

DRM40

RELIABILITY DATA

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* 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 λss 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)

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

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

Where :

- λ_{equip} : Total equipment failure rate (FITs = Failures in 10⁹ 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

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

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)} : Maximum collector (channel) dissipation
 (P_{ch(max)})

T_{j(max)} : Maximum junction (channel) temperature
 (T_{ch(max)})

θ_{j-c} : Thermal impedance between junction (channel) and case
 (θ_{ch-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.	$V_{in} = 10VDC$	Load = 100%	$T_a = 70^{\circ}C$
Q2 TPW4R008NH,L1Q TOSHIBA	$T_{jmax} = 150^{\circ}C$ $P_d = 0.465 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 111.63^{\circ}C$ D.F. = 74.42%	$\theta_{j-c} = 0.93^{\circ}C/W$ $\Delta T_c = 41.2^{\circ}C$	$P_{ch(max)} = 142 W$ $T_c = 111.2^{\circ}C$
Q4 TPW4R008NH,L1Q TOSHIBA	$T_{jmax} = 150^{\circ}C$ $P_d = 0.465 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 112.43^{\circ}C$ D.F. = 74.95%	$\theta_{j-c} = 0.93^{\circ}C/W$ $\Delta T_c = 42^{\circ}C$	$P_{c(max)} = 142 W$ $T_c = 112^{\circ}C$
PC1 TLP241AF(D4,F(O TOSHIBA	$T_{jmax} = 125^{\circ}C$ $P_d = 0.04174 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 91.15^{\circ}C$ D.F. = 72.92%	$\theta_{j-c} = 30^{\circ}C/W$ $\Delta T_c = 19.9^{\circ}C$	$P_{d(max)} = 0.05 W$ $T_c = 89.9^{\circ}C$
PC2 TLP241AF(D4,F(O TOSHIBA	$T_{jmax} = 125^{\circ}C$ $P_d = 0.04174 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 89.85^{\circ}C$ D.F. = 71.88%	$\theta_{j-c} = 30^{\circ}C/W$ $\Delta T_c = 18.6^{\circ}C$	$P_{d(max)} = 0.05 W$ $T_c = 88.6^{\circ}C$
PD301 HLMP-1521 AGILENT	$I_f = 3.03 mA$ Allowable $I_f (max) = 20 mA$ (at $T_a = 70^{\circ}C$) D.F. = 15.15%	$\Delta T_c = 14.8^{\circ}C$	$T_a = 84.8^{\circ}C$
PD302 HLMP-1521 AGILENT	$I_f = 3.03 mA$ Allowable $I_f (max) = 20 mA$ (at $T_a = 70^{\circ}C$) D.F. = 15.15%	$\Delta T_c = 15.0^{\circ}C$	$T_a = 85^{\circ}C$
PD303 HLMP-1521 AGILENT	$I_f = 0.55 mA$ Allowable $I_f (max) = 20 mA$ (at $T_a = 70^{\circ}C$) D.F. = 2.75%	$\Delta T_c = 12.7^{\circ}C$	$T_a = 82.7^{\circ}C$
A1 LM5050MK-1/NOPB TI	$T_{jmax} = 125^{\circ}C$ $P_d = 0.000735 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 101.73^{\circ}C$ D.F. = 81.38%	$\theta_{j-c} = 41.3^{\circ}C/W$ $\Delta T_c = 31.7^{\circ}C$	$T_c = 101.7^{\circ}C$
A3 LM5050MK-1/NOPB TI	$T_{jmax} = 125^{\circ}C$ $P_d = 0.000735 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 104.03^{\circ}C$ D.F. = 83.22%	$\theta_{j-c} = 41.3^{\circ}C/W$ $\Delta T_c = 34^{\circ}C$	$T_c = 104^{\circ}C$
A5 LM239ADRG4 TI	$T_{jmax} = 150^{\circ}C$ $P_d = 0.0095 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 90.32^{\circ}C$ D.F. = 60.21%	$\theta_{j-a} = 86^{\circ}C/W$ $\Delta T_c = 19.5^{\circ}C$	$T_c = 89.5^{\circ}C$
A6 LM2902DR2G ON SEMI.	$T_{jmax} = 150^{\circ}C$ $P_d = 0.0125 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 92.38^{\circ}C$ D.F. = 61.58%	$\theta_{j-a} = 86^{\circ}C/W$ $\Delta T_c = 21.3^{\circ}C$	$T_c = 91.3^{\circ}C$

