

# DATASHEET & RELIABILITY DATA

## KSP50 SERIES

(주)오디피

Open Digital Power Corp.

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MAX. Power 50.0W Isolated DC-DC Converter

## KSP50 Series Small Size Excellent Efficiency DC-DC Converter

### - Introduction

#### 1. Features



- Six side shield compact size
- Excellent Efficiency & Reliability
- Built in ceramic Capacitor only (high reliability)
- Isolated Input – Output
- 300kHz fixed frequency & Current mode Control
- Low output Ripple & Noise
- Built-in over current protection circuit
- Built-in over voltage protection circuit
- Positive logic input remote on/off control
- Adjustable output voltage
- RoHS compatible design
- Safety : NRTL/CE Standard(UL/EN60950-1) (Approvals pending)
- Wide 2 :1 input range
- Built-in Input UVLO (Under Voltage Lock Out)

#### 2. Applications

- Electric vehicle, Railroad
- Distributed Power Systems
- Data and telecommunication
- Industrial applications
- FA control

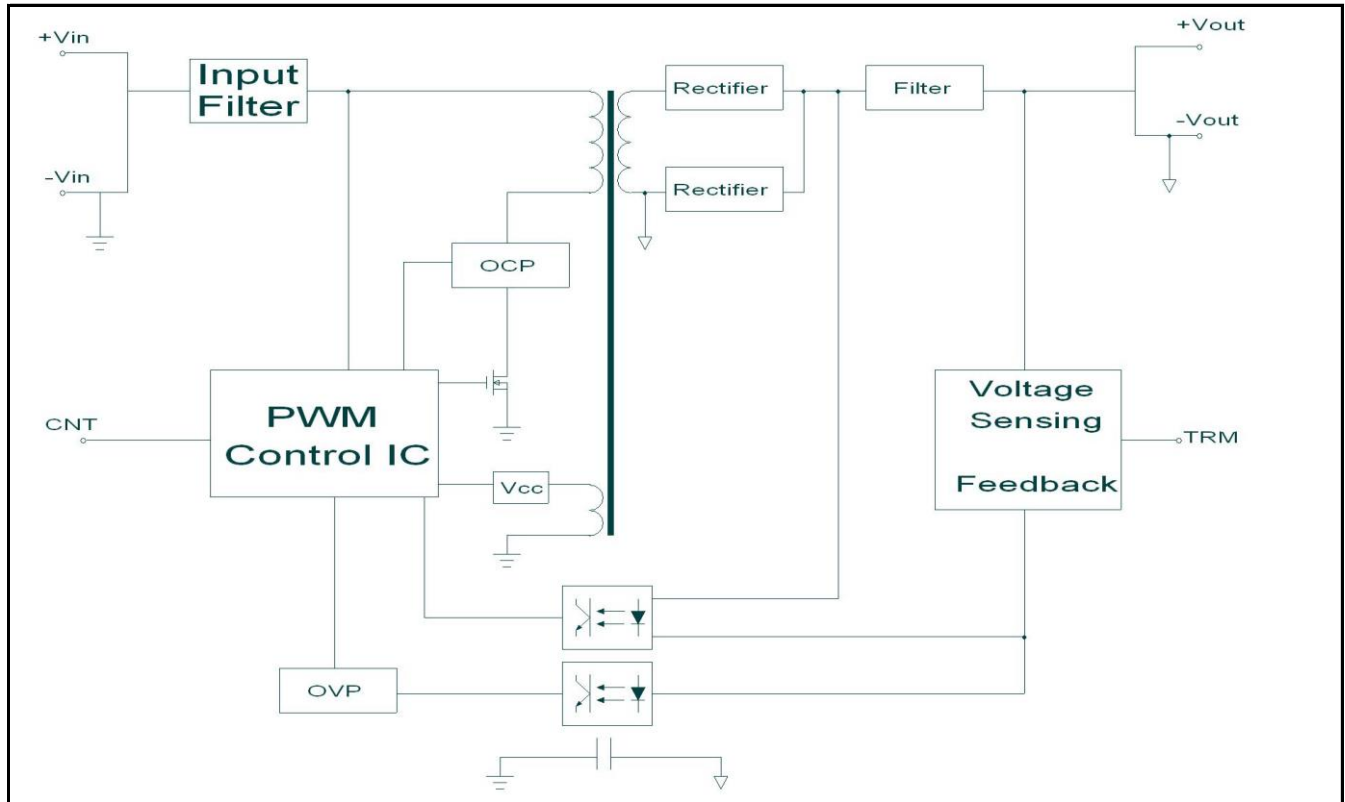
#### 3. Environment

- Operating Temperature :  $-40^{\circ}\text{C} \sim 85^{\circ}\text{C}$  (Refer to derating curve)
- Operating Humidity : 5% ~ 95% RH (Non condensing)
- Storage Temperature :  $-40^{\circ}\text{C} \sim 105^{\circ}\text{C}$
- Cooling : Free-Air Convection or Forced air (Refer to derating curve)
- MTBF :  $3.6 * 10^5$  hrs



## - Datasheet

### 1. Internal Circuit Architecture



### 2. Maximum Ratings

Characteristics		Symbol	Min.	Typ.	Max.	Unit
Input Voltage Continuis	KSP50 - 24 - XX	Vin	18	-	36	VDC
	KSP50 - 48 - XX		36	-	75	
	KSP50 - 72 - XX		55	-	90	
	KSP50 - 110 - XX		65	-	150	
Operating Ambient Temperature		Ta	-40	-	70	℃
Storage Temperature		Tstg	-40	-	105	℃
Withstand Voltage			-	-	500	Vac

### 3. Electrical Characteristics

#### – Input Section

Ta : 25°C, Vin : Typical Input Voltage

Characteristics		Symbol	Min.	Typ.	Max.	Unit
Operating Voltage Range	KSP50 – 24 – XX	Vin	18	24	36	VDC
	KSP50 – 48 – XX		36	48	75	
	KSP50 – 72 – XX		55	72	90	
	KSP50 – 110 – XX		65	110	150	
Under Voltage Lock Out (UVLO)	Power up Threshold	KSP50-24	15	16	17	VDC
		KSP50-48	31	33	35	
		KSP50-72	46	48	50	
		KSP50-110	54	57	60	
	Power down Threshold (after turn-on)	KSP50-24	14	15	16	
		KSP50-48	29	31	33	
		KSP50-72	43	45	47	
		KSP50-110	49	52	55	
Maximum Input Current (Vin : rated, Io : 100%)	KSP50 – 24 – XX	Iin		2.28		A
	KSP50 – 48 – XX			1.14		
	KSP50 – 72 – XX			0.78		
	KSP50 – 110 – XX			0.53		
No Load Input Current (Vin : rated)	KSP50 – 24 – XX					mA
	KSP50 – 48 – XX					
	KSP50 – 72 – XX					
	KSP50 – 110 – XX					

#### – Output Section

Ta : 25°C, Vin : Minimum, Typical, Maximum Input Voltage

Characteristics		Symbol	Min.	Typ.	Max.	Unit
Output Voltage Accuracy		Vo	–	–	±2	%
Regulation	Line Regulation (From min. Vin to max. Vin, constant load)		–	–	±0.5	%
	Load Regulation (From no load to maximum load)		–	–	±1	%
Output Ripple and Noise (Vin : Rated, Io : Max., BW : 20MHz, use the external capacitor between +Vo and –Vo (MLCC : 105, el-cap. : 47uF))		mVp-p	–	–	1% of Vout note1	mVp-p (peak to peak)

note1. 3.3Vout : 75mVp-p, 5Vout : 75mVp-p

Characteristics		Symbol	Min.	Typ.	Max.	Unit
Output Current	KSP50 – XX – 3R3	I <sub>o</sub>	–	–	11.0	A
	KSP50 – XX – 05		–	–	10.0	
	KSP50 – XX – 12		–	–	4.2	
	KSP50 – XX – 15		–	–	3.3	
Output Current Limit (OCP : Over Current Protection, recovers automatically)			105	–	–	%
Dynamic Load Response (V <sub>in</sub> : rated, I <sub>o</sub> : from 25% to 50%, from 50% to 25%, BW : 20MHz, Freq. : 100Hz, Duty : 0.5, Tr/Tf : 100us)			–	–	3% of V <sub>out</sub>	mVp-p (peak to peak)
Start – Up Time		T <sub>start</sub>	–	–	10	ms
Turn – on Overshoot			–	–	5	%
Efficiency (V <sub>in</sub> : Rated. I <sub>o</sub> : Max.)	KSP50 – 24 – 3R3		–	90	–	%
	KSP50 – 24 – 05		–	92	–	
	KSP50 – 24 – 12		–	93	–	
	KSP50 – 24 – 15		–	93	–	
	KSP50 – 48 – 3R3		–	90	–	%
	KSP50 – 48 – 05		–	92	–	
	KSP50 – 48 – 12		–	93	–	
	KSP50 – 48 – 15		–	93	–	
	KSP50 – 72 – 3R3		–	90	–	%
	KSP50 – 72 – 05		–	91	–	
	KSP50 – 72 – 12		–	90	–	
	KSP50 – 72 – 15		–	90	–	
	KSP50 – 110 – 3R3		–	86	–	%
	KSP50 – 110 – 05		–	89	–	
	KSP50 – 110 – 12		–	88	–	
	KSP50 – 110 – 15		–	88	–	

## 4. Isolation Characteristics

Characteristics		Symbol	Min.	Typ.	Max.	Unit
Withstand Voltage (AC500V, 1minute)	Input – Output		–	–	500	Vac
	Input – Case		–	–	500	Vac
	Output – Case		–	–	500	Vac
Isolation Resistance (DC500V at 25℃ and 70%RH)	Output – Case	Riso	100	–	–	MΩ

## 5. General Characteristics

Characteristics	Symbol	Min.	Typ.	Max.	Unit
Remote on / off control (CNT Pin, Positive Logic Module on : Logic High or open Module off : Logic Low or Short to –Vin)	CNT				
External Trim Adj. Range (TRM Pin, Vout variation by external parts)	TRM	–10	–	+10	%
Switching Frequency			300		kHz
MTBF (MIL-HDBK-217F)		$3.6 \times 10^5$			hrs
Dimension (W x H x L)		51.0 x 43.2 x 16.0			mm
Weight		–	74	–	grams

