DATASHEET &
RELIABILITY DATA

NOF60 SERIES

㈜오디피

Open Digital Power Corp.

Contents

MAX. Power 60W Isolated Open Frame Type Small AC-DC Converter

NOF60 Series Isolated Open Frame Type Small AC-DC Converter

Features

- Power Saving Mode Operation
- Very Small, High Efficiency
- Isolated Input - Output
- 65kHz fixed frequency and Current mode Control
- Low output Ripple & Noise
- Built-in over current protection circuit
- Short Circuit Protection
- Universal Input Voltage(Free Voltage)
- Built in EMI Filter
- Safety standard : CB, CE approved (CB : IEC60950-1, CE : EN60950-1)
- RoHS compatible design

Environment

- Operating Temperature : -40℃ ~ 70℃
- Operating Humidity : 20% ~ 90% RH (Non condensing)
- Storage Temperature : -40℃ ~ 85℃
- Cooling : Free-Air Convection
- MTBF : 3.0 x 10^5 hrs

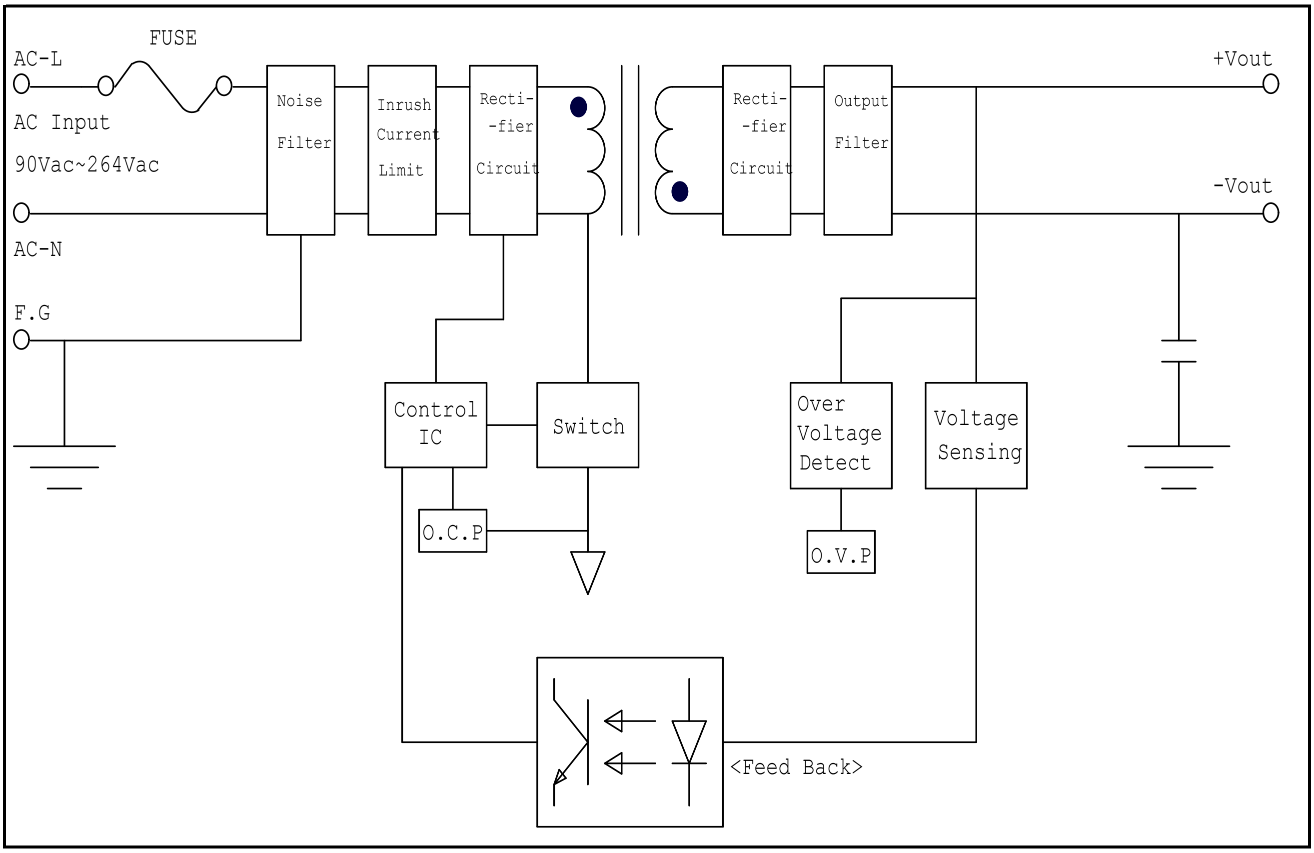
Model Name Structure

NOF 60 - 12

- NOF → Series Name
- 60 → Output Power
- 12 → Output Voltage

- Datasheet

1. Internal Circuit Architecture



2. Maximum Ratings

Characteristics		Symbol	Min.	Typ.	Max.	Unit
No-load Power Consump -tion	NOF60 - XX				0.3	W
Freauency	NOF60 - XX		44	-	440	Hz
Input Voltage Continuis	NOF60-12	Vin	90	-	264	Vac
	NOF60-15		90	-	264	
	NOF60-24		90	-	264	
	NOF60-48		90	-	264	
Operating Ambient Temperature		Ta	-40	-	70	℃
Storage Temperature		Tstg	-40	-	85	℃
Withstand Voltage (Input - Output)			-	-	3000	Vac

3. Electrical Characteristics

- Input Section

Ta : 25℃, Vin : Typical Input Voltage

Characteristics		Symbol	Min.	Typ.	Max.	Unit
No-load Power Consump -tion	NOF60 – XX				0.3	W
Operating Voltage Range	NOF60 – XX	Vin	90	110, 220	264	Vac
Freauency	NOF60 – XX		44	50, 60	440	Hz
Max. Input Current (Vin : rated, Io : 100%)	NOF60 – XX	Iin			1.4	A
Max. No Load Input Current (Vin : rated)	NOF60 – XX				0.03	A
Inrush Current (In : 220Vac)	NOF60 – XX				60	A
Leakage Current (In : 220Vac)	NOF60 – XX				0.35	mA