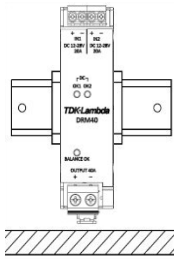
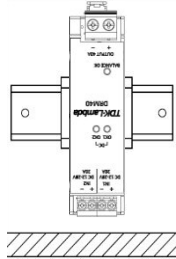
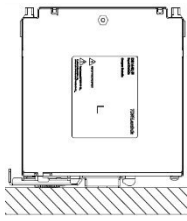
(2) Component Derating List

Location No.	$V_{in} = 30VDC$ $Load = 100\%$ $T_a = 70^{\circ}C$
Q2 TPW4R008NH,L1Q TOSHIBA	$T_{jmax} = 150^{\circ}C$ $P_d = 0.465 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 114.23^{\circ}C$ $D.F. = 76.15\%$ $\theta_{j-c} = 0.93^{\circ}C/W$ $\Delta T_c = 43.8^{\circ}C$ $P_{ch(max)} = 142 W$ $T_c = 113.8^{\circ}C$
Q4 TPW4R008NH,L1Q TOSHIBA	$T_{jmax} = 150^{\circ}C$ $P_d = 0.465 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 115.53^{\circ}C$ $D.F. = 77.02\%$ $\theta_{j-c} = 0.93^{\circ}C/W$ $\Delta T_c = 45.1^{\circ}C$ $P_{c(max)} = 142 W$ $T_c = 115.1^{\circ}C$
PC1 TLP241AF(D4,F(O TOSHIBA	$T_{jmax} = 125^{\circ}C$ $P_d = 0.05337 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 103.60^{\circ}C$ $D.F. = 82.88\%$ $\theta_{j-c} = 30^{\circ}C/W$ $\Delta T_c = 32^{\circ}C$ $P_{d(max)} = 0.05 W$ $T_c = 102^{\circ}C$
PC2 TLP241AF(D4,F(O TOSHIBA	$T_{jmax} = 125^{\circ}C$ $P_d = 0.05337 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 103.00^{\circ}C$ $D.F. = 82.40\%$ $\theta_{j-c} = 30^{\circ}C/W$ $\Delta T_c = 31.4^{\circ}C$ $P_{d(max)} = 0.05 W$ $T_c = 101.4^{\circ}C$
PD301 HLMP-1521 AGILENT	$I_f = 11.33 mA$ $\Delta T_c = 17.7^{\circ}C$ $T_a = 87.7^{\circ}C$ $Allowable I_f (max) = 20 mA (at T_a=70^{\circ}C)$ $D.F. = 56.65\%$
PD302 HLMP-1521 AGILENT	$I_f = 11.33 mA$ $\Delta T_c = 17.9^{\circ}C$ $T_a = 87.9^{\circ}C$ $Allowable I_f (max) = 20 mA (at T_a=70^{\circ}C)$ $D.F. = 56.65\%$
PD303 HLMP-1521 AGILENT	$I_f = 4.02 mA$ $\Delta T_c = 13.9^{\circ}C$ $T_a = 83.9^{\circ}C$ $Allowable I_f (max) = 20 mA (at T_a=70^{\circ}C)$ $D.F. = 20.10\%$
A1 LM5050MK-1/NOPB TI	$T_{jmax} = 125^{\circ}C$ $P_d = 0.0033 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 104.44^{\circ}C$ $D.F. = 83.55\%$ $\theta_{j-c} = 41.3^{\circ}C/W$ $\Delta T_c = 34.3^{\circ}C$ $T_c = 104.3^{\circ}C$
A3 LM5050MK-1/NOPB TI	$T_{jmax} = 125^{\circ}C$ $P_d = 0.0033 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 107.94^{\circ}C$ $D.F. = 86.35\%$ $\theta_{j-c} = 41.3^{\circ}C/W$ $\Delta T_c = 37.8^{\circ}C$ $T_c = 107.8^{\circ}C$
A5 LM239ADRG4 TI	$T_{jmax} = 150^{\circ}C$ $P_d = 0.0355 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 112.95^{\circ}C$ $D.F. = 75.30\%$ $\theta_{j-a} = 86^{\circ}C/W$ $\Delta T_c = 39.9^{\circ}C$ $T_c = 109.9^{\circ}C$
A6 LM2902DR2G ON SEMI.	$T_{jmax} = 150^{\circ}C$ $P_d = 0.0407 W$ $T_j = T_c + ((\theta_{j-c}) \times P_d) = 110.40^{\circ}C$ $D.F. = 73.60\%$ $\theta_{j-a} = 86^{\circ}C/W$ $\Delta T_c = 36.9^{\circ}C$ $T_c = 106.9^{\circ}C$

