pd = 39 mW, Δ Ta = 34.6 °C, Tc = 94.6 °C Tj = Ta + ((θ j-a) × Pd) = 119.0 °C D.F. = 79.3%

Location No.	Vin = 24VDC Load = 100% Ta = 60°C		
Q101 2SC2712-Y-TE85L TOSHIBA	Tjmax = 150 °C, Pd = 0 W, Tj = Ta + ((θ j-a) × Pd) = 88.2°C D.F. = 58.8%	θ j-a = 833 °C/W, Δ Ta = 28.2 °C,	Pc(max) = 150 mW Ta = 88.2 °C
Q102 2SA1162-Y-TE85L TOSHIBA	Tjmax = 150 °C, Pd = 1 mW, Tj = Ta + ((θ j-a) × Pd) = 92.0 °C D.F. = 61.3%	θ j-a = 833 °C/W, Δ Ta = 31.2 °C,	Pc(max) = 150 mW Ta = 91.2 °C
Q103 2SC2712-Y-TE85L TOSHIBA	Tjmax = 150 °C, Pd = 0 mW, Tj = Ta + ((θ j-a) × Pd) = 87.8 °C D.F. = 58.5%	θ j-a = 833 °C/W, Δ Ta = 27.8 °C,	Pc(max) = 150 mW Ta = 87.8 °C
Q104 2SA1162-Y-TE85L TOSHIBA	Tjmax = 150 °C, Pd = 1 mW, Tj = Ta + ((θ j-a) × Pd) = 91.4 °C D.F. = 61.0%	θ j-a = 833 °C/W, Δ Ta = 30.6 °C,	Pc(max) = 150 mW Ta = 90.6 °C
Q105 2SC2712-Y-TE85L TOSHIBA	Tjmax = 150 °C, Pd = 8 mW, Tj = Ta + ((θ j-a) × Pd) = 93.3°C D.F. = 62.2%	θ j-a = 833 °C/W, Δ Ta = 26.6 °C,	Pc(max) = 150 mW Ta = 86.6 °C
Q106 2SC2712-Y-TE85L TOSHIBA	Tjmax = 150 °C, Pd = 8 mW, Tj = Ta + ((θ j-a) × Pd) = 94.5 °C D.F. = 63.0%	θ j-a = 833 °C/W, Δ Ta = 27.8 °C,	Pc(max) = 150 mW Ta = 87.8 °C
A101 HA17431UA04-TL HITACHI	Tjmax = 150 °C, Pd = 9 mW, Tj = Ta + ((θ j-a) × Pd) = 91.9 °C D.F. = 61.3%	θ j-a = 156.3 °C/W, Δ Ta = 30.5 °C,	Pd(max) = 800 m W Ta = 90.5 °C
A102 HA17431UA04-TL HITACHI	Tjmax = 150 °C, Pd = 9 mW, Tj = Ta + ((θ j-a) × Pd) = 92.2 °C D.F. = 61.5%	θ j-a = 156.3 °C/W, Δ Ta = 30.8 °C,	Pd(max) = 800 m W Ta = 90.8 °C

3. MAIN COMPONENTS TEMPERATURE RISE ΔT LIST

MODEL : DLP-PU/EJ

Measuring Conditions

Mounting Method (Standard Mounting)	
Input Voltage (VDC)	24
Output Voltage (VDC)	23.5
Output Current (A)	20

※ Condition Ta = 60°C , Convection cooling .

Output Derating (100%) Ta = 60°C		Standard Mounting
Location No.	Parts Name	ΔT Temperature rise (°C)
D1	S.B.D	28.4
D2	S.B.D	28.6
D3	S.B.D	28.6
D4	S.B.D	28.4
D101	CHIP DIODE	28.6
D102	CHIP DIODE	24.2
D105	CHIP DIODE	24.2
Z101	CHIP ZENER	26.7
Z102	CHIP ZENER	28.7
Z103	CHIP ZENER	29.4
Z104	CHIP ZENER	29.2
Z105	CHIP ZENER	34.2
Z106	CHIP ZENER	34.6
Q101	CHIP TRANSISTOR	28.2
Q102	CHIP TRANSISTOR	31.2
Q103	CHIP TRANSISTOR	27.8
Q104	CHIP TRANSISTOR	30.6
Q105	CHIP TRANSISTOR	26.6
Q106	CHIP TRANSISTOR	27.8
A101	SHUNT REGULATOR	30.5
A102	SHUNT REGULATOR	30.8