## 6. Environment

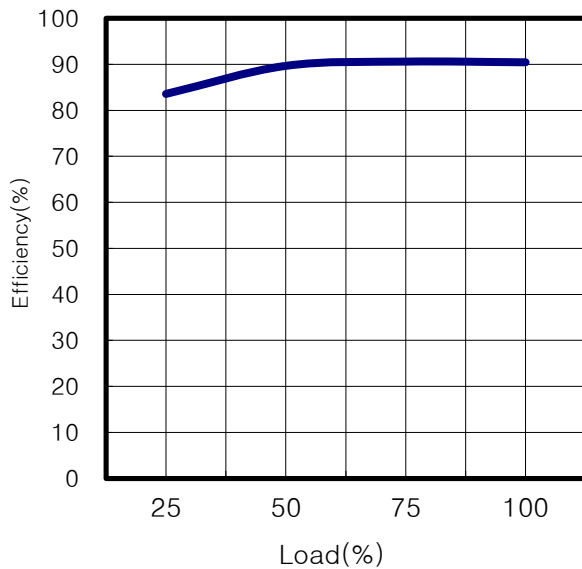
Characteristics	Symbol	Min.	Typ.	Max.	Unit
Operating Temperature Range	Ta	–40	–	85	℃
Operating Humidity (non Condensing)		5	–	95	%RH
Storage Temperature	Tstg	–40	–	105	℃



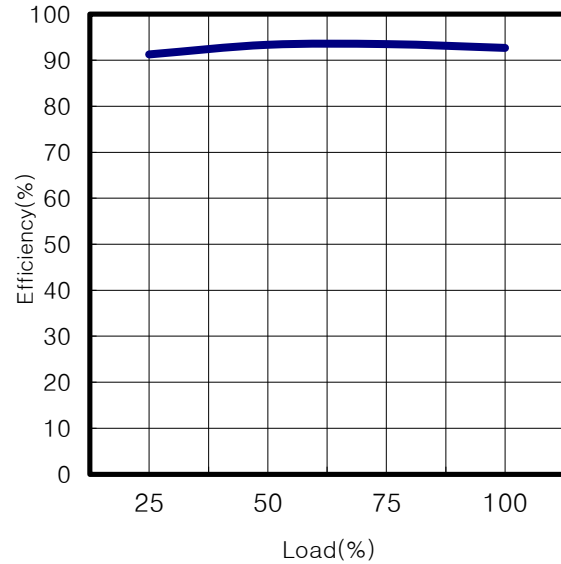
## 7. Characteristics Curves

– KSP50 Series Efficiency Curves

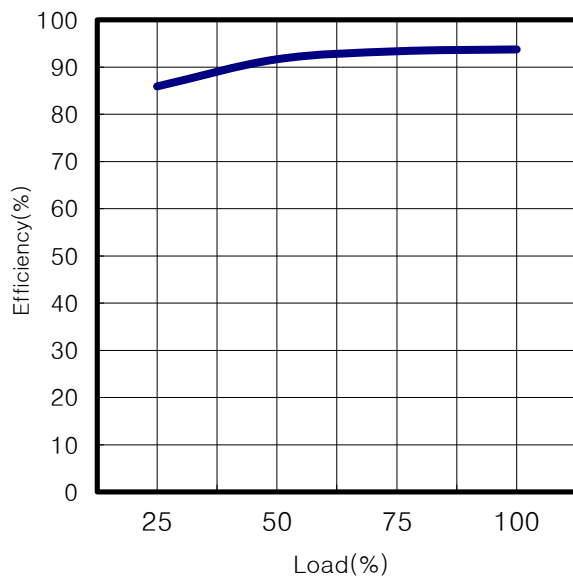
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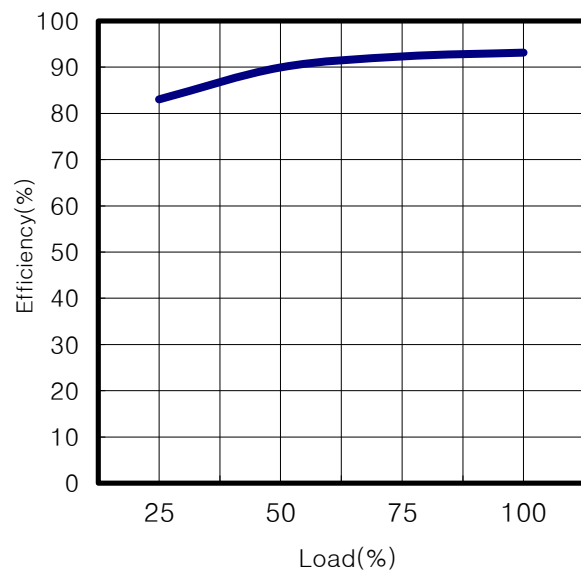
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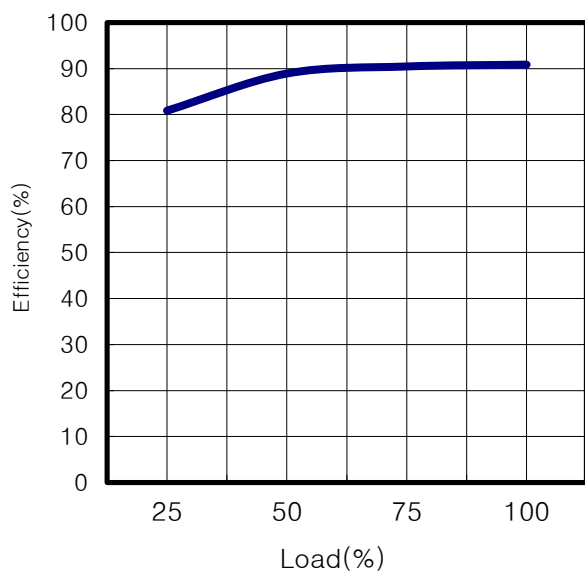


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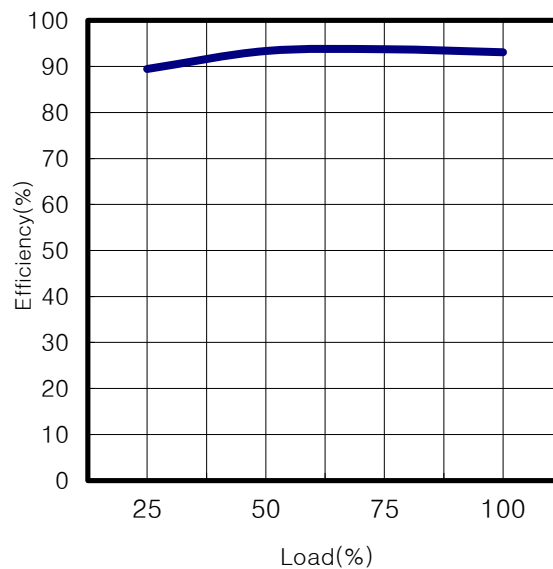


## KSP50 Series DC-DC Converter

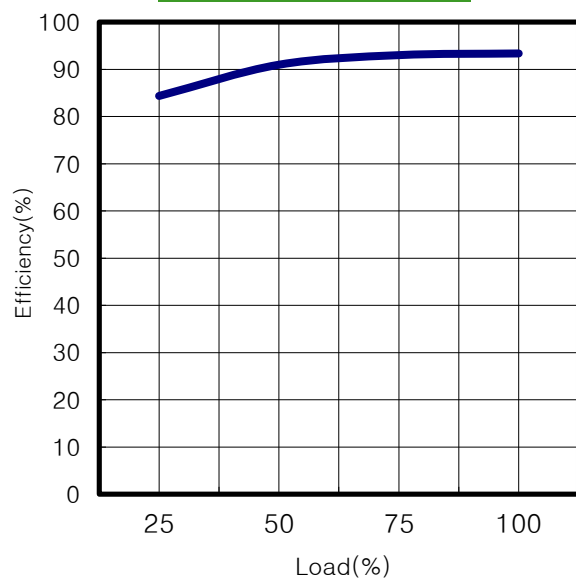
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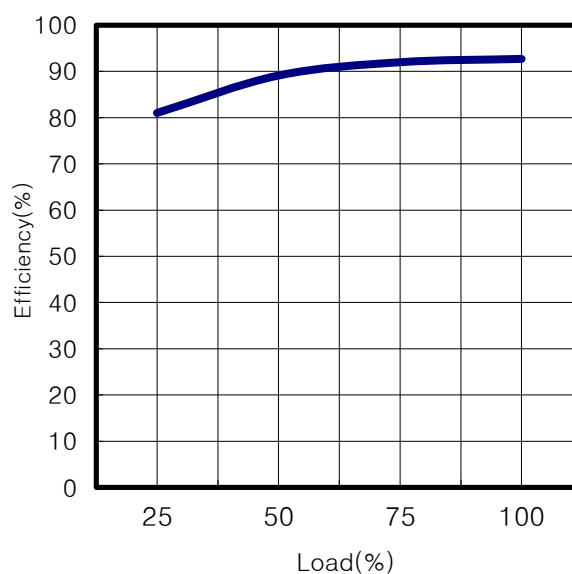
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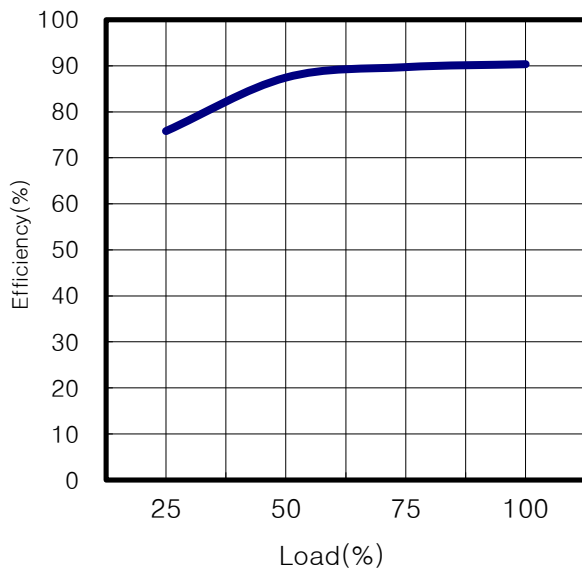