- Output Section

Ta : 25℃, Vin : Minimum, Typical, Maximum Input Voltage

Characteristics		Symbol	Min.	Typ.	Max.	Unit
Output Voltage Accuracy	Single	Vo	–	–	±2	%
Regulation	Line Regulation (From min. Vin to max. Vin, constant load)		–	–	±1	%
	Load Regulation (From no load to maximum load)		–	–	±1	%(@Single)
Output Ripple and Noise (Vin : Rated, Io : Max., BW : 20MHz)		mVp-p	–	–	1% of Vout	mV (peak to peak)

Characteristics		Symbol	Min.	Typ.	Max.	Unit
Output Current	NOF60 – 12 NOF60 – 15 NOF60 – 24 NOF60 – 48	Io	– – –	– – –	5 4 2.5 1.25	A
Output Current Limit (OCP : Over Current Protection, recovers automatically)			105	–	–	%
Over Voltage Protection			115	–	140	%
Output Voltage adj. Range			-10	0	+10	%
Dynamic Load Response (Vin : rated, Io : from 50% to 100%, from100% to 50%, BW : 20MHz, Freq. : 50Hz, Duty : 0.5, Tr/Tf : 100us			–	–	3% of Vout	mV (peak to peak)
Start – Up Time		Tstart			1.5	s
Turn – on Overshoot			–	–	5	%
Efficiency (Vin : Rated, Io : Max.)	NOF60 – 12 NOF60 – 15 NOF60 – 24 NOF60 – 48		– – –	86 87 89 88	– – –	%

4. Isolation Characteristics

Characteristics		Symbol	Min.	Typ.	Max.	Unit
Withstand Voltage	Input – Output		–	–	3000	Vac
	Input – FRG		–	–	2000	Vac
	Output – FRG		–	–	500	Vac
Isolation Resistance (DC500V at 25℃ and 70%RH)	Output – FRG	Riso	70	–	–	MΩ

5. General Characteristics

Characteristics	Symbol	Min.	Typ.	Max.	Unit
Remote on / off control (CNT Pin, Negative Logic Module on : Logic Low or Short to -Vin Module off : Logic High or open)	CNT				
Internal Trim Adj. Range (by VR1)		-10	0	+10	%
Switching Frequency			65		kHz
MTBF (MIL-HDBK-217F)		3.0×10^5			hrs
Dimension (L x W x H)		110 x 50 x 28			mm
Weight				170	grams

6. Environment

Characteristics	Symbol	Min.	Typ.	Max.	Unit
Operating Temperature Range	Ta	-40	-	70	℃
Operating Humidity (non Condensing)		20	-	90	%RH
Storage Temperature	Tstg	-40	-	85	℃

- Reliability Data

1. MTBF

Calculating Reliable Values of MTBF

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

Method is :

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

For a given equipment environment where :

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

λg = Generic failure rate for the i th generic part (Failures / 10^6 Hours)

πQ = Quality factor for the i th generic part (πQ = 1)

Ni = Quanty 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	3	0.012	0.0360000
3	Voltage Regulaor	1	0.002	0.0020000
4	Diode (Zener)	5	0.002	0.0100000
5	Diode (FRD)	3	0.069	0.2070000
6	Diode (SBD)	1	0.027	0.0270000
7	Bridge Diode	1	0.066	0.0660000
8	LED	1	0.00023	0.0002300
9	Varistor	1	0.0013	0.0013000
10	Photo-coupler	1	0.07	0.0700000
11	Thyristor	0	0.0022	-
12	Elec.- Cap.	6	0.019	0.1140000
13	Ceramic Cap.	6	0.026	0.1560000
14	MLCC	8	0.053	0.4240000
15	Choke coil	1	0.00022	0.0002200
16	Switching transformer	1	0.0042	0.0042000
17	Line Filter	1	0.0044	0.0044000
18	Resistor	36	0.0024	0.0864000
19	Resistor Variable	1	0.0024	0.0024000
20	Thermister	1	0.0019	0.0019000
21	Connertor	2	0.052	0.1040000
22	Soldering Point	195	0.0078	1.5210000
23	PCB	1	0.37	0.3700000
24	Fuse	1	0.01	0.0100000
Total Equipment Failure Rate (λequip)				3.2330500
MTBF = 10^6 / λequip(F/T)				309,305.455
MTBF ≒ 300,000[Hours]				

2. Lifetime

The shortest lifetime parts is an electrolytic capacitor. Thus, the lifetime of SMPS is lifetime of electrolytic capacitors.

Lifetime of electrolytic capacitor can be calculated by the following factors.

- T_0 : Load life rating
- T_{max} : Maximum temperature rating of capacitor
- T_{case} : Temperature of case

$$T[hour] = T_0 * 2^{\frac{T_{max} - T_{case}}{10}}$$

T : Life Time(Electrolytic Cap.)
T_0 : Load Life Rating
T_{max} : Max. Tepmerature rating of capacitor
T_{case} : Temperature of case

NOF60-12 <(12VDC, 5A(100% Load)>, [unit : hrs]			
110Vac Input		220Vac Input	
$T_{amb.}$: 25℃	$T_{amb.}$: 50℃	$T_{amb.}$: 25℃	$T_{amb.}$: 50℃
> 100,000 hrs	**38,000 hrs**	**> 100,000 hrs**	**64,000 hrs**

NOF60-15 <(15VDC, 4A(100% Load)>, [unit : hrs]			
110Vac Input		220Vac Input	
$T_{amb.}$: 25℃	$T_{amb.}$: 50℃	$T_{amb.}$: 25℃	$T_{amb.}$: 50℃
> 100,000 hrs	**42,000 hrs**	**> 100,000 hrs**	**75,000 hrs**