4. ABNORMAL TEST

MODEL : DLP-PU/EJ

(1) Conditions

Input : 24VDC(Channel A only) Output : 23.5V / 20A Ta : 25°C , 70%RH

(2) Test results (Original unit state: LED A: ON, LED B: OFF, RELAY A: Contact + to OK, RELAY B: Contact + to F)

(Da : Damaged, Relay OK: Contact + to OK, Relay F: Contact + to F)

No.	Test position		Test mode		Test results												
					1	2	3	4	5	6	7	8	9	10	11	12	
	Location No.	Test Point	Short	Open	Fire	Smoke	Burst	Smell	Red Hot	Damaged	LED ON(A)	LED ON(B)	Relay(A) OK	Relay(B) OK	No Change	Others	Note
1	Q101	B-E	O								O		O		O		
2		C-E	O								O		O		O		
3		B-C	O								O		O		O		
4		B		O							O		O		O		
5		C		O							O		O		O		
6		E		O							O		O		O		
7	Q102	B-E	O								O		O		O		
8		C-E	O								O	O	O	O			
9		B-C	O								O	O	O	O			
10		B		O							O		O		O		
11		C		O							O		O		O		
12		E		O							O		O		O		
13	Q103	B-E	O								O		O		O		
14		C-E	O													O	LED(A,B) OFF,Relay(A,B) F
15		B-C	O													O	LED(A,B) OFF,Relay(A,B) F
16		B		O							O		O		O		
17		C		O							O		O		O		
18		E		O							O		O		O		
19	Q104	B-E	O													O	LED(A,B) OFF,Relay(A,B) F
20		C-E	O								O		O		O		
21		B-C	O								O		O		O		
22		B		O												O	LED(A,B) OFF,Relay(A,B) F
23		C		O												O	LED(A,B) OFF,Relay(A,B) F
24		E		O												O	LED(A,B) OFF,Relay(A,B) F
25	Q105	B-E	O													O	LED(A,B) OFF,Relay(A,B) F
26		C-E	O								O		O		O		
27		B-C	O								O		O		O		
28		B		O												O	LED(A,B) OFF,Relay(A,B) F
29		C		O												O	LED(A,B) OFF,Relay(A,B) F
30		E		O												O	LED(A,B) OFF,Relay(A,B) F
31	Q106	B-E	O								O		O		O		
32		C-E	O								O	O	O	O			
33		B-C	O								O	O	O	O			
34		B		O							O		O		O		
35		C		O							O		O		O		
36		E		O							O		O		O		

(Da : Damaged, Relay OK: Contact + to OK, Relay F: Contact + to F)

No.	Test position		Test mode		Test results												
					1	2	3	4	5	6	7	8	9	10	11	12	
	Location No.	Test Point	Short	Open	Fire	Smoke	Burst	Smell	Red Hot	Damaged	LED ON(A)	LED ON(B)	Relay(A) OK	Relay(B) OK	No Change	Others	Note
37	D1		O								O		O		O		
38				O							O		O		O		
39	D2		O								O		O		O		
40				O							O		O		O		
41	D3		O								O	O	O	O			
42				O							O		O		O		
43	D4		O								O	O	O	O			
44				O							O		O		O		
45	D101		O								O		O		O		
46				O												O	LED(A,B) OFF,Relay(A,B) F
47	D102		O								O		O		O		
48				O							O		O		O		
49	D103		O							O							Da: LED (A),Q105
50				O							O		O		O		
51	D104		O								O		O		O		
52				O							O		O		O		
53	D105		O								O		O		O		
54				O							O		O		O		
55	Z101		O								O		O		O		
56				O							O		O		O		
57	Z102		O								O		O		O		
58				O							O		O		O		
59	Z103		O													O	LED(A,B) OFF,Relay(A,B) F
60				O							O		O		O		
61	Z104		O													O	LED(A,B) OFF,Relay(A,B) F
62				O							O		O		O		
63	Z105		O								O		O		O		
64				O												O	LED(A,B) OFF,Relay(A,B) F
65	Z106		O								O		O		O		
66				O							O		O		O		
67	A101	A-K	O								O	O	O	O			
68		K-REF	O								O	O	O	O			
69		A-REF	O								O		O		O		
70		A		O							O		O		O		
71		K		O							O		O		O		
72		REF		O							O		O		O		
73	A102	A-K	O								O		O		O		
74		K-REF	O								O		O		O		
75		A-REF	O													O	LED(A,B) OFF,Relay(A,B) F
76		A		O							O		O		O		
77		K		O													
78		REF		O							O		O		O		
79	RY1(Coil)		O							O							Da: LED (A),Q105
80				O												O	LED(A,B) OFF,Relay(A,B) F
81	RY2(Coil)		O								O		O		O		
82				O							O		O		O		

