DRM40

RELIABILITY DATA

INDEX

* Test results are typical data. Nevertheless the following results are considered to be reference data because all units have nearly the same characteristics.

1. Calculated values for MTBF

MODEL : DRM40

(1) Calculating Method

Calculated based on parts stress reliability projection of Tellcordia (*1).
Individual failure rate lss 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)

$$\mathrm{MTBF} = \frac{1}{\lambda_{equip}} = \frac{1}{\sum_{i=1}^{m} N_i \cdot \lambda_{ssi}} \times 10^9 \,(\mathrm{hours})$$

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

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 :

Input Voltage : 30Vdc
Output Voltage & Current : 30Vdc, 40A (100%)
Environmental Factor : GB(Ground, Benign)
Mounting Method : Standard Mounting

MTBF (Ta=25°C) ≈ 6,670,604 Hours

2. Component derating

MODEL : DRM40

(1) Calculating Method

(a) Measuring Conditions

Input : 10VDC & 30VDC Ambient Temperature: 70 °C
Output: 10VDC & 30VDC, 40A(100%) Mounting Method: Standard mounting

(b) Semiconductors

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

(c) ICs, Resistors, Capacitors, etc.

Ambient temperature, operating condition, power dissipation and so on are within derating criteria

(d) Calculating method of Thermal Impedance

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

Tc : Case temperature at start point of derating ; 25°C in general

Ta : Ambient temperature at start point of derating ; 25°C in general

T_l : Lead temperature at start point of derating ; 25°C in general

Pc(max) : Maximum collector (channel) dissipation
(Pch(max))

Tj(max) : Maximum junction (channel) temperature
(Tch(max))

θ j-c : Thermal impedance between junction (channel) and case
(θch-c)

θ j-a : Thermal impedance between junction (channel) and air

θ j-l : Thermal impedance between junction (channel) and lead

θ j-pin : Thermal impedance between junction (channel) and pin

(2) Component Derating List

Location No.	Vin = 10VDC Load = 100% Ta = 70°C
Q2 TPW4R008NH,L1Q TOSHIBA	Tjmax = 150 °C θ j-c = 0.93 °C/W Pch(max)= 142 W Pd = 0.465 W ΔTc = 41.2 °C Tc= 111.2 °C Tj = Tc + ((θ j-c) x Pd) = 111.63 °C D.F. = 74.42%
Q4 TPW4R008NH,L1Q TOSHIBA	Tjmax = 150 °C θ j-c = 0.93 °C/W Pc(max)= 142 W Pd = 0.465 W ΔTc = 42 °C Tc= 112 °C Tj = Tc + ((θ j-c) x Pd) = 112.43 °C D.F. = 74.95%
PC1 TLP241AF(D4,F(O TOSHIBA	Tjmax = 125 °C θ j-c = 30 °C/W Pd(max)= 0.05 W Pd = 0.04174 W ΔTc = 19.9 °C Tc= 89.9 °C Tj = Tc + ((θ j-c) x Pd) = 91.15 °C D.F. = 72.92%
PC2 TLP241AF(D4,F(O TOSHIBA	Tjmax = 125 °C θ j-c = 30 °C/W Pd(max)= 0.05 W Pd = 0.04174 W ΔTc = 18.6 °C Tc= 88.6 °C Tj = Tc + ((θ j-c) x Pd) = 89.85 °C D.F. = 71.88%
PD301 HLMP-1521 AGILENT	If = 3.03 mA ΔTc = 14.8 °C Ta= 84.8 °C Allowable If (max) = 20 mA (at Ta=70°C) D.F. = 15.15%
PD302 HLMP-1521 AGILENT	If = 3.03 mA ΔTc = 15.0 °C Ta= 85 °C Allowable If (max) = 20 mA (at Ta=70°C) D.F. = 15.15%
PD303 HLMP-1521 AGILENT	If = 0.55 mA ΔTc = 12.7 °C Ta= 82.7 °C Allowable If (max) = 20 mA (at Ta=70°C) D.F. = 2.75%
A1 LM5050MK-1/NOPB TI	Tjmax = 125 °C θ j-c = 41.3 °C/W Pd = 0.000735 W ΔTc = 31.7 °C Tc= 101.7 °C Tj = Tc + ((θ j-c) x Pd) = 101.73 °C D.F. = 81.38%
A3 LM5050MK-1/NOPB TI	Tjmax = 125 °C θ j-c = 41.3 °C/W Pd = 0.000735 W ΔTc = 34 °C Tc= 104 °C Tj = Tc + ((θ j-c) x Pd) = 104.03 °C D.F. = 83.22%
A5 LM239ADRG4 TI	Tjmax = 150 °C θ j-a = 86 °C/W Pd = 0.0095 W ΔTc = 19.5 °C Tc= 89.5 °C Tj = Tc + ((θ j-c) x Pd) = 90.32 °C D.F. = 60.21%
A6 LM2902DR2G ON SEMI.	Tjmax = 150 °C θ j-a = 86 °C/W Pd = 0.0125 W ΔTc = 21.3 °C Tc= 91.3 °C Tj = Tc + ((θ j-c) x Pd) = 92.38 °C D.F. = 61.58%