3. Main components temperature rise ΔT list

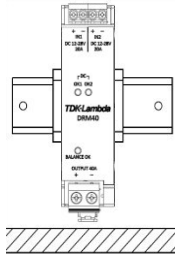
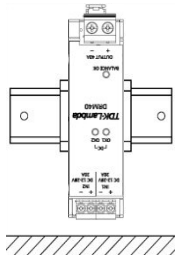
MODEL : DRM40

Condition:

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

Output Derating $T_a = 70^\circ\text{C}$		DT Temperature rise ($^\circ\text{C}$)		
		$I_o = 100\%$	$I_o = 75\%$	
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

Output Derating Ta = 70°C		DT Temperature rise (°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 Institute
 Address: No. 100 Jinshui Road, Wuxi, Jiangsu, P. R. China

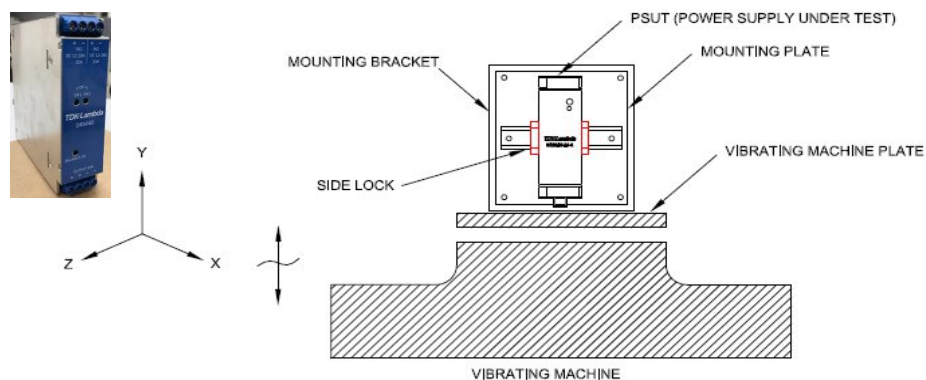
(3) Number of D.U.T (Device Under Test)