(Da : Damaged, Relay OK: Contact + to OK, Relay F: Contact + to F)

No.	Test position	Test Mode		Test Results												
	Location No.	Short	Open	1 Fire	2 Smoke	3 Burst	4 Smell	5 Red Hot	6 Damaged	7 LED ON(A)	8 LED ON(B)	9 Relay(A) OK	10 Relay(B) OK	11 No Change	12 Others	Note
83	PD1	O										O				
84			O												O	LED(A,B) OFF,Relay(A,B) F
85	PD2	O								O		O		O		
86			O							O		O		O		
87	VR1	O								O		O		O		
88			O							O		O		O		
89	VR2	O								O		O		O		
90			O							O		O		O		
91	R101	O								O		O		O		
92			O							O		O		O		
93	R102	O								O		O		O		
94			O							O		O		O		
95	R103	O								O		O		O		
96			O							O		O		O		
97	R104	O								O		O		O		
98			O							O		O		O		
99	R105	O								O		O		O		
100			O							O		O		O		
101	R107	O								O		O		O		
102			O							O		O		O		
103	R108	O								O		O		O		
104			O							O		O		O		
105	R109	O								O		O		O		
106			O							O		O		O		
107	R110	O								O		O		O		
108			O							O		O		O		
109	R111	O								O		O		O		
110			O							O		O		O		
111	R113	O													O	LED(A,B) OFF,Relay(A,B) F
112			O							O		O		O		
113	R114	O								O		O		O		
114			O												O	LED(A,B) OFF,Relay(A,B) F
115	R115	O								O		O		O		
116			O												O	LED(A,B) OFF,Relay(A,B) F
117	R116	O								O		O		O		
118			O							O		O		O		
119	R117	O								O		O		O		
120			O												O	LED(A,B) OFF,Relay(A,B) F
121	R118	O								O		O		O		
122			O							O		O		O		

5. VIBRATION TEST

MODEL : DLP-PU/EJ

(1) Vibration Test Class

Frequency Variable Endurance Test

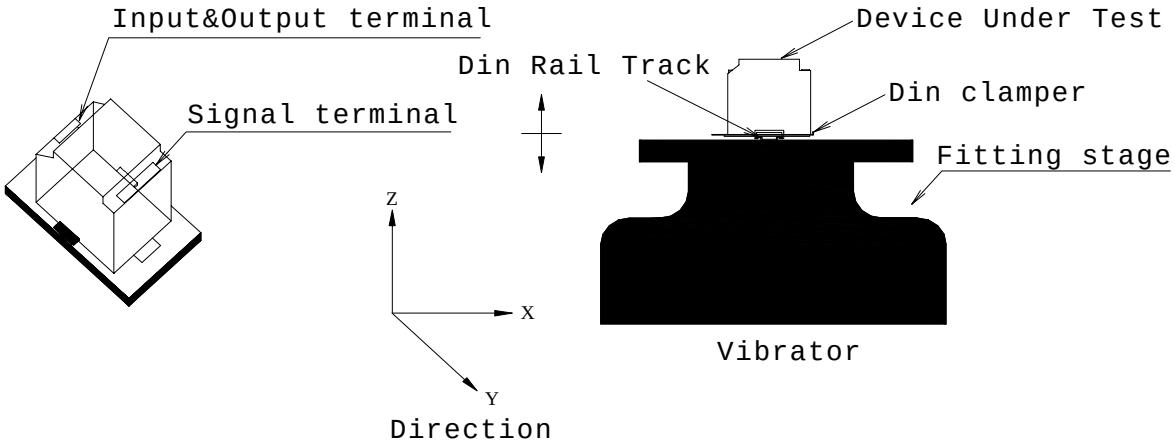
(2) Equipment Used

- Controller : DP550 (DP CORP. USA)
- Vibrator : V870 (LDS CORP. UK)

(3) Test Conditions

- Sweep frequency 10 ~ 55Hz
- Sweep time 1.0 min.
- Acceleration Constant 9.8m/s^2 (1G)
- Direction X, Y, Z.
- Test time 1 hour each

(4) Test Method



(5) Test Results

O K

Vin : 24VDC

Iout : 100%

Check item		Low input voltage alarm level(V)	High input voltage alarm level(V)	D.U.T.State
Before Test		19.2	30.3	———
After Test	X	19.2	30.3	O.K.
	Y	19.3	30.4	O.K.
	Z	19.3	30.5	O.K.