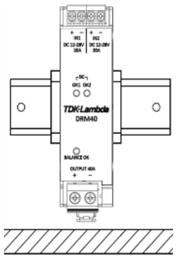
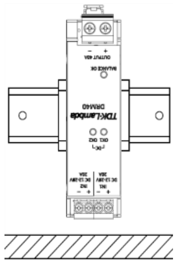
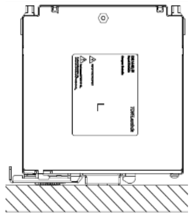
(2) Component Derating List

Location No.	Vin = 30VDC Load = 100% Ta = 70°C
Q2 TPW4R008NH,L1Q TOSHIBA	Tjmax = 150 °C θ j-c = 0.93 °C/W Pch(max)= 142 W Pd = 0.465 W ΔTc = 43.8 °C Tc= 113.8 °C Tj = Tc + ((θ j-c) x Pd) = 114.23 °C D.F. = 76.15%
Q4 TPW4R008NH,L1Q TOSHIBA	Tjmax = 150 °C θ j-c = 0.93 °C/W Pc(max)= 142 W Pd = 0.465 W ΔTc = 45.1 °C Tc= 115.1 °C Tj = Tc + ((θ j-c) x Pd) = 115.53 °C D.F. = 77.02%
PC1 TLP241AF(D4,F(O TOSHIBA	Tjmax = 125 °C θ j-c = 30 °C/W Pd(max)= 0.05 W Pd = 0.05337 W ΔTc = 32 °C Tc= 102 °C Tj = Tc + ((θ j-c) x Pd) = 103.60 °C D.F. = 82.88%
PC2 TLP241AF(D4,F(O TOSHIBA	Tjmax = 125 °C θ j-c = 30 °C/W Pd(max)= 0.05 W Pd = 0.05337 W ΔTc = 31.4 °C Tc= 101.4 °C Tj = Tc + ((θ j-c) x Pd) = 103.00 °C D.F. = 82.40%
PD301 HLMP-1521 AGILENT	If = 11.33 mA ΔTc = 17.7 °C Ta= 87.7 °C Allowable If (max) = 20 mA (at Ta=70°C) D.F. = 56.65%
PD302 HLMP-1521 AGILENT	If = 11.33 mA ΔTc = 17.9 °C Ta= 87.9 °C Allowable If (max) = 20 mA (at Ta=70°C) D.F. = 56.65%
PD303 HLMP-1521 AGILENT	If = 4.02 mA ΔTc = 13.9 °C Ta= 83.9 °C Allowable If (max) = 20 mA (at Ta=70°C) D.F. = 20.10%
A1 LM5050MK-1/NOPB TI	Tjmax = 125 °C θ j-c = 41.3 °C/W Pd = 0.0033 W ΔTc = 34.3 °C Tc= 104.3 °C Tj = Tc + ((θ j-c) x Pd) = 104.44 °C D.F. = 83.55%
A3 LM5050MK-1/NOPB TI	Tjmax = 125 °C θ j-c = 41.3 °C/W Pd = 0.0033 W ΔTc = 37.8 °C Tc= 107.8 °C Tj = Tc + ((θ j-c) x Pd) = 107.94 °C D.F. = 86.35%
A5 LM239ADRG4 TI	Tjmax = 150 °C θ j-a = 86 °C/W Pd = 0.0355 W ΔTc = 39.9 °C Tc= 109.9 °C Tj = Tc + ((θ j-c) x Pd) = 112.95 °C D.F. = 75.30%
A6 LM2902DR2G ON SEMI.	Tjmax = 150 °C θ j-a = 86 °C/W Pd = 0.0407 W ΔTc = 36.9 °C Tc= 106.9 °C Tj = Tc + ((θ j-c) x Pd) = 110.40 °C D.F. = 73.60%