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		Test Mode		Test Results												NOTE			
	LOCATION	POINT	SHORT	OPEN	1 FIRE	2 SMOKE	3 BURST	4 SMELL	5 REDHOT	6 DAMAGE	7 FUSE BLOW	8 OV.P.	9 OC.P.	10 NO OUTPUT	11 NO CHANGE	12 OTHERS				
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													
	LOC A T I O N	TEST POINT	SH ORT	OP EN	1 F I R E	2 S M O K E	3 B U R S T	4 S M E L L	5 R E D H O T	6 D A M A G E	7 F U S E B L O W	8 O V E R P O W E R	9 O C C U P Y	10 N O O U T P U T	11 N O C H A N G E	12 O T H E R S	NOTE	
8	PC2	1-2	<input type="radio"/>												<input type="radio"/>		No signal at PC2	
		3-4	<input type="radio"/>												<input type="radio"/>			
		1		<input type="radio"/>												<input type="radio"/>		PD302 turns off
		2		<input type="radio"/>												<input type="radio"/>		PD302 turns off
		3		<input type="radio"/>											<input type="radio"/>			
9	A1	1-2	<input type="radio"/>												<input type="radio"/>		Internal loss increase	
		2-3	<input type="radio"/>											<input type="radio"/>				
		4-5	<input type="radio"/>												<input type="radio"/>		Internal loss increase	
		5-6	<input type="radio"/>												<input type="radio"/>		Internal loss increase	
		1		<input type="radio"/>											<input type="radio"/>		Internal loss increase	
		2		<input type="radio"/>											<input type="radio"/>		Internal loss increase	
		3		<input type="radio"/>											<input type="radio"/>			
		4		<input type="radio"/>											<input type="radio"/>		Internal loss increase	
		5		<input type="radio"/>											<input type="radio"/>		Internal loss increase	
10	A3	1-2	<input type="radio"/>												<input type="radio"/>		Internal loss increase	
		2-3	<input type="radio"/>											<input type="radio"/>				
		4-5	<input type="radio"/>												<input type="radio"/>		Internal loss increase	
		5-6	<input type="radio"/>												<input type="radio"/>		Internal loss increase	
		1		<input type="radio"/>											<input type="radio"/>		Internal loss increase	
		2		<input type="radio"/>											<input type="radio"/>		Internal loss increase	
		3		<input type="radio"/>											<input type="radio"/>			
		4		<input type="radio"/>											<input type="radio"/>		Internal loss increase	
		5		<input type="radio"/>											<input type="radio"/>		Internal loss increase	
11	A5	1-2	<input type="radio"/>												<input type="radio"/>			
		2-3	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>								<input type="radio"/>		Da : R17,R18, Z10	
		3-4	<input type="radio"/>												<input type="radio"/>		PD303 turns off	
		4-5	<input type="radio"/>												<input type="radio"/>		PD303 turns off	
		5-6	<input type="radio"/>												<input type="radio"/>		PD303 turns off	
		6-7	<input type="radio"/>												<input type="radio"/>		PD303 turns off	
		1		<input type="radio"/>											<input type="radio"/>			
		2		<input type="radio"/>											<input type="radio"/>			
		3		<input type="radio"/>											<input type="radio"/>			
		4		<input type="radio"/>											<input type="radio"/>		PD303 turns off	
		5		<input type="radio"/>											<input type="radio"/>			
		6		<input type="radio"/>											<input type="radio"/>		PD303 turns off	
		7		<input type="radio"/>											<input type="radio"/>			
12		<input type="radio"/>											<input type="radio"/>					

No.	Test Position		Test Mode		Test Results														
	LOCATION	POINT	SHORT	OPEN	1 F I R E	2 S M O K E	3 B U R S T	4 S M E L L	5 R E D H O T	6 D A M A G E	7 F U S E B L O W	8 O V P .	9 O C P .	10 N O O U T P U T	11 N O C H A N G E	12 O T H E R S	NOTE		
12	A6	1-2	<input type="radio"/>															<input type="radio"/>	PD303 turns off
		2-3	<input type="radio"/>															<input type="radio"/>	PD303 turns off
		3-4	<input type="radio"/>															<input type="radio"/>	PD303 turns off
		4-5	<input type="radio"/>															<input type="radio"/>	PD303 turns off
		5-6	<input type="radio"/>															<input type="radio"/>	PD303 turns off
		6-7	<input type="radio"/>															<input type="radio"/>	PD303 turns off
		1		<input type="radio"/>														<input type="radio"/>	PD303 turns off
		2		<input type="radio"/>													<input type="radio"/>	<input type="radio"/>	PD303 blinks once when open the pin
		3		<input type="radio"/>														<input type="radio"/>	PD303 turns off
		4		<input type="radio"/>														<input type="radio"/>	PD303 turns off
		5		<input type="radio"/>														<input type="radio"/>	PD303 turns off
		6		<input type="radio"/>												<input type="radio"/>	<input type="radio"/>	PD303 blinks once when open the pin	
		7		<input type="radio"/>														<input type="radio"/>	PD303 turns off
11		<input type="radio"/>														<input type="radio"/>	PD303 turns off		

6. Thermal shock test

MODEL : DRM40

(1) Equipment used

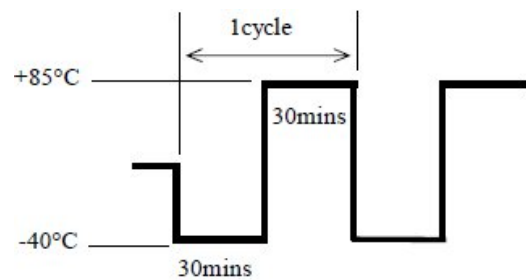
Thermal shock chamber (ESPEC CORP.)

(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