NOF60-24 <(24VDC, 2.5A(100% Load)>, [unit : hrs]			
110Vac Input		220Vac Input	
$T_{amb.}$: 25℃	$T_{amb.}$: 50℃	$T_{amb.}$: 25℃	$T_{amb.}$: 50℃
> 100,000 hrs	**44,000 hrs**	**> 100,000 hrs**	**76,000 hrs**

NOF60-48 <(48VDC, 1.25A(100% Load)>, [unit : hrs]			
110Vac Input		220Vac Input	
$T_{amb.}$: 25℃	$T_{amb.}$: 50℃	$T_{amb.}$: 25℃	$T_{amb.}$: 50℃
> 100,000 hrs	**45,000 hrs**	**> 100,000 hrs**	**76,000 hrs**

3. 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 >

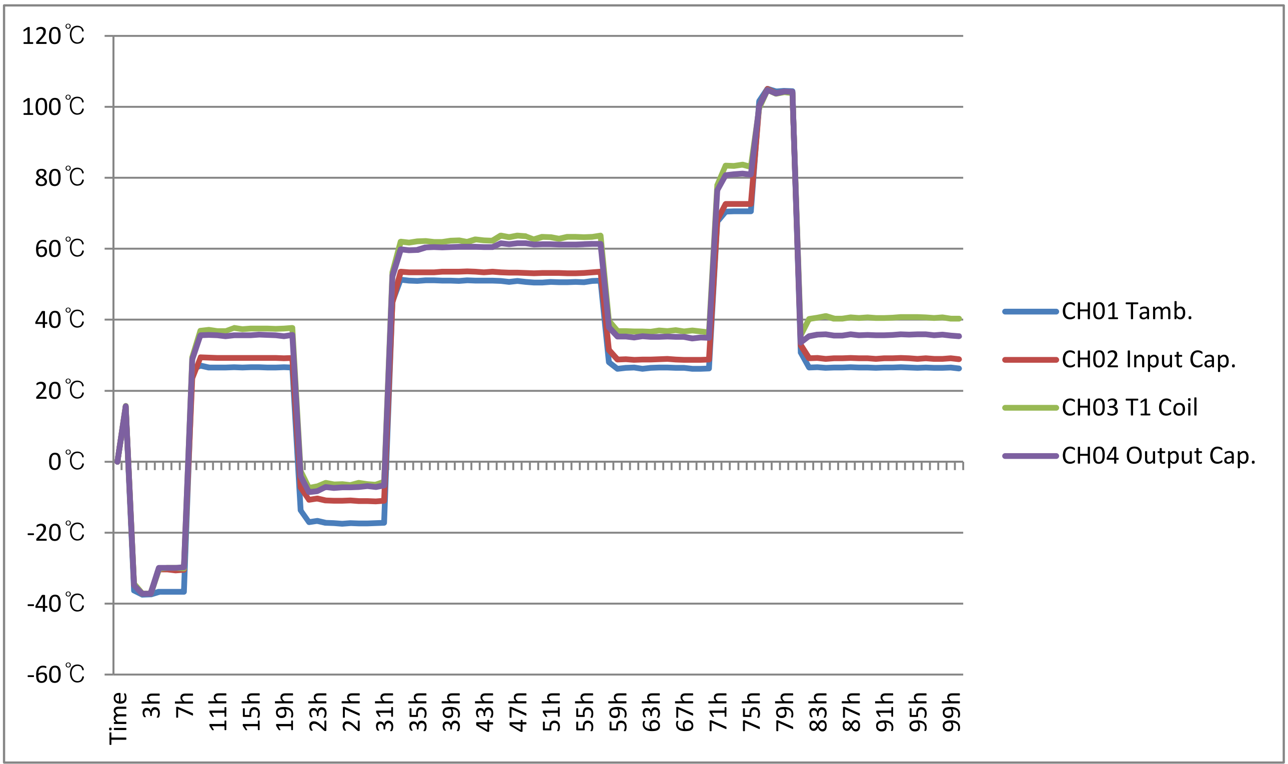
Segment	Time	Temp.	Humidity	Description	Input 'SW'
A	2 hours	-40℃	0%	Low temperature storage	off
B	4 hours	-40℃	0%	Low temperature operation	on
C	12 hours	25℃	0%	Room temperature operation	on
D	10 hours	-20℃	0%	Low temperature operation	on
E	12 hours	50℃	0%	High temperature operation	on
F	12 hours	50℃	50%	High-temperature & humidity operation	on
G	12 hours	25℃	0%	Room temperature operation	on
H	4 hours	70℃	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 >

3.1. Environmental Stress Test Results

a. Test Sample : NOF60-12

b. 100 hours in one cycle test graph



c. Characteristics test results (@ Input Voltage : 220Vac)

Segment	Test Time	$T_{amb.}$/Humi.	Output Voltage	Start up	Ripple / Noise	Output Load Condition
A	3h	-40℃ / 0%	**11.96V**	**OK**	**40 / 66 [mVp-p]**	50% Load
B	7h	-40℃ / 0%	**11.96V**	**OK**	**36 / 58 [mVp-p]**	50% Load
C	10h	25℃ / 0%	**11.99V**	**OK**	**8 / 32 [mVp-p]**	100% Load
D	24h	-20℃ / 0%	**11.98V**	**OK**	**21 / 42 [mVp-p]**	100% Load
E	33h	50℃ / 0%	**11.99V**	**OK**	**8 / 36 [mVp-p]**	100% Load
F	48h	50℃ / 50%	**11.98V**	**OK**	**8 / 32 [mVp-p]**	100% Load
G	57h	25℃ / 0%	**11.98V**	**OK**	**8 / 32 [mVp-p]**	100% Load
H	72h	70℃ / 90%	**11.98V**	**OK**	**8 / 46 [mVp-p]**	100% Load
I	81h	25℃ / 0%	**11.98V**	**OK**	**8 / 38 [mVp-p]**	100% Load
J	100h	25℃ / 0%	**11.99V**	**OK**	**8 / 36 [mVp-p]**	100% Load
Test Result			**Pass**	**Pass**	**Pass**	