3. Main components temperature rise ΔT list

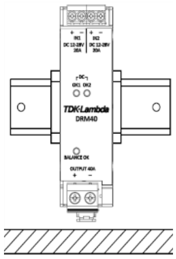
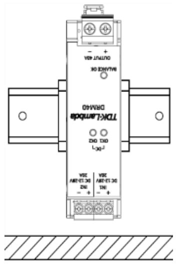
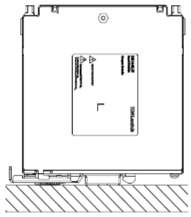
MODEL : DRM40

Condition:

Mounting Method (Standard Mounting Method:(A))	(A)	(B)	(C)
			
Input Voltage (VDC)	10	10	
Output Voltage (VDC)	10	10	
Output Current (A)	40	30	

		DT Temperature rise (°C)		
Output Derating Ta = 70°C		Io = 100%	Io = 75%	
Location No	Parts Name	Mounting A	Mounting B	Mounting C
Q2	MOSFET	41.2	24.5	26.2
Q4	MOSFET	42.0	24.4	26.2
A1	CHIP IC	31.7	20.4	21.5
A3	CHIP IC	34.0	20.4	22.5
A5	CHIP IC	19.5	9.4	11.8
A6	CHIP IC	21.3	10.7	13.3
PC1	OPTO COUPLER	19.9	6.3	9.8
PD301	LED	14.8	8.8	12.6
PD302	LED	15.0	9.3	13.2
PD303	LED	12.7	9.7	12.3

Condition:

Mounting Method (Standard Mounting Method:(A))	(A)	(B)	(C)
			
Input Voltage (VDC)	30	30	
Output Voltage (VDC)	30	30	
Output Current (A)	40	30	

		DT Temperature rise (°C)		
Output Derating Ta = 70°C		Io = 100%	Io = 75%	
Location No	Parts Name	Mounting A	Mounting B	Mounting C
Q2	MOSFET	43.8	29.6	31.8
Q4	MOSFET	45.1	29.9	32.3
A1	CHIP IC	34.3	25.7	26.9
A3	CHIP IC	37.8	26.9	30.0
A5	CHIP IC	39.9	29.1	34.3
A6	CHIP IC	36.9	27.7	33.7
PC1	OPTO COUPLER	32.0	21.2	30.7
PD301	LED	17.7	12.3	18.8
PD302	LED	17.9	12.5	19.4
PD303	LED	13.9	12.2	15.8

4. Vibration test

MODEL : DRM40

(1) Vibration Test Class

Frequency variable endurance class

(2) Equipment Used

Jiangsu Electronic Information Product Quality Supervision & Inspection intitute
Address: No. 100 Jinshui Road, Wuxi, Jiangsu, P. R. China

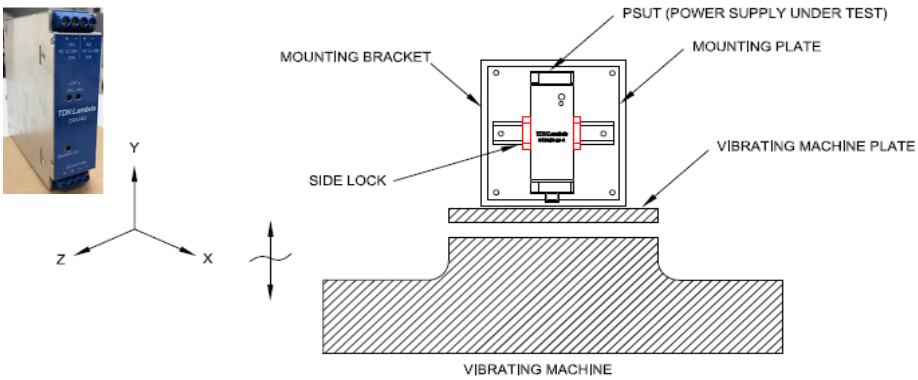
(3) Number of D.U.T (Device Under Test)

1 Unit

(4) Test Conditions

Sweep Frequency	:10-55 Hz	Direction	:X,Y,Z
Sweep Time	:1 minute	Test Time	:1 hour per axis
Constant acceleration	:2.2g	Non-operation	
Mounting	:Mounting C		

(5) Test Method



Fix the DUT on the mounting rail with stopper on each corner.
Mounting C position as per picture above.