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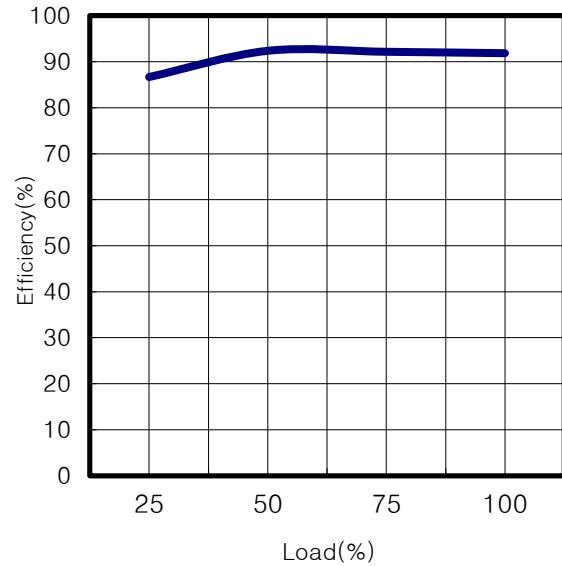


## KSP50 Series DC-DC Converter

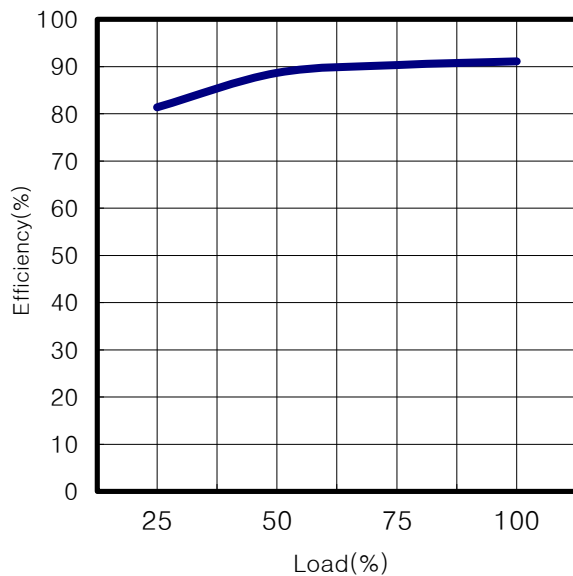
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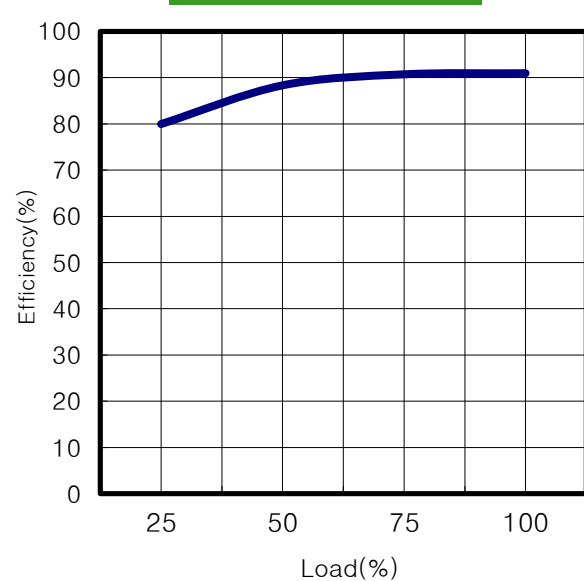
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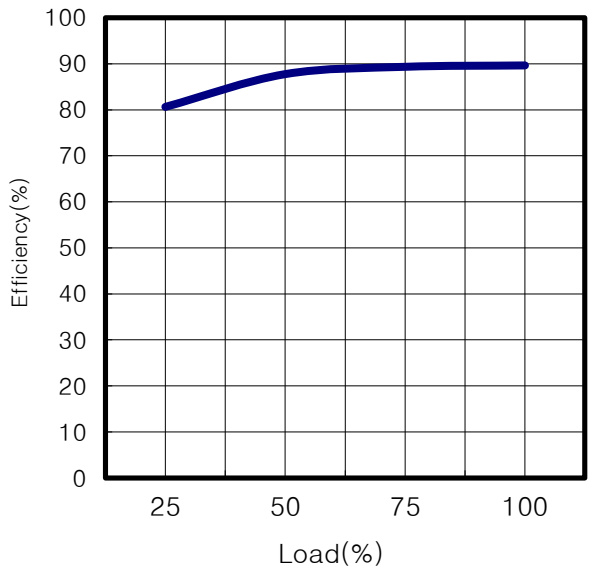


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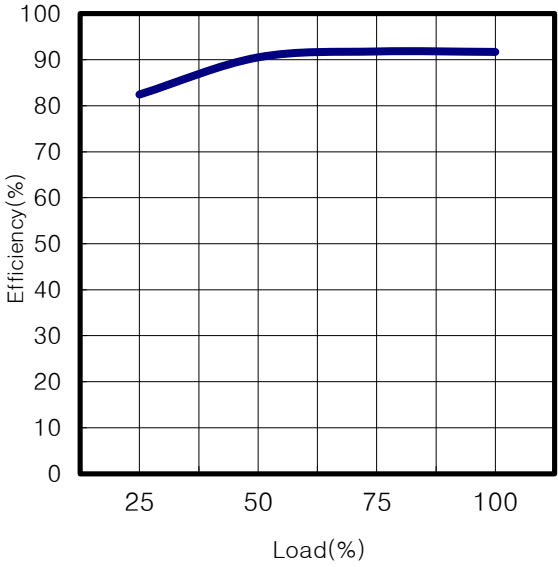


KSP50 Series DC-DC Converter

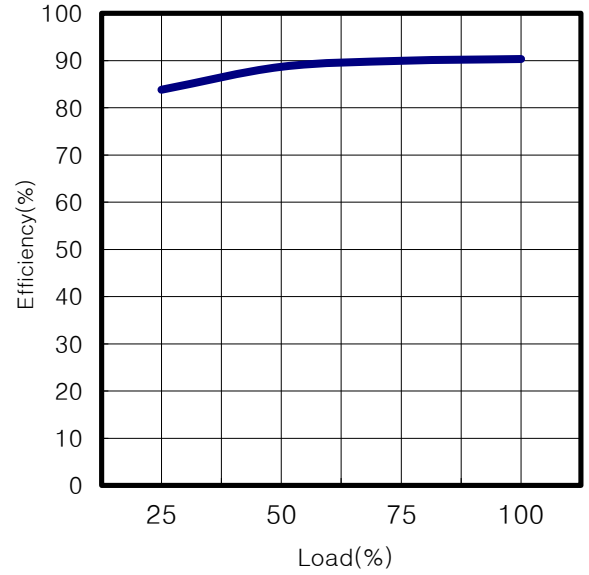
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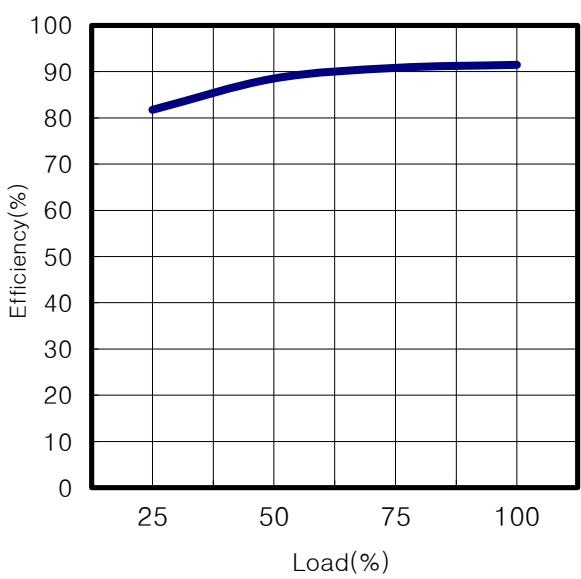
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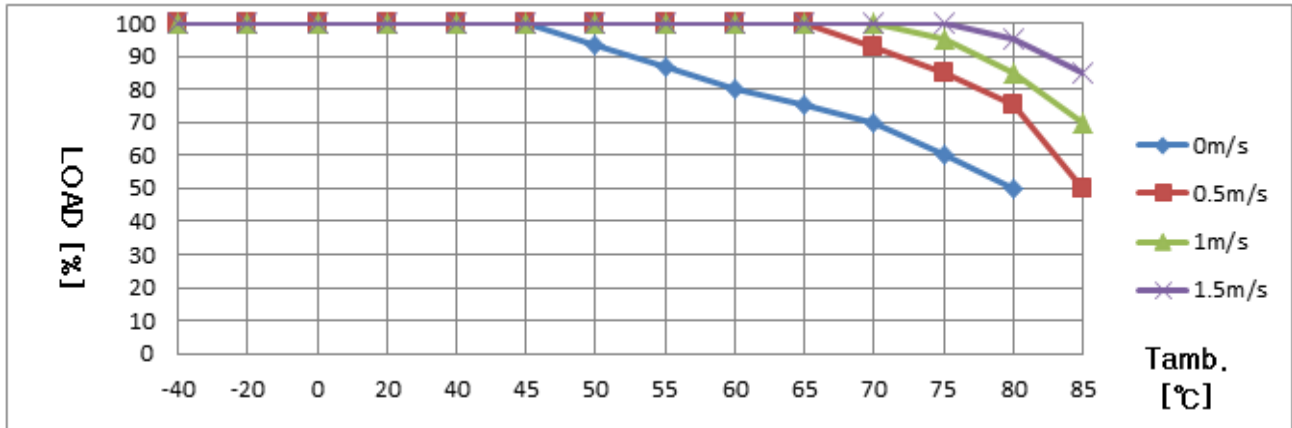


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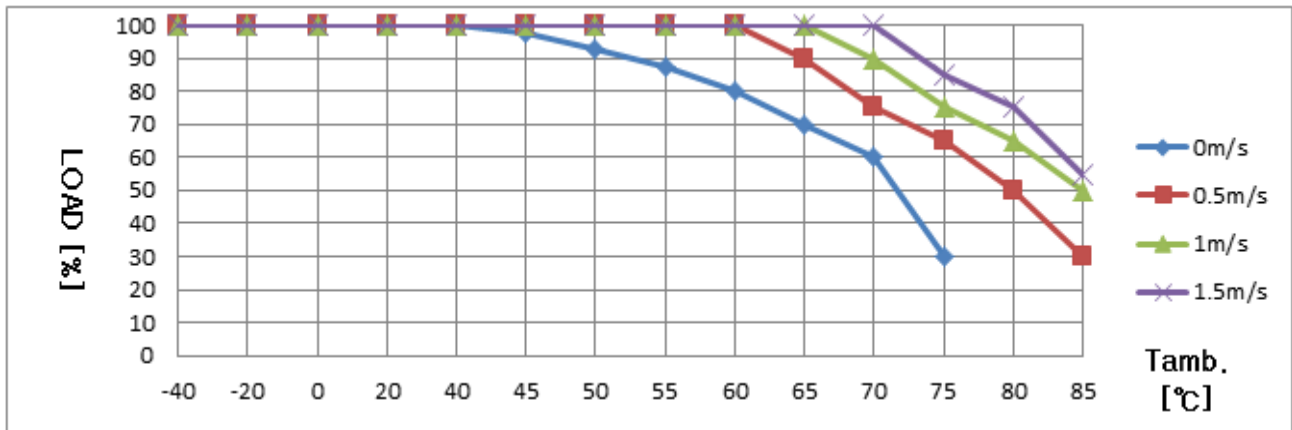


– KSP50 Derating curve

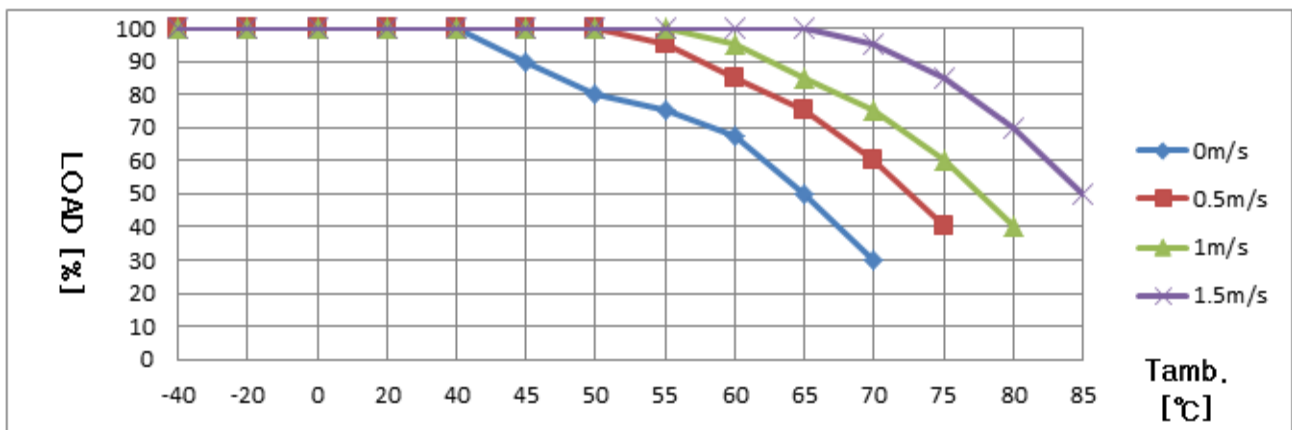
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<KSP50-48-XX>



<KSP50-72,110-XX>



## - Reliability Data

### 1. MTBF

Calculating Reliable Values of MTBF

Calculated based on part count reliability projection of MIL-HDBK-217F individual failure rates  $\lambda g$  is given to each part and MTBF is calculated by the count of each part.

Method is :

$$MTBF = \frac{10^6}{\sum_{i=1}^n Ni(\lambda g \cdot \pi Q)_i} = \frac{10^6}{\lambda_{equip}} \quad [\text{hours}]$$

For a given equipment environment where :

$\lambda_{equip}$  = Total equipment failure rate (Failures /  $10^6$  Hours)

$\lambda g$  = Generic failure rate for the  $i$  th generic part (Failures /  $10^6$  Hours)

$\pi Q$  = Quality factor for the  $i$  th generic part ( $\pi Q = 1$ )

$Ni$  = Quantity of  $i$  th generic part

$n$  = Number of different generic part categories in the equipment

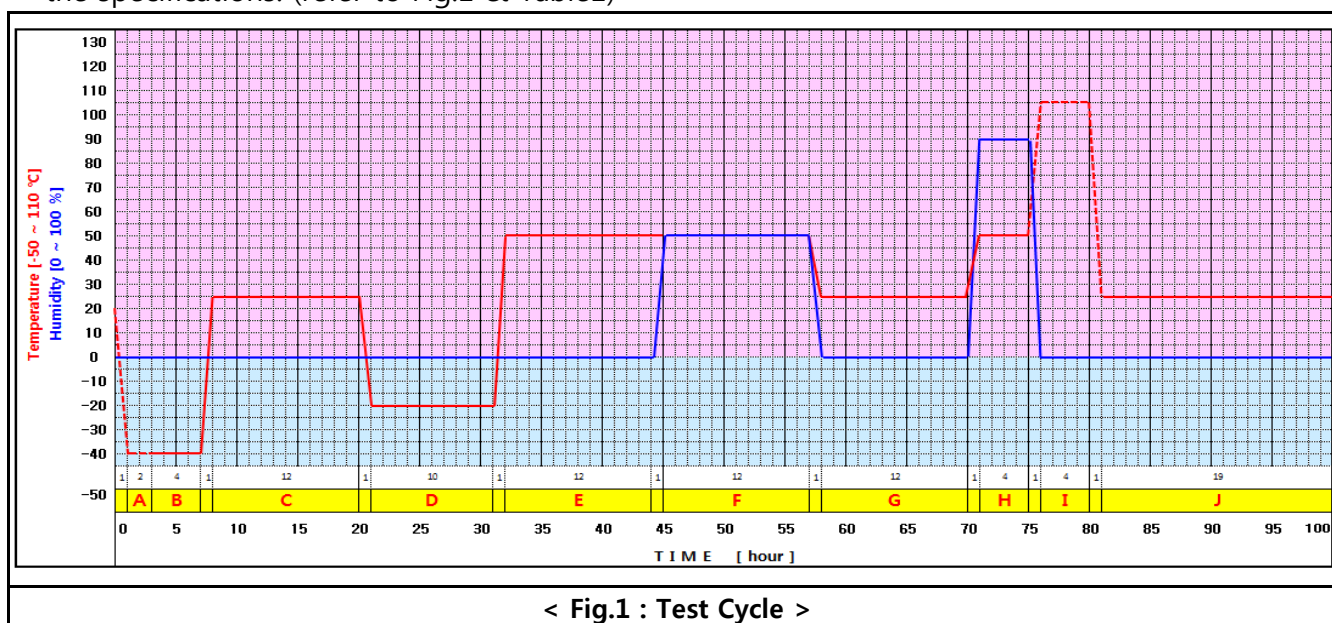
	PART	Number	Failure Rate	Failure Rate
1	Logic IC	1	0.015	0.0150000
2	FET	5	0.012	0.0600000
3	Voltage Regulaor	1	0.002	0.0020000
4	Diode (Zener)	4	0.002	0.0080000
5	Diode (FRD)	2	0.069	0.1380000
6	Diode (SBD)	1	0.027	0.0270000
7	Bridge Diode	0	0.066	—
8	LED	0	0.00023	—
9	Varistor	0	0.0013	—
10	Photo-coupler	2	0.07	0.1400000
11	Thyristor	1	0.0022	0.0022000
12	Elec.- Cap.	0	0.019	—
13	Ceramic Cap.	37	0.026	0.9620000
14	MLCC	0	0.053	—
15	Choke coil	1	0.00022	0.0002200
16	Switching transformer	3	0.0042	0.0126000
17	Line Filter	0	0.0044	—
18	Resistor	31	0.0024	0.0744000
19	Resistor Variable	0	0.0024	—
20	Thermister	0	0.0019	—
21	Connertor	0	0.052	—
22	Soldering Point	123	0.0078	0.9594000
23	PCB	1	0.37	0.3700000
24	Fuse	0	0.01	—
Total Equipment Failure Rate ( $\lambda_{equip}$ )				2.7708200
MTBF = $10^6 / \lambda_{equip}$ (F/T)				360,903.992
MTBF $\approx$ 360,000[Hours]				

## 2. Environmental Stress Test(EST)

The purpose of the environment stress test is to ensure reliability by setting in advance the following environment and verified.

- transport process and conservation status
- environmental change conditions that can be applied to the product from the process of the end-user

Test cycle consists of 10 segments(total 100 hours). Test results of all segments must meet the specifications. (refer to Fig.1 & Table1)



< Fig.1 : Test Cycle >

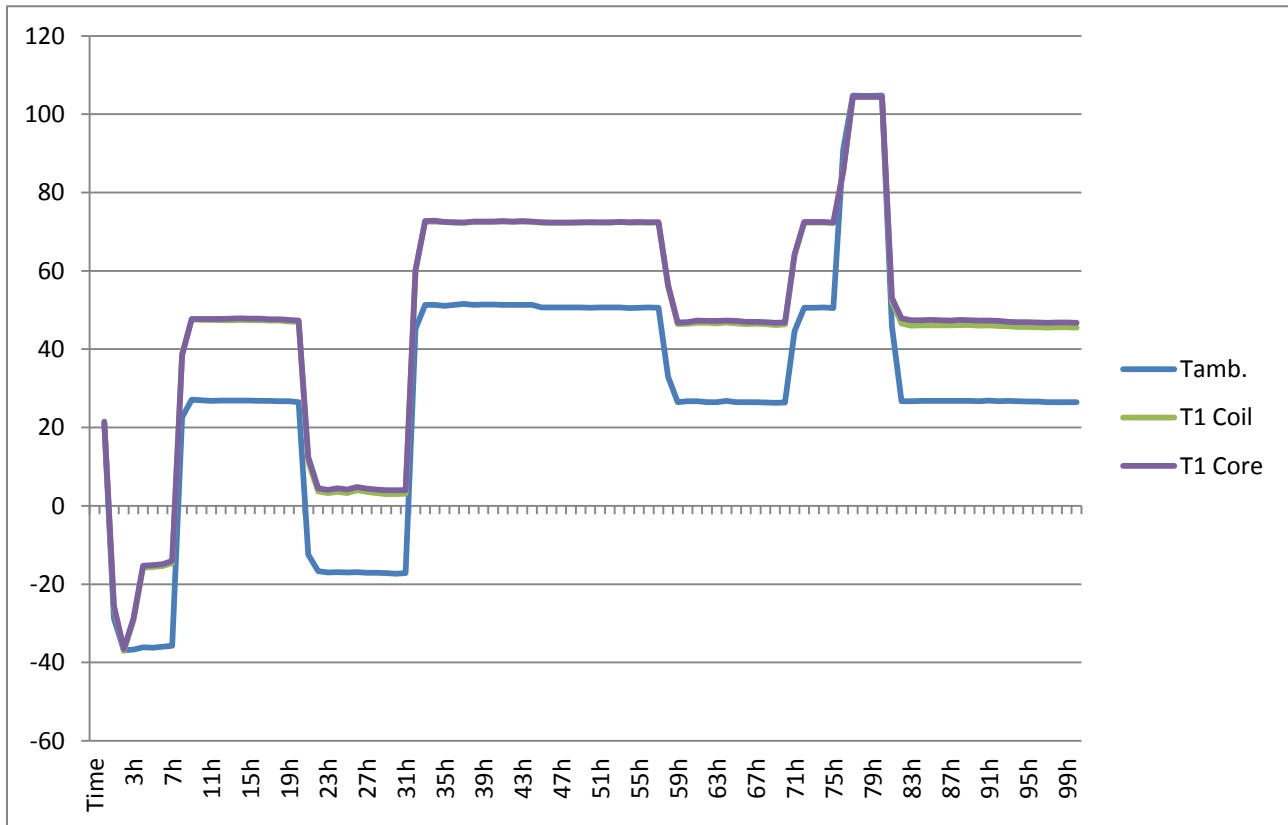
Segment	Time	Temp.	Humidity	Description	Input 'SW'
A	2 hours	-40℃	0%	Low temperature storage	off
B	4 hours	-40℃	0%	Low temperature operation	on
C	12 hours	25℃	0%	Room temperature operation	on
D	10 hours	-20℃	0%	Low temperature operation	on
E	12 hours	50℃	0%	High temperature operation	on
F	12 hours	50℃	50%	High-temperature & humidity operation	on
G	12 hours	25℃	0%	Room temperature operation	on
H	4 hours	50℃	90%	High-temperature & humidity operation	on
I	4 hours	105℃	0%	High temperature storage	off
J	19 hours	25℃	0%	Room temperature operation	on

< Table1 : Segment Description >

## 2.1. Environmental Stress Test Results

a. Test Sample : KSP50-24-05

b. 100 hours in one cycle test graph



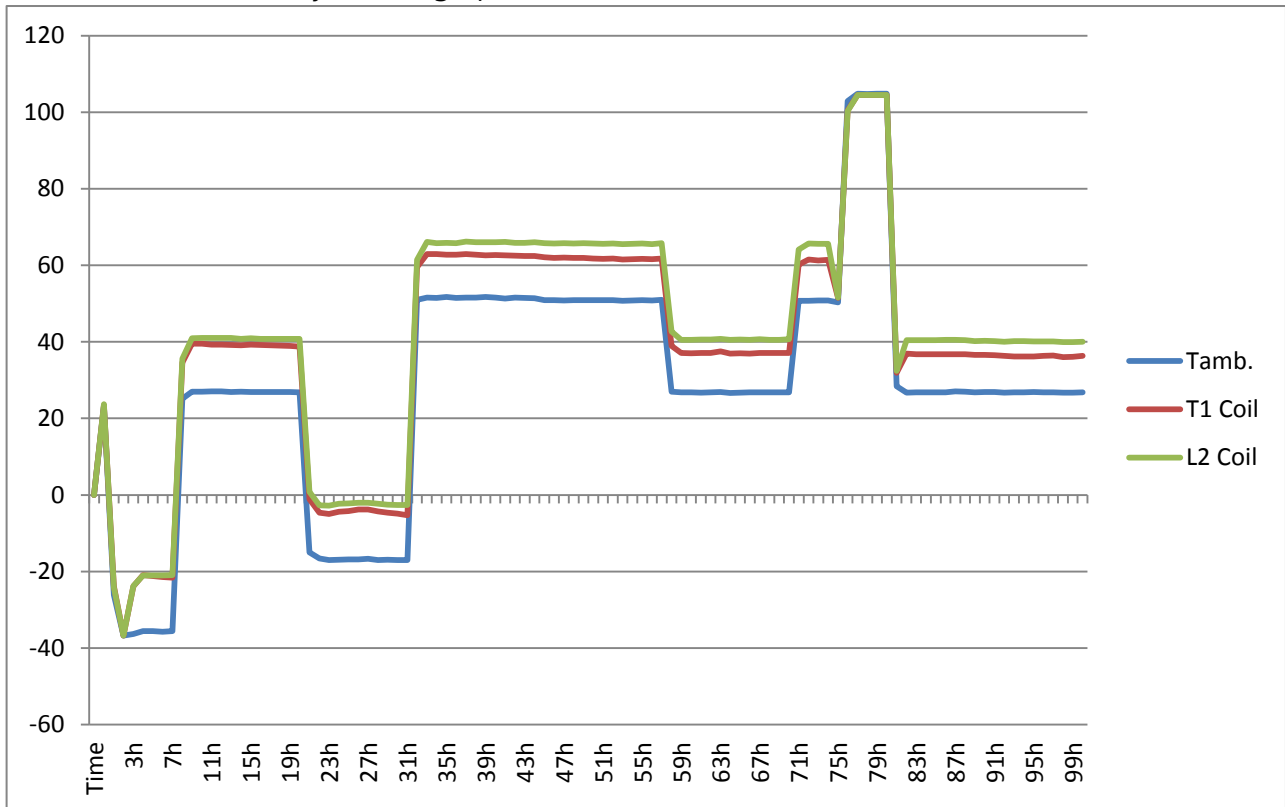
c. Characteristics test results (@ Input Voltage : 24VDC)

Segment	Test Time	T <sub>amb</sub> /Humi.	Output Voltage	Start up	Ripple / Noise	Output Load Condition
A	3h	-40°C / 0%	4.97V	OK	47 [mVp-p]	100% Load
B	9h	25°C / 0%	4.98V	OK	47 [mVp-p]	100% Load
C	24h	-20°C / 0%	4.98V	OK	47 [mVp-p]	100% Load
D	33h	50°C / 0%	4.97V	OK	51 [mVp-p]	100% Load
E	48h	50°C / 50%	4.98V	OK	51 [mVp-p]	100% Load
F	58h	25°C / 0%	4.98V	OK	51 [mVp-p]	100% Load
G	72h	50°C / 90%	4.97V	OK	51 [mVp-p]	100% Load
H	81h	25°C / 0%	4.98V	OK	51 [mVp-p]	100% Load
I	100h	25°C / 0%	4.97V	OK	51 [mVp-p]	100% Load
Test Result			Pass	Pass	Pass	



d. Test Sample : KSP50-48-12

e. 100 hours in one cycle test graph

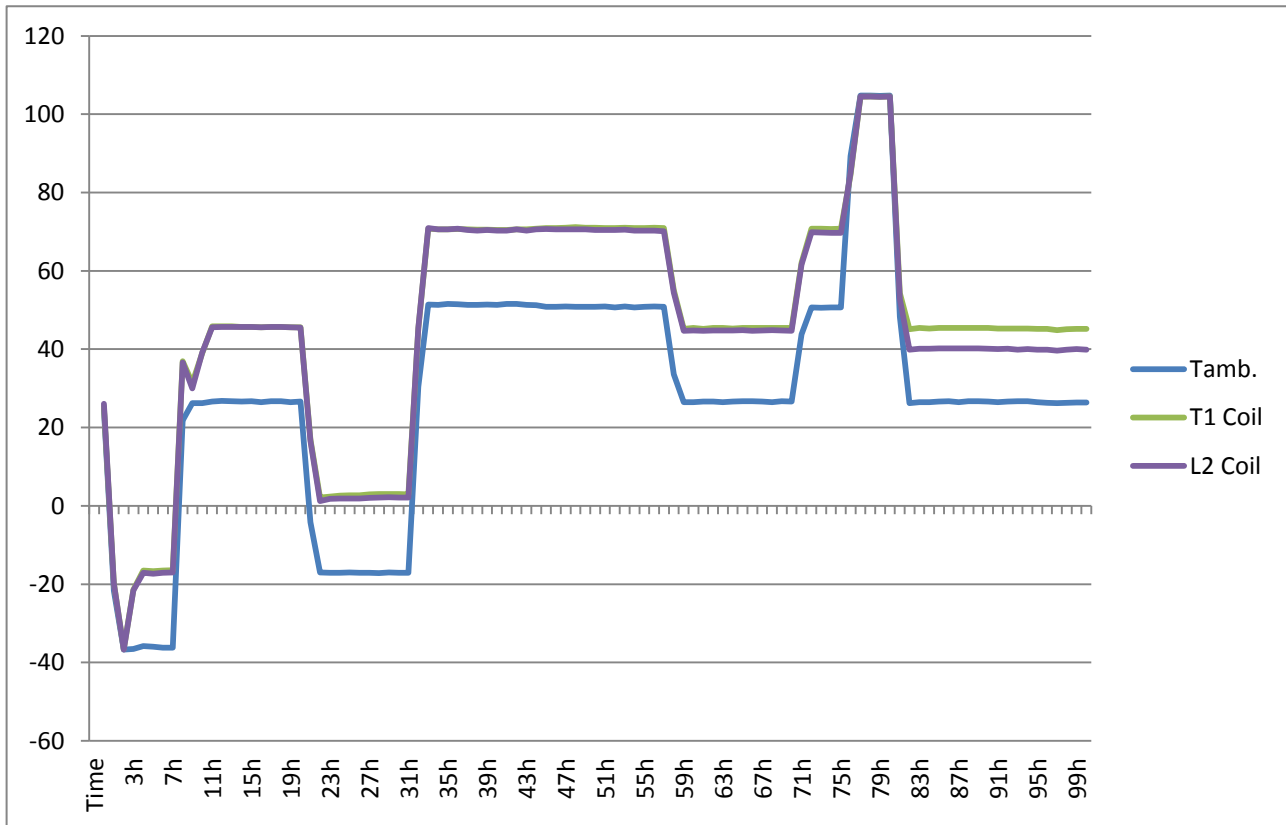


f. Characteristics test results (@ Input Voltage : 48VDC)

Segment	Test Time	T <sub>amb</sub> /Humi.	Output Voltage	Start up	Ripple / Noise	Output Load Condition
<b>A</b>	3h	-40°C / 0%	12.08V	OK	112 [mVp-p]	100% Load
<b>B</b>	9h	25°C / 0%	12.01V	OK	112 [mVp-p]	100% Load
<b>C</b>	24h	-20°C / 0%	12.06V	OK	112 [mVp-p]	100% Load
<b>D</b>	33h	50°C / 0%	11.98V	OK	112 [mVp-p]	100% Load
<b>E</b>	48h	50°C / 50%	11.99V	OK	112 [mVp-p]	100% Load
<b>F</b>	58h	25°C / 0%	12.00V	OK	112 [mVp-p]	100% Load
<b>G</b>	72h	50°C / 90%	11.99V	OK	103 [mVp-p]	100% Load
<b>H</b>	81h	25°C / 0%	12.04V	OK	103 [mVp-p]	100% Load
<b>I</b>	100h	25°C / 0%	11.99V	OK	103 [mVp-p]	100% Load
Test Result			Pass	Pass	Pass	

g. Test Sample : KSP50-72-12

h. 100 hours in one cycle test graph

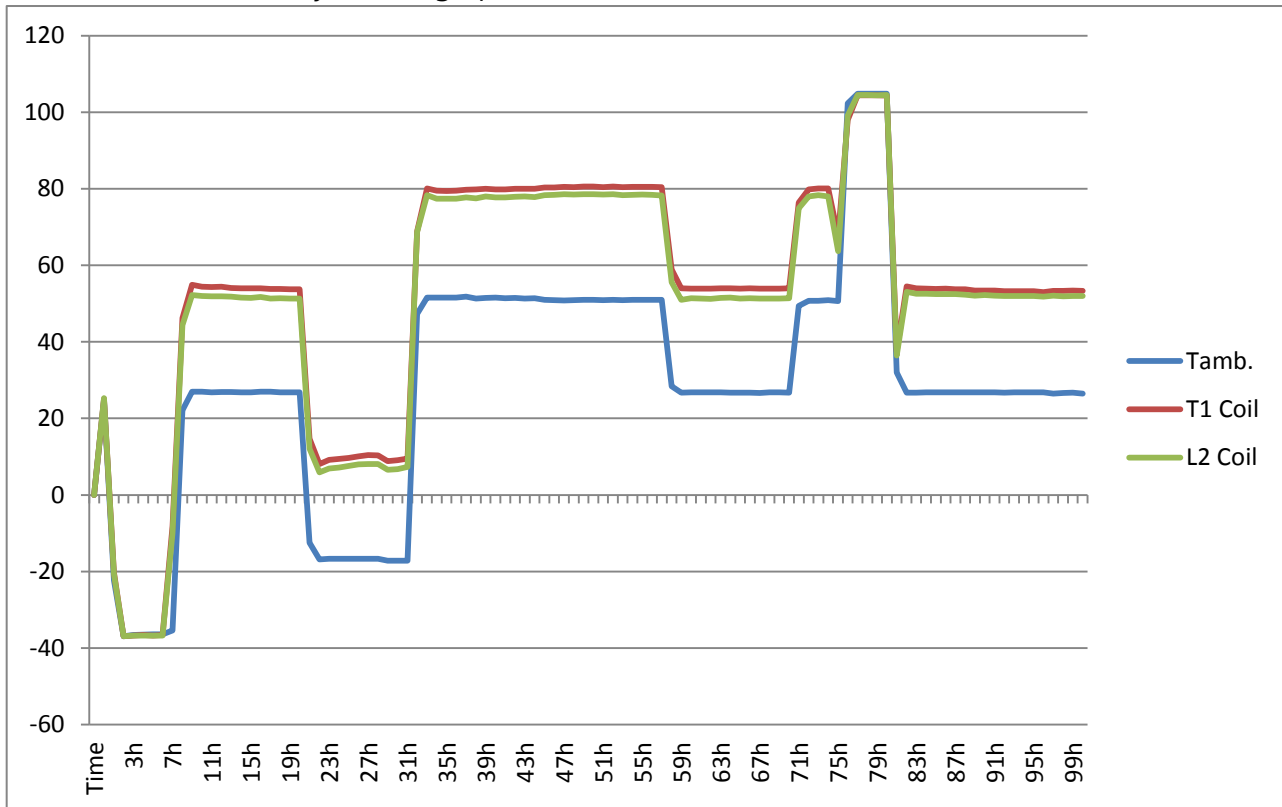


i. Characteristics test results (@ Input Voltage : 72VDC)

Segment	Test Time	T <sub>amb</sub> /Humi.	Output Voltage	Start up	Ripple / Noise	Output Load Condition
<b>A</b>	3h	-40°C / 0%	12.06V	OK	112 [mVp-p]	100% Load
<b>B</b>	9h	25°C / 0%	12.03V	OK	112 [mVp-p]	100% Load
<b>C</b>	24h	-20°C / 0%	12.02V	OK	112 [mVp-p]	100% Load
<b>D</b>	33h	50°C / 0%	12.02V	OK	112 [mVp-p]	100% Load
<b>E</b>	48h	50°C / 50%	12.01V	OK	112 [mVp-p]	100% Load
<b>F</b>	58h	25°C / 0%	12.02V	OK	112 [mVp-p]	100% Load
<b>G</b>	72h	50°C / 90%	12.01V	OK	112 [mVp-p]	100% Load
<b>H</b>	81h	25°C / 0%	12.04V	OK	112 [mVp-p]	100% Load
<b>I</b>	100h	25°C / 0%	12.01V	OK	112 [mVp-p]	100% Load
Test Result			Pass	Pass	Pass	

j. Test Sample : KSP50-110-05

k. 100 hours in one cycle test graph



l. Characteristics test results (@ Input Voltage : 110VDC)

Segment	Test Time	T <sub>amb</sub> /Humi.	Output Voltage	Start up	Ripple / Noise	Output Load Condition
A	3h	-40°C / 0%	4.80V	OK	68 [mVp-p]	100% Load
B	9h	25°C / 0%	4.82V	OK	61 [mVp-p]	100% Load
C	24h	-20°C / 0%	4.83V	OK	61 [mVp-p]	100% Load
D	33h	50°C / 0%	4.79V	OK	53 [mVp-p]	100% Load
E	48h	50°C / 50%	4.80V	OK	53 [mVp-p]	100% Load
F	58h	25°C / 0%	4.81V	OK	53 [mVp-p]	100% Load
G	72h	50°C / 90%	4.79V	OK	53 [mVp-p]	100% Load
H	81h	25°C / 0%	4.87V	OK	53 [mVp-p]	100% Load
I	100h	25°C / 0%	4.80V	OK	53 [mVp-p]	100% Load
Test Result			Pass	Pass	Pass	

### 3. Main Components $\Delta t$ Test

The purpose of the test is to ensure the reliability and margin by measuring the heating value of the main components.

#### 3.1. KSP50-24-05 (@ 100% Load, Airflow : 1m/s)

Test Point \ Test Condition	Vin : 18VDC		Vin : 24VDC		Vin : 36VDC	
	T <sub>amb.</sub>	34.4°C	T <sub>amb.</sub>	33.4°C	T <sub>amb.</sub>	31.8°C
	T <sub>c</sub>	$\Delta t$	T <sub>c</sub>	$\Delta t$	T <sub>c</sub>	$\Delta t$
IC	66.2°C	<b>31.8°C</b>	61.5°C	<b>28.1°C</b>	66.5°C	<b>34.7°C</b>
Input FET	88.3°C	<b>53.9°C</b>	78.2°C	<b>44.8°C</b>	84.2°C	<b>52.4°C</b>
Sync. FET	80.4°C	<b>46.0°C</b>	71.6°C	<b>38.2°C</b>	71.9°C	<b>40.1°C</b>
Freewheeling FET	76.2°C	<b>41.8°C</b>	73.7°C	<b>40.3°C</b>	78.2°C	<b>46.4°C</b>
Trans Coil	75.2°C	<b>40.8°C</b>	69.0°C	<b>35.6°C</b>	69.5°C	<b>37.7°C</b>
Trans Core	66.7°C	<b>32.3°C</b>	61.5°C	<b>28.1°C</b>	63.2°C	<b>31.4°C</b>
Inductor Coil	63.3°C	<b>28.9°C</b>	64.3°C	<b>30.9°C</b>	70.0°C	<b>38.2°C</b>
Inductor Core	50.0°C	<b>15.6°C</b>	50.8°C	<b>17.4°C</b>	54.5°C	<b>22.7°C</b>

#### 3.2. KSP50-110-05 (@ 100% Load, Airflow : 1m/s)

Test Point \ Test Condition	Vin : 65VDC		Vin : 110VDC		Vin : 150VDC	
	T <sub>amb.</sub>	28.7°C	T <sub>amb.</sub>	28.8°C	T <sub>amb.</sub>	29.4°C
	T <sub>c</sub>	$\Delta t$	T <sub>c</sub>	$\Delta t$	T <sub>c</sub>	$\Delta t$
IC	58.6°C	<b>29.9°C</b>	68.7°C	<b>39.9°C</b>	71.6°C	<b>42.2°C</b>
Input FET	65.5°C	<b>36.8°C</b>	78.6°C	<b>49.8°C</b>	81.7°C	<b>52.3°C</b>
Sync. FET	62.0°C	<b>33.3°C</b>	69.2°C	<b>40.4°C</b>	71.0°C	<b>41.6°C</b>
Freewheeling FET	63.5°C	<b>34.8°C</b>	74.9°C	<b>46.1°C</b>	77.7°C	<b>48.3°C</b>
Trans Coil	63.4°C	<b>34.7°C</b>	72.0°C	<b>43.2°C</b>	72.1°C	<b>42.7°C</b>
Trans Core	62.1°C	<b>33.4°C</b>	71.3°C	<b>42.5°C</b>	72.1°C	<b>42.7°C</b>
Inductor Coil	68.8°C	<b>40.1°C</b>	77.3°C	<b>48.5°C</b>	80.4°C	<b>51.0°C</b>
Inductor Core	65.3°C	<b>36.6°C</b>	75.0°C	<b>46.2°C</b>	77.5°C	<b>48.1°C</b>

## 4. Derating of Semiconductor

Compare  $T_{jmax}$ (maximum junction temperature) and  $T_j$  and is expressed as a percentage.  
 $T_j$  is the value calculated by the temperature of the case and the power dissipation and the thermal impedance.

- Measuring Components : FET, Rectifier diode
- Calculating method of derating ratio

$$\text{Derating Ratio} = \frac{T_j}{T_{j(max)}} \times 100 [\%]$$

$$T_j = T_c + (R_{\theta(J-C)} \times P_d)$$

$T_c$  : Case Temperature

$R_{\theta(J-C)}$  : Thermal impedance between junction and case

$P_d$  : Power dissipation

### 4.1. KSP50-24-05 (@ 100% Load, Airflow : 1m/s)

Condition Components	Vin : 18VDC		Load : 100%	T <sub>amb.</sub> : 70°C
IC1 (Active clamp PWM IC)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.14 W	T <sub>j</sub> = 117.4 °C	Derating Ratio = 78.3%
	R <sub>Θ(J-A)</sub> : 125 °C/W			
	T <sub>c</sub> : 99.9°C			
Q2 (Input FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.16 W	T <sub>j</sub> = 114.8 °C	Derating Ratio = 76.5%
	R <sub>Θ(J-A)</sub> : 50 °C/W			
	T <sub>c</sub> : 106.8°C			
Q4 (Sync. FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.45 W	T <sub>j</sub> = 114.6 °C	Derating Ratio = 76.4%
	R <sub>Θ(J-C)</sub> : 25 °C/W			
	T <sub>c</sub> : 103.3°C			
Q5 (Freewheeling FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.45 W	T <sub>j</sub> = 116.1 °C	Derating Ratio = 77.4%
	R <sub>Θ(J-C)</sub> : 25 °C/W			
	T <sub>C</sub> : 104.8°C			

Condition Components	Vin : 36VDC		Load : 100%	T <sub>amb.</sub> : 70°C
IC1 (Active clamp PWM IC)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.17 W	T <sub>j</sub> = 126.0 °C	Derating Ratio = 84.0%
	R <sub>Θ(J-A)</sub> : 125 °C/W			
	T <sub>c</sub> : 104.7°C			
Q2 (Input FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.04 W	T <sub>j</sub> = 124.4 °C	Derating Ratio = 82.9%
	R <sub>Θ(J-A)</sub> : 50 °C/W			
	T <sub>c</sub> : 122.4°C			
Q4 (Sync. FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.45 W	T <sub>j</sub> = 121.4 °C	Derating Ratio = 80.9%
	R <sub>Θ(J-C)</sub> : 25 °C/W			
	T <sub>c</sub> : 110.1°C			
Q5 (Freewheeling FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.45 W	T <sub>j</sub> = 127.7 °C	Derating Ratio = 85.1%
	R <sub>Θ(J-C)</sub> : 25 °C/W			
	T <sub>C</sub> : 116.4°C			

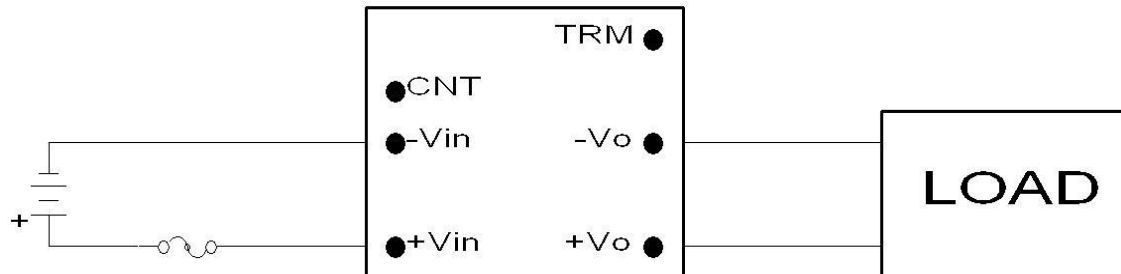
#### 4.2. KSP50-110-05 (@ 100% Load, Airflow : 1m/s)

Condition Components	Vin : 65VDC		Load : 100%	T <sub>amb.</sub> : 55°C
IC1 (Active clamp PWM IC)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.14 W	T <sub>j</sub> = 102.4 °C	Derating Ratio = 68.3%
	R <sub>Θ(J-A)</sub> : 125 °C/W			
	T <sub>c</sub> : 84.9°C			
Q2 (Input FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.09 W	T <sub>j</sub> = 94.1 °C	Derating Ratio = 62.7%
	R <sub>Θ(J-C)</sub> : 25 °C/W			
	T <sub>c</sub> : 91.8°C			
Q4 (Sync. FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.45 W	T <sub>j</sub> = 100.0 °C	Derating Ratio = 66.7%
	R <sub>Θ(J-C)</sub> : 25 °C/W			
	T <sub>c</sub> : 88.3°C			
Q5 (Freewheeling FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.45 W	T <sub>j</sub> = 101.1 °C	Derating Ratio = 67.4%
	R <sub>Θ(J-C)</sub> : 25 °C/W			
	T <sub>C</sub> : 89.8°C			

Condition Components	Vin : 150VDC		Load : 100%	T <sub>amb.</sub> : 55°C
IC1 (Active clamp PWM IC)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.14 W	Derating Ratio = 76.5%	
	R <sub>Θ(J-A)</sub> : 125 °C/W	T <sub>j</sub> = 114.7 °C		
	T <sub>c</sub> : 97.2°C			
Q2 (Input FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.02 W	Derating Ratio = 71.9%	
	R <sub>Θ(J-C)</sub> : 25 °C/W	T <sub>j</sub> = 107.8 °C		
	T <sub>c</sub> : 107.3°C			
Q4 (Sync. FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.45 W	Derating Ratio = 71.9%	
	R <sub>Θ(J-C)</sub> : 25 °C/W	T <sub>j</sub> = 107.9 °C		
	T <sub>c</sub> : 96.6°C			
Q5 (Freewheeling FET)	T <sub>j(max)</sub> : 150 °C	P <sub>d</sub> : 0.45 W	Derating Ratio = 76.4%	
	R <sub>Θ(J-C)</sub> : 25 °C/W	T <sub>j</sub> = 114.6 °C		
	T <sub>c</sub> : 103.3°C			

## - Application Sheet

### 1. Basic Connection



### 2. Input Section

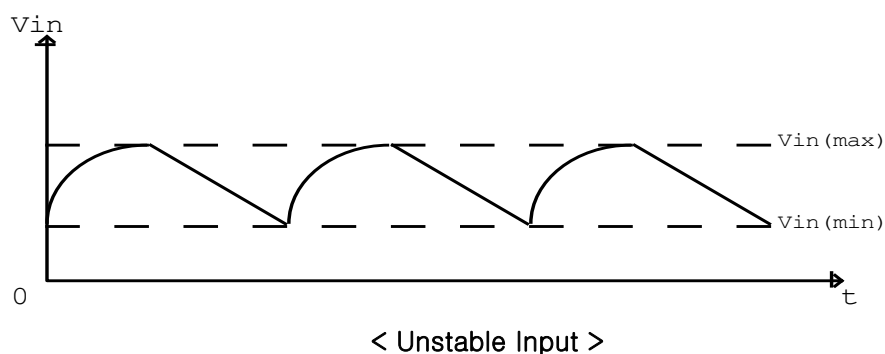
#### - Input fuse

Generally, encapsulated power supplies do not have internal fuse. To ensure safe operation, an external fuse(Regular or Slow Blow Type) is recommended.

Series	KSP50 Series
Vin	
24V	6A
48V	3A
72V	2A
110V	2A

#### - Unstable Input

Input voltage is comprised of both the DC voltage(average rectified voltage)and the peak to peak ripple voltage. Peak to peak ripple voltage should be minimized so that the input voltage is within the standard input voltage range as follows.





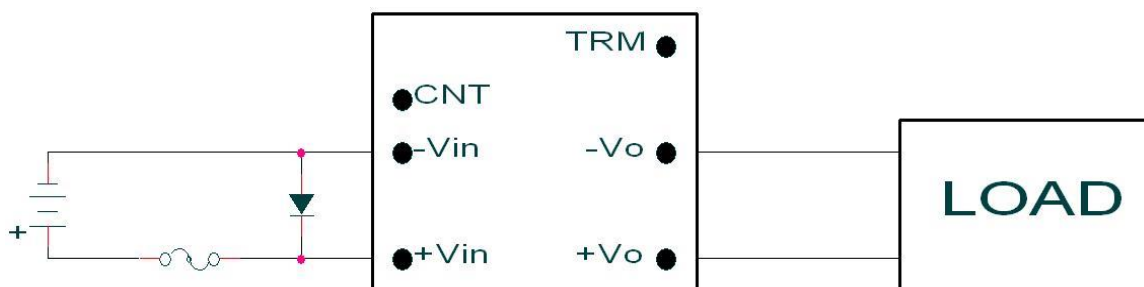
## KSP50 Series DC-DC Converter

### – Battery Input

When using a battery as the input power supply, make sure that the maximum and minimum input voltage do not away out of the standard input voltage range.

### – Input Reverse-polarity voltage protection

Accidently reversing the input connections could damage the module. Thus. If the connections may be accidentally reversed. Use a protective diode and an input fuse as shown below.



### – Remote On/Off Control(CNT)

Without switching the input on/off, the output can be enabled and disabled using this function. This function is useful for sequence control when building multiple output power supplies. This control circuit is on the input side using the CNT pin. Ground of CNT pin is the input -V terminal.

CNT level for -Vin		OUTPUT
High level	Open	ON
Low level	Short to -Vin	OFF

< Positive Logic on/off Control >

### – Under Voltage Lock Out(UVLO)

MODEL	Power Up Threshold (Typ.)	Power Down Threshold (Typ.)
KSP50 – 24 – XX	16V	15V
KSP50 – 48 – XX	33V	31V
KSP50 – 72 – XX	48V	45V
KSP50 – 110 – XX	57V	52V

### 3. Output Section

#### – Output Ripple and Noise Measurement Method

The measurement for output ripple and noise are based on normal probe with 20MHz bandwidth scope. Upon measurement of the ripple voltage, make sure that the scope probe leads are not too long. If a precise measurement can be made, the noise occurs from circumference must be reduced.

#### – Line Regulation

The line regulation means to the change in output voltage when the input voltage is varied within the input voltage range, at constant load and constant ambient temperature. The measurement point for the input and output voltage are  $\pm V_{in}$  pins,  $\pm V_{out}$  pins respectively.

#### – Load Regulation

The load regulation means to the change in output voltage when the load is changed from minimum load to maximum load, at constant input voltage and constant ambient temperature. The measurement point for the input and output voltage are  $\pm V_{in}$  pins,  $\pm V_{out}$  pins respectively.

#### – Output Voltage Variation(TRM)

The output voltage can be varied within  $\pm 10\%$  of the standard output voltage when use the external parts-resistors and variable resistor.

External Resistors :

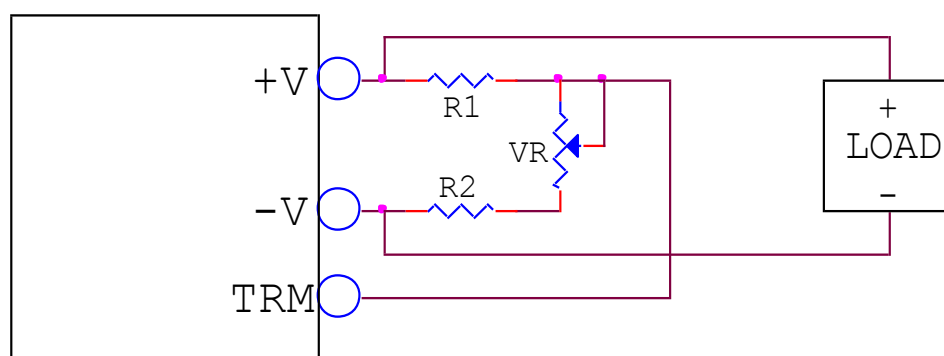
Resistance tolerance  $\pm 5\%$

Variable Resistor(VR) :

Total resistance tolerance  $\pm 20\%$

Remaining Resistance : Value less than 1%

$V_o$	R1	R2	VR
3.3V	1.5k $\Omega$	680 $\Omega$	1k $\Omega$
5V	1k $\Omega$	680 $\Omega$	1k $\Omega$
12V	3.9k $\Omega$	680 $\Omega$	1k $\Omega$
15V	5.6k $\Omega$	750 $\Omega$	1k $\Omega$



< Trim Method >

### – Over Current Protection(OCP)

The KSP50 series is built into an OCP(Over Current Protection) circuit. When the OCP triggers, the output voltage will be fall. If overload condition is removed, the output will automatically recover.

### – Over Voltage Protection(OVP)

The KSP50 series is built into an OVP(Over Voltage Protection) circuit. When the OVP triggers, the output voltage is shutdown. The input must be taken out (for at least five seconds), and than reinputted manually. Otherwise, the module will not output.

## 4. Environment

### – Temperature

#### Operation Temperature

The range of ambient temperature in °C over which a module can be operated safely at either rated or derated output power. Refer to derating curve as page 10.

#### Storage Temperature

The range of ambient temperature in °C over which a module may be stored long term without damage. The storage temperature range is from -40°C to 105°C.

### – Humidity

#### Operating & Storage Humidity

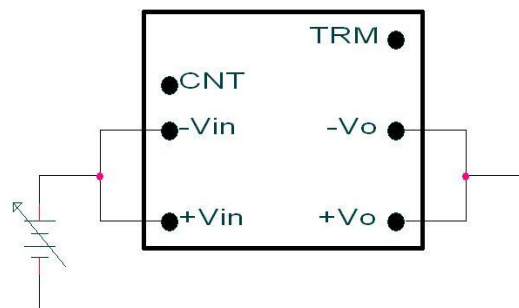
The range of ambient humidity in % over which a module can be operated safely at either rated or derated output power. The operating humidity range is from 5% to 95%RH.  
The range of ambient humidity in % over which a module may be stored long term without damage. The storage humidity range is from 5% to 95%RH.

## 5. Isolation

### Isolation Resistance

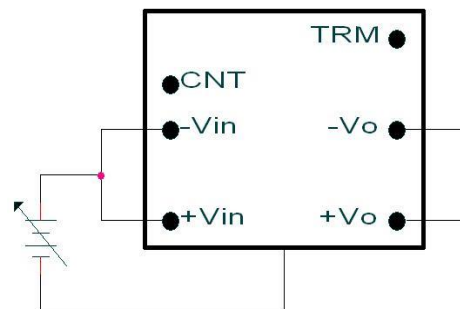
The electrical separation between input and output of a module by means of the power transformer. The isolation resistance is a function of materials and spacings employed throughout the module. Please don't test with a voltage above standard voltage for the Isolation Resistance Test.

#### <INPUT-OUTPUT>



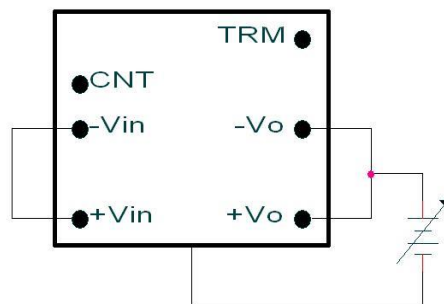
500VDC, 100M $\Omega$

#### <INPUT-CASE>



500VDC, 100M $\Omega$

#### <OUTPUT-CASE>

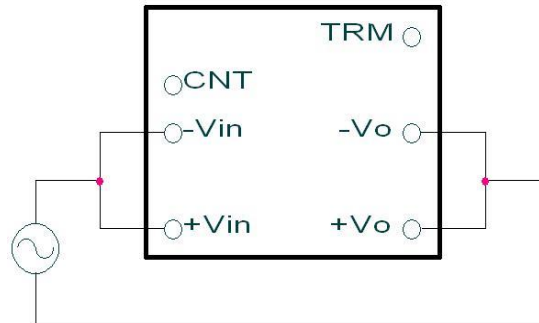


500VDC, 70M $\Omega$

### Withstand Voltage

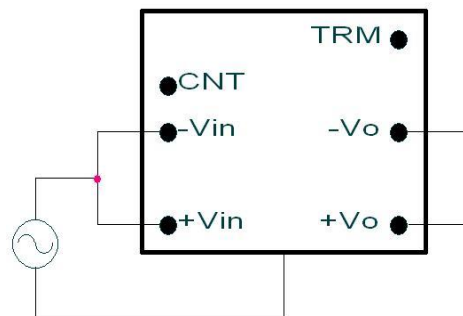
For the withstand voltage test, the applied voltage must be increased gradually from zero to the testing value, and then decreased gradually at shut down. Especially stay away from use of a timer. Where a pulse of several times the applied voltage can be generated.

#### <INPUT-OUTPUT>



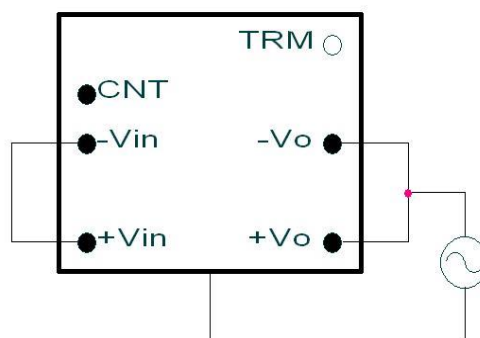
0.5kVAC 1minute

#### <INPUT-CASE>



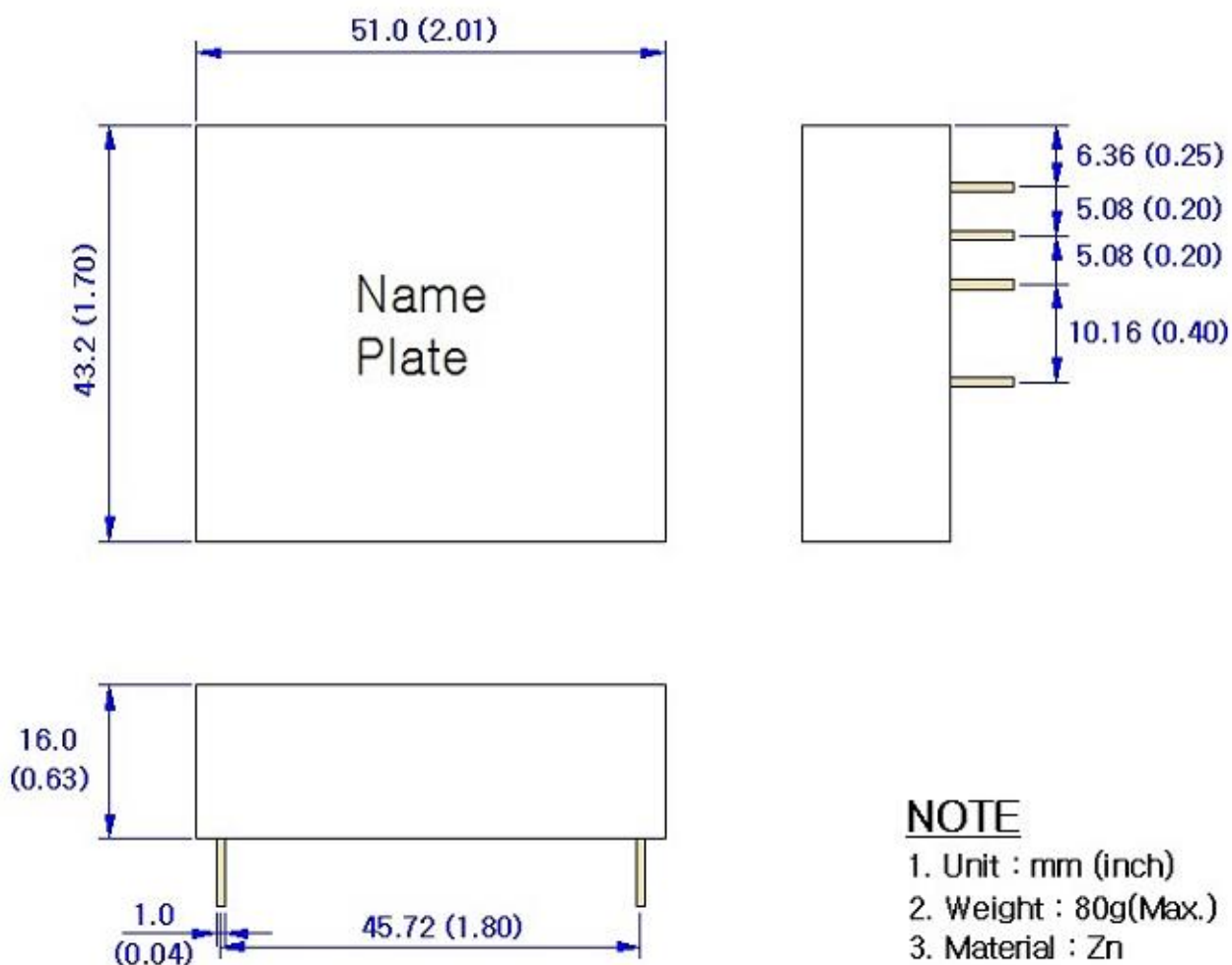
0.5kVAC 1minute

#### <OUTPUT-CASE>



0.5kVAC 1minute

## 6. Outline Dimensions <Unit : mm (inch)>



### NOTE

1. Unit : mm (inch)
2. Weight : 80g(Max.)
3. Material : Zn