4. Main Components Δt Test

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

4.1. NOF60-12 (@ 100% Load)

Test Condition / Test Point	Vin : 110Vac, 60Hz		Vin : 220Vac, 60Hz	
	$T_{amb.}$	35.7℃	$T_{amb.}$	35.3℃
	Tc	Δt	Tc	Δt
Bridge Diode	94.8℃	**59.1℃**	72.1℃	**36.8℃**
1st Input Cap.	64.7℃	**29.0℃**	54.8℃	**19.5℃**
2nd Input Cap.	71.3℃	**35.6℃**	60.9℃	**25.6℃**
FET	83.6℃	**47.9℃**	78.0℃	**42.7℃**
Trans Coil	87.6℃	**51.9℃**	87.6℃	**52.3℃**
Trans Core	82.1℃	**46.4℃**	82.7℃	**47.4℃**
Output Diode	102.9℃	**67.2℃**	105.6℃	**70.3℃**
Output Cap.	72.5℃	**36.8℃**	75.6℃	**40.3℃**

4.2. NOF60-15 (@ 100% Load)

Test Condition / Test Point	Vin : 110Vac, 60Hz		Vin : 220Vac, 60Hz	
	$T_{amb.}$	32.3℃	$T_{amb.}$	31.4℃
	Tc	Δt	Tc	Δt
Bridge Diode	88.6℃	**56.3℃**	67.2℃	**35.8℃**
1st Input Cap.	60.8℃	**28.5℃**	50.7℃	**19.3℃**
2nd Input Cap.	66.5℃	**34.2℃**	56.5℃	**25.1℃**
FET	79.6℃	**47.3℃**	73.7℃	**42.3℃**
Trans Coil	83.9℃	**51.6℃**	82.9℃	**51.5℃**
Trans Core	78.4℃	**46.1℃**	79.3℃	**47.9℃**
Output Diode	89.8℃	**57.5℃**	96.9℃	**65.5℃**
Output Cap.	63.4℃	**31.1℃**	71.0℃	**39.6℃**

4.3. NOF60-24 (@ 100% Load)

Test Condition / Test Point	Vin : 110Vac, 60Hz		Vin : 220Vac, 60Hz	
	$T_{amb.}$	29.8℃	$T_{amb.}$	29.2℃
	Tc	Δt	Tc	Δt
Bridge Diode	86.6℃	**56.8℃**	65.6℃	**36.4℃**
1st Input Cap.	57.9℃	**28.1℃**	49.2℃	**20.0℃**
2nd Input Cap.	63.3℃	**33.5℃**	54.8℃	**25.6℃**
FET	76.5℃	**46.7℃**	73.6℃	**44.4℃**
Trans Coil	83.3℃	**53.5℃**	84.5℃	**55.3℃**
Trans Core	75.9℃	**46.1℃**	77.5℃	**48.3℃**
Output Diode	85.6℃	**55.8℃**	86.9℃	**57.7℃**
Output Cap.	56.4℃	**26.6℃**	59.0℃	**29.8℃**

4.4. NOF60-48 (@ 100% Load)

Test Condition / Test Point	Vin : 110Vac, 60Hz		Vin : 220Vac, 60Hz	
	$T_{amb.}$	33.7℃	$T_{amb.}$	34.9℃
	Tc	Δt	Tc	Δt
Bridge Diode	92.2℃	**58.5℃**	71.0℃	**36.1℃**
1st Input Cap.	60.3℃	**26.6℃**	53.4℃	**18.5℃**
2nd Input Cap.	66.9℃	**33.2℃**	61.0℃	**26.1℃**
FET	83.0℃	**49.3℃**	79.2℃	**44.3℃**
Trans Coil	87.6℃	**53.9℃**	92.9℃	**58.0℃**
Trans Core	78.6℃	**44.9℃**	84.0℃	**49.1℃**
Output Diode	82.7℃	**49.0℃**	94.5℃	**59.6℃**
Output Cap.	59.9℃	**26.2℃**	72.3℃	**37.4℃**

5. Derating of Semiconductor

Compare Tjmax(maximum junction temperature) and TJ and is expressed as a percentage.
Tj is the value calculated by the temperature of the case and the power dissipation and the thermal impedance.

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

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

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

T_c : Case Temperature

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

P_d : Power dissipation

5.1. NOF60-12

Components \ Condition	Vin : 110Vac, 60Hz	Load : 100%	$T_{amb.}$: 50℃
BD1 (Bridge Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 11 ℃/W T_c : 105℃	P_d : 1.18 W T_j = 118 ℃	**Derating Ratio = 78.7%**
Q1 (FET)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 5 ℃/W T_c : 99.5℃	P_d : 1.72 W T_j = 108 ℃	**Derating Ratio = 72.0%**
D4 (Rectifier Diode)	$T_{j(max)}$: 175 ℃ $R_{\Theta(J\text{-}C)}$: 0.9 ℃/W T_c : 117℃	P_d : 3.20 W T_j = 120 ℃	**Derating Ratio = 68.6%**
Components \ Condition	**Vin : 220Vac, 60Hz**	**Load : 100%**	**$T_{amb.}$: 50℃**
BD1 (Bridge Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 11 ℃/W T_c : 86℃	P_d : 0.53 W T_j = 91.8 ℃	**Derating Ratio = 61.2%**
Q1 (FET)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 5 ℃/W T_c : 94℃	P_d : 0.38 W T_j = 96 ℃	**Derating Ratio = 64.0%**
D4 (Rectifier Diode)	$T_{j(max)}$: 175 ℃ $R_{\Theta(J\text{-}C)}$: 0.9 ℃/W T_c : 120℃	P_d : 3.20 W T_j = 123 ℃	**Derating Ratio = 70.3%**

5.2. NOF60-15

Components \ Condition	Vin : 110Vac, 60Hz	Load : 100%	$T_{amb.}$: 50℃
BD1 (Bridge Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 11 ℃/W T_c : 106℃	P_d : 1.17 W T_j = 119 ℃	**Derating Ratio = 79.3%**
Q1 (FET)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 5 ℃/W T_c : 97.3℃	P_d : 1.71 W T_j = 106 ℃	**Derating Ratio = 70.7%**
D4 (Rectifier Diode)	$T_{j(max)}$: 175 ℃ $R_{\Theta(J-C)}$: 0.9 ℃/W T_c : 108℃	P_d : 2.56 W T_j = 110 ℃	**Derating Ratio = 62.9%**

Components \ Condition	Vin : 220Vac, 60Hz	Load : 100%	$T_{amb.}$: 50℃
BD1 (Bridge Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 11 ℃/W T_c : 86℃	P_d : 0.52 W T_j = 91.7 ℃	**Derating Ratio = 61.1%**
Q1 (FET)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 5 ℃/W T_c : 93℃	P_d : 0.38 W T_j = 95 ℃	**Derating Ratio = 63.3%**
D4 (Rectifier Diode)	$T_{j(max)}$: 175 ℃ $R_{\Theta(J-C)}$: 0.9 ℃/W T_c : 116℃	P_d : 2.56 W T_j = 118.3 ℃	**Derating Ratio = 67.6%**

5.3. NOF60-24

Components \ Condition	Vin : 110Vac, 60Hz	Load : 100%	$T_{amb.}$: 50℃
BD1 (Bridge Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 11 ℃/W T_c : 107℃	P_d : 1.18 W T_j = 120 ℃	**Derating Ratio = 80.0%**
Q1 (FET)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 5 ℃/W T_c : 96.7℃	P_d : 1.71 W T_j = 105 ℃	**Derating Ratio = 70.0%**
D4 (Rectifier Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 3 ℃/W T_c : 106℃	P_d : 2.45 W T_j = 113 ℃	**Derating Ratio = 75.3%**

Components \ Condition	Vin : 220Vac, 60Hz	Load : 100%	$T_{amb.}$: 50℃
BD1 (Bridge Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 11 ℃/W T_c : 86℃	P_d : 0.53 W T_j = 91.8 ℃	**Derating Ratio = 61.2%**
Q1 (FET)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 5 ℃/W T_c : 94.4℃	P_d : 0.39 W T_j = 96 ℃	**Derating Ratio = 64.0%**
D4 (Rectifier Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J-C)}$: 3 ℃/W T_c : 108℃	P_d : 2.45 W T_j = 115 ℃	**Derating Ratio = 76.7%**

5.4. NOF60-48

Condition / Components	Vin : 110Vac, 60Hz	Load : 100%	$T_{amb.}$: 50℃
BD1 (Bridge Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 11 ℃/W T_c : 107℃	P_d : 1.14 W T_j = 120 ℃	**Derating Ratio = 80.0%**
Q1 (FET)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 5 ℃/W T_c : 99.3℃	P_d : 1.72 W T_j = 108 ℃	**Derating Ratio = 72.0%**
D4 (Rectifier Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 3 ℃/W T_c : 99℃	P_d : 1.56 W T_j = 104 ℃	**Derating Ratio = 69.3%**

Condition / Components	Vin : 220Vac, 60Hz	Load : 100%	$T_{amb.}$: 50℃
BD1 (Bridge Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 11 ℃/W T_c : 86℃	P_d : 0.51 W T_j = 91.6 ℃	**Derating Ratio = 61.1%**
Q1 (FET)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 5 ℃/W T_c : 94.3℃	P_d : 0.39 W T_j = 96 ℃	**Derating Ratio = 64.0%**
D4 (Rectifier Diode)	$T_{j(max)}$: 150 ℃ $R_{\Theta(J\text{-}C)}$: 3 ℃/W T_c : 109.6℃	P_d : 1.56 W T_j = 114 ℃	**Derating Ratio = 76.0%**

6. Abnormal Test

5.3	TABLE: Fault condition tests						P
	Ambient temperature (°C) ....:				20 – 25		—
	Power source for EUT: Manufacturer, model/type, output rating ....:				-		—
Component No.	Fault	Supply voltage (V)	Test time	Fuse #	Fuse current (A)	Observation	
1. D4	SC	264 Vac	10 min	F1	2.5	Immediately output IP, NC, NT, NCD, NH, NB. FI: 0.02 to 0.05 A	
2. C14	SC	264 Vac	10 min	F1	2.5	Immediately output IP, NC, NT, NCD, NH, NB. FI: 0.02 to 0.15 A	
3. PC1 (1, 2)	SC	264 Vac	10 min	F1	2.5	Immediately output IP, NC, NT, NCD, NH, NB. FI: 0.02 to 0.37 A	
4. PC1 (3, 4)	SC	264 Vac	10 min	F1	2.5	Immediately output IP, NC, NT, NCD, NH, NB. FI: 0.02 A	
5. BD1* (+, ~)	SC	264 Vac	1 s	F1	2.5	Immediately fuse(F1) opened, Q1, BD1, damaged, NC, NT, NB, NH FI: 0 A	
5-1. BD1* (+, ~)	SC	90 Vac	1 s	F1	2.5	Immediately fuse(F1) opened, Q1, BD1, damaged, NC, NT, NB, NH FI: 0 A	

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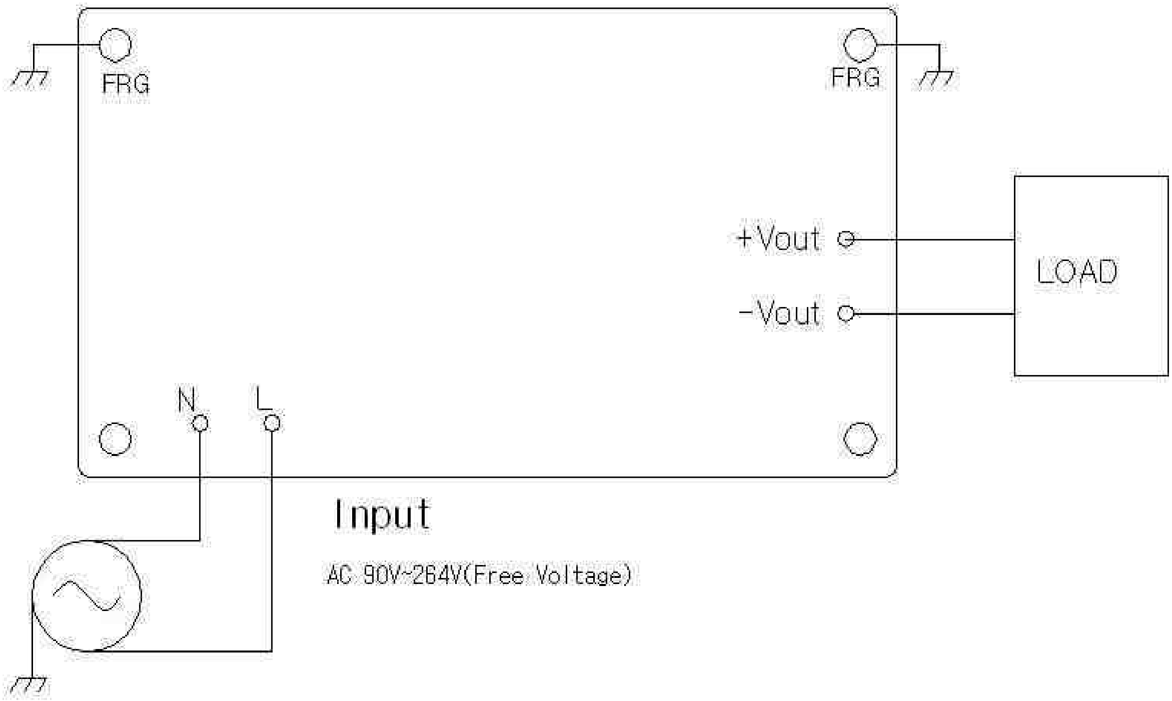
EN 60950-1							
Clause	Requirement + Test				Result - Remark		Verdict
6. C6*	SC	264 Vac	1 s	F1	2.5	Immediately fuse(F1) opened, Q1, BD1, damaged, NC, NT, NB, NH FI: 0 A	
6-1. C6*	SC	90 Vac	1 s	F1	2.5	Immediately fuse(F1) opened, Q1, BD1, damaged, NC, NT, NB, NH FI: 0 A	
7. Q2 (1, 2)	SC	264 Vac	10 min	F1	2.5	Immediately input current decrea sed, NC, NT, NCD, NH, NB. FI: 0.48 A	
8. Q3 (1, 3)	SC	264 Vac	10 min	F1	2.5	Normal operated, NC, NT, NCD, NH, NB. FI:0.51 A	
9. U1 (1, 8)	SC	264 Vac	10 min	F1	2.5	Immediately output IP, NC, NT, NCD, NH, NB. FI: 0.02 A	
10. U1 (2, 6)	SC	264 Vac	10 min	F1	2.5	Immediately output IP, NC, NT, NCD, NH, NB. FI: 0.02 A	
11. Q1 (1, 3)	SC	264 Vac	10 min	F1	2.5	Immediately output IP, NC, NT, NCD, NH, NB. FI: 0.02 A	
12. Q1* (1, 2)	SC	264 Vac	1 s	F1	2.5	Immediately fuse(F1) opened, R22, R23, Q1 damaged, NC, NT, NB, NH FI: 0 A	
12-1. Q1* (1, 2)	SC	90 Vac	1 s	F1	2.5	Immediately fuse(F1) opened, R22, R23, Q1 damaged, NC, NT, NB, NH FI: 0 A	
13. Q1* (2, 3)	SC	264 Vac	1 s	F1	2.5	Immediately fuse(F1) opened, R21, R22, R23, Q1 damaged, NC , NT, NB, NH. FI: 0 A	
13-1. Q1* (2, 3)	SC	90 Vac	1 s	F1	2.5	Immediately fuse(F1) opened, R21, R22, R23, Q1 damaged, NC , NT, NB, NH. FI: 0 A	
14. D1	SC	264 Vac	10 min	F1	2.5	Immediately output IP, NC, NT, NCD, NH, NB. FI: 0.02 to 0.15 A	
15. C14	SC	264 Vac	10 min	F1	2.5	Immediately output IP, NC, NT, NCD, NH, NB. FI: 0.02 to 0.15 A	

- Application Sheet

1. Basic Connection



※ For safety and improved noise, ensure secure connection of the FRG terminal to the ground terminal of the equiptment.
※ To avoid excessive voltage drop and improved noise, short and thick wire should be used to connect the load.

2. Input Section

Input Fuse
Generally, ac-dc converter(NOF Series) has internal fuse. Refer to Fuse Rating table.
Avoid using fast-blow fuse.

< Fuse Rating table > Type : SS-5C, Time-Delay

	NOF5,10	NOF20	NOF40	NOF60	NOF75	NOF100	OFS150
Fuse	1.0A	1.6A	2.0A	2.5A	3.15A	4.0A	5.0A

UL/CSA or IEC approved type should be used to meet safety requirements.

3. Output Section

Output Ripple and Noise Measurement Method

The measurement for output ripple and noise are based on normal probe with 20㎒ 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.

Regulation

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 output voltage are ±Vout 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 output voltage are ±Vout pins respectively.

Output Voltage adjustment

The output voltage can be varied within ±10% of the standard output voltage.(By the VR1)
When turn VR1 counterclockwise, the output voltage increase.
If the output voltage is increased excessively, the OVP(Over Voltage Protection) will trigger.

4. Protection

Over Voltage Protection

The NOF series is built into an OVP(Over Voltage Protection) circuit.
When the OVP triggers, the output voltage is clamped 70%~90% of output voltage.
The input must be taken out (for at least five seconds), and than reinputted manually.
Otherwise, the module will maintain the clamped voltage.

Over Current Protection

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

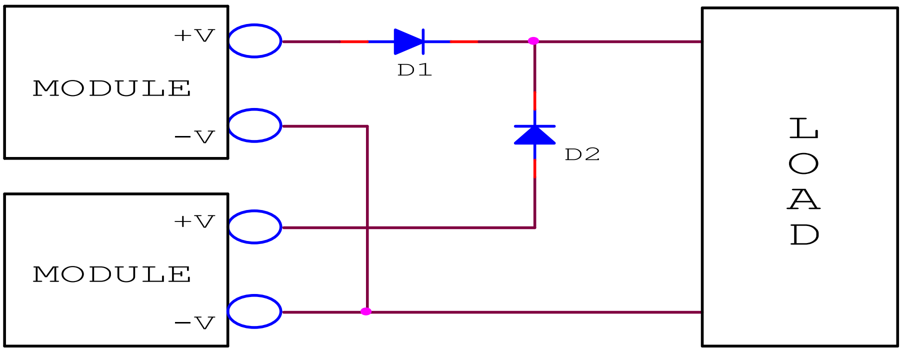
Short Circuit Protection

The NOF series is built into an short circuit protection circuit. It is similar to OCP circuit. When output is short condition, the output voltage will fall. If short condition is removed, the output will automatically recover. However, if the short condition continues damage to the module could occur.

5. Operation Method

Parallel Operation

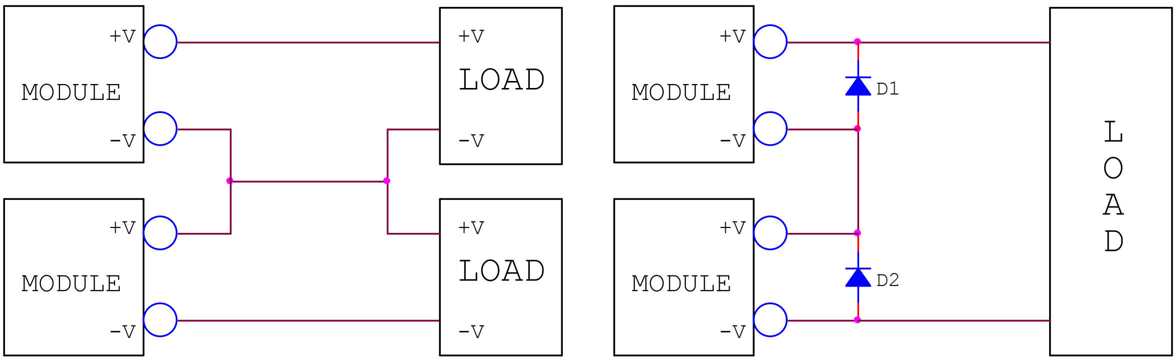
The module can be operated parallel connection. Refer to diagram as shown below.



Please, you must consider both revers voltage and forward current of diode, when you choose a diode.
Maximum reverse voltage(Vrm) ： Vrm > 1.5 X Vo
Forward current(If) ：If > 3 X Io
Also, design a heatsink according to power loss at diode. If you want to reduce power loss, use a schottky barrer diode.
Power loss = Vf(forward voltage) X Io(output current)

Series Operation

Series operation is available by connecting the outputs of two or more module as shown below.



< A. General Series Operation > < B. Complemental Series Operation >

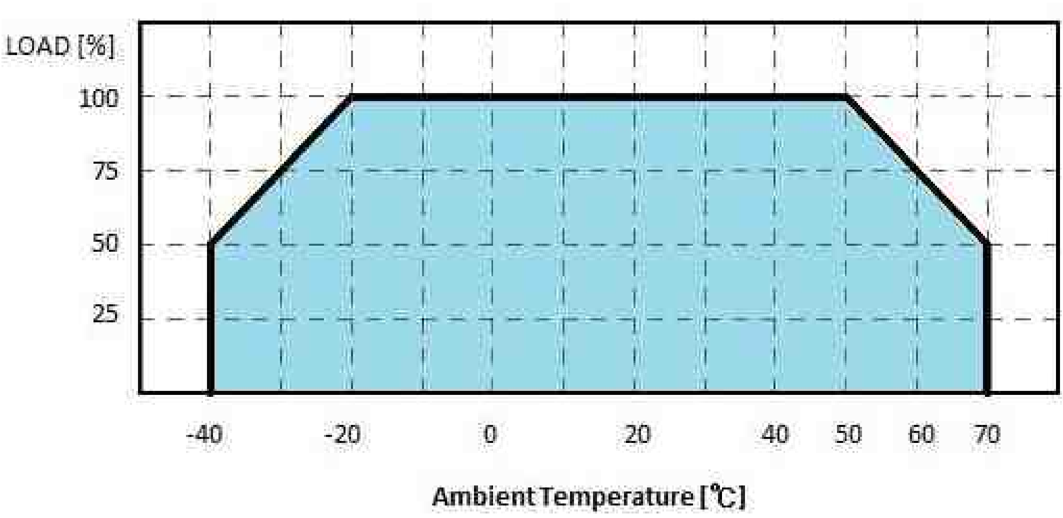
Please, you must consider both revers voltage and forward current of diode, when you choose a diode.
Maximum reverse voltage(Vrm) ： Vrm > 1.5 X Vo
Forward current(If) ：If > 3 X Io
Also, design a heatsink according to power loss at diode. If you want to reduce power loss, use a schottky barrer diode.
Power loss = Vf(forward voltage) X Io(output current)

6. Environment

Temperature

Operation Temperature

The range of ambient temperature in ℃ over which a module can be operated safely at either rated or derated output power. Refer to derating curve as shown below.



※ Operating Temperature Range : From -40℃ to 70℃

< Derating Curve>

Storage Temperature

The range of ambient temperature in ℃ over which a module may be stored long term without damage. The storage temperature range is from -40℃ to 85℃.

Humidity

Operation Humidity

The range of ambient humidity in % over which a module can be operated safely at either rated or derated output power. Refer to derating curve as shown below. The operating humidity range is from 20% to 90%RH.

Storage Humidity

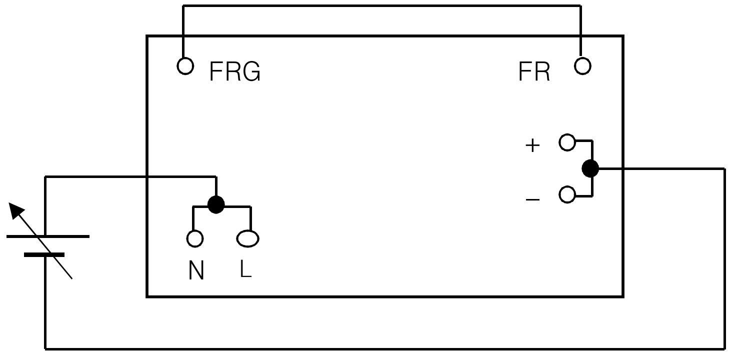
The range of ambient humidity in % over which a module may be stored long term without damage. The storage humidity range is from 20% to 90%RH.

7. Isolation

Isolation Resistance

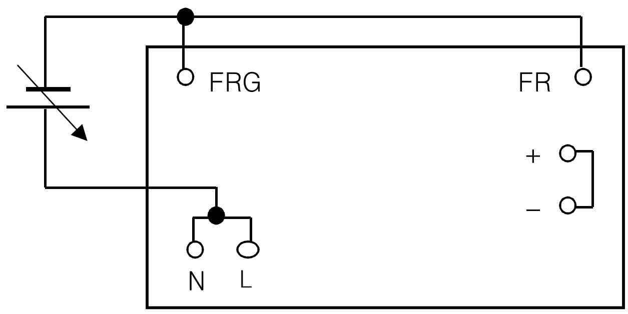
The electrical separation between input and output of a module by means of the power transformer. The isolation resistance is a function of materials and spacings employed throughout the module. Please don't test with a voltage above standard voltage for the Isolation Resistance Test.

< INPUT - OUTPUT>



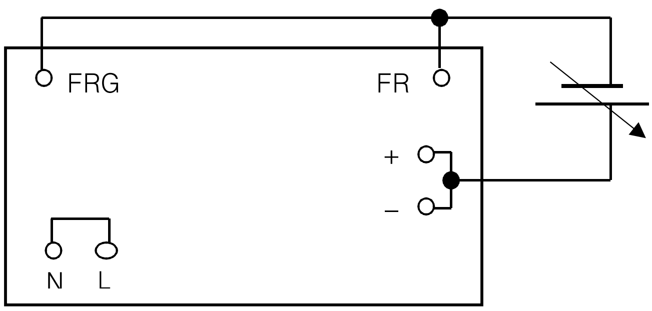
500VDC, 100MΩ

<INPUT - FRG>



500VDC, 100MΩ

< OUTPUT - FRG>

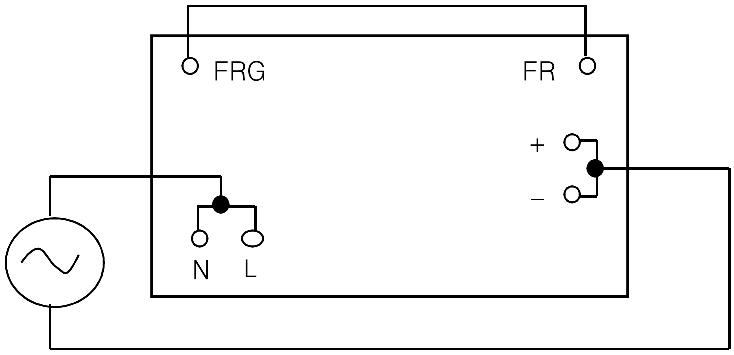


500VDC, 70MΩ

Withstand Voltage

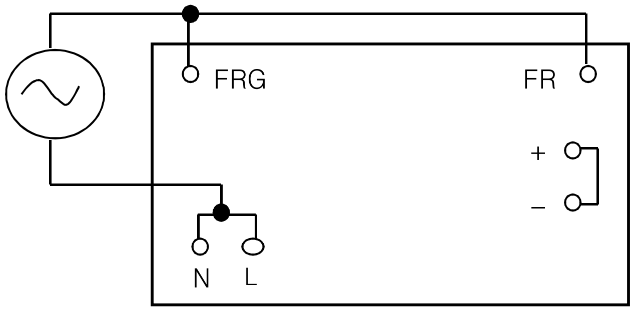
For the withstand voltage test, the applied voltage must be increased gradually from zero to the testing value, and then decreased gradually at shut down. Especially stay away from use of a timer. Where a pulse of several times the applied voltage can be generated.

< INPUT - OUTPUT>



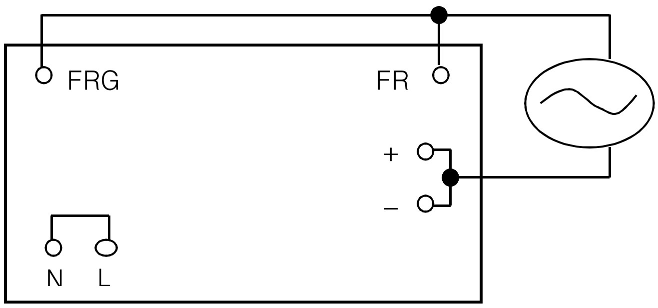
3kVAC (10mA) 1minute

<INPUT - FRG>