(6) Acceptable Condition

1. Not broken
2. No abnormal output after test

(7) Test Results - OK

5. Abnormal test

MODEL : DRM40

(1) Test Condition and Circuit

Input Voltage: 24VDC Output: 24V, 40A(100%) Ta : 25°C

(2) Test Results

(Da : Damaged)

No.	Test Position: LOCATION	Test Position: TEST POINT	Test Mode: SHORT	Test Mode: OPEN	Test Results: 1 FIRE	2 SMOKE	3 BURST	4 SMELL	5 RED HOT	6 DAMAGE	7 FUSE BLOW	8 O.V.P.	9 O.C.P.	10 NO OUTPUT	11 NO CHANGE	12 OTHERS	NOTE
1	Q1	G-S	○													○	Internal loss increase
		D-S	○												○		
		D-G	○													○	Internal loss increase
		G		○												○	Internal loss increase
		D		○												○	Internal loss increase
		S		○												○	Internal loss increase
2	Q3	G-S	○													○	Internal loss increase
		D-S	○												○		
		D-G	○													○	Internal loss increase
		G		○												○	Internal loss increase
		D		○												○	Internal loss increase
		S		○												○	Internal loss increase
3	D3	A-K	○												○		
		A-K		○											○		
4	D7	A-K	○												○		
		A-K		○											○		
5	Z4	A-K	○													○	Internal loss increase
		A-K		○											○		
6	Z5	A-K	○													○	Internal loss increase
		A-K		○											○		
7	PC1	1-2	○												○		No signal at PC1
		3-4	○												○		
		1		○												○	PD301 turns off
		2		○												○	PD301 turns off
		3		○											○		
		4		○											○		

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.V.P.	9 O.C.P.	10 NO OUTPUT	11 NO CHANGE	12 OTHERS	NOTE
8	PC2	1-2	○												○		No signal at PC2
		3-4	○												○		
		1		○												○	PD302 turns off
		2		○												○	PD302 turns off
		3		○											○		
		4		○											○		
9	A1	1-2	○													○	Internal loss increase
		2-3	○												○		
		4-5	○													○	Internal loss increase
		5-6	○													○	Internal loss increase
		1		○												○	Internal loss increase
		2		○												○	Internal loss increase
		3		○											○		
		4		○												○	Internal loss increase
		5		○												○	Internal loss increase
		6		○												○	Internal loss increase
10	A3	1-2	○													○	Internal loss increase
		2-3	○												○		
		4-5	○													○	Internal loss increase
		5-6	○													○	Internal loss increase
		1		○												○	Internal loss increase
		2		○												○	Internal loss increase
		3		○											○		
		4		○												○	Internal loss increase
		5		○												○	Internal loss increase
		6		○												○	Internal loss increase
11	A5	1-2	○												○		
		2-3	○			○		○								○	Da : R17,R18, Z10
		3-4	○													○	PD303 turns off
		4-5	○													○	PD303 turns off
		5-6	○													○	PD303 turns off
		6-7	○													○	PD303 turns off
		1		○											○		
		2		○											○		
		3		○											○		
		4		○												○	PD303 turns off
		5		○											○		
		6		○												○	PD303 turns off
		7		○											○		
		12		○											○		

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.V.P.	9 O.C.P.	10 NO OUTPUT	11 NO CHANGE	12 OTHERS	NOTE
12	A6	1-2	○													○	PD303 turns off
		2-3	○													○	PD303 turns off
		3-4	○													○	PD303 turns off
		4-5	○													○	PD303 turns off
		5-6	○													○	PD303 turns off
		6-7	○													○	PD303 turns off
		1		○												○	PD303 turns off
		2		○											○		PD303 blinks once when open the pin
		3		○												○	PD303 turns off
		4		○												○	PD303 turns off
		5		○												○	PD303 turns off
		6		○											○		PD303 blinks once when open the pin
		7		○												○	PD303 turns off
		11		○												○	PD303 turns off

6. Thermal shock test

MODEL : DRM40

(1) Equipment used

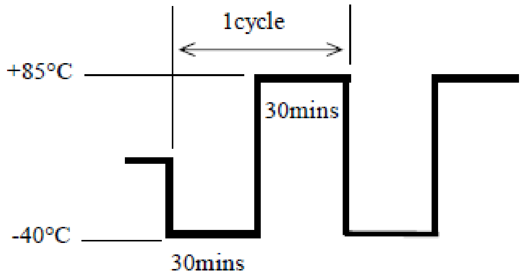
Thermal shock chamber (ESPEC CORP.)

(2) Number of D.U.T. (Device Under Test)

1 unit

(3) Test Conditions

Ambient temperature	: -40°C ⇔ 85°C
Test time	: 30 min each temp
Test cycle	: 766 cycles
Operating	: Not operating



(4) Test Method

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

(5) Acceptable Condition

1. Not broken
2. No abnormal output after test

(6) Test Results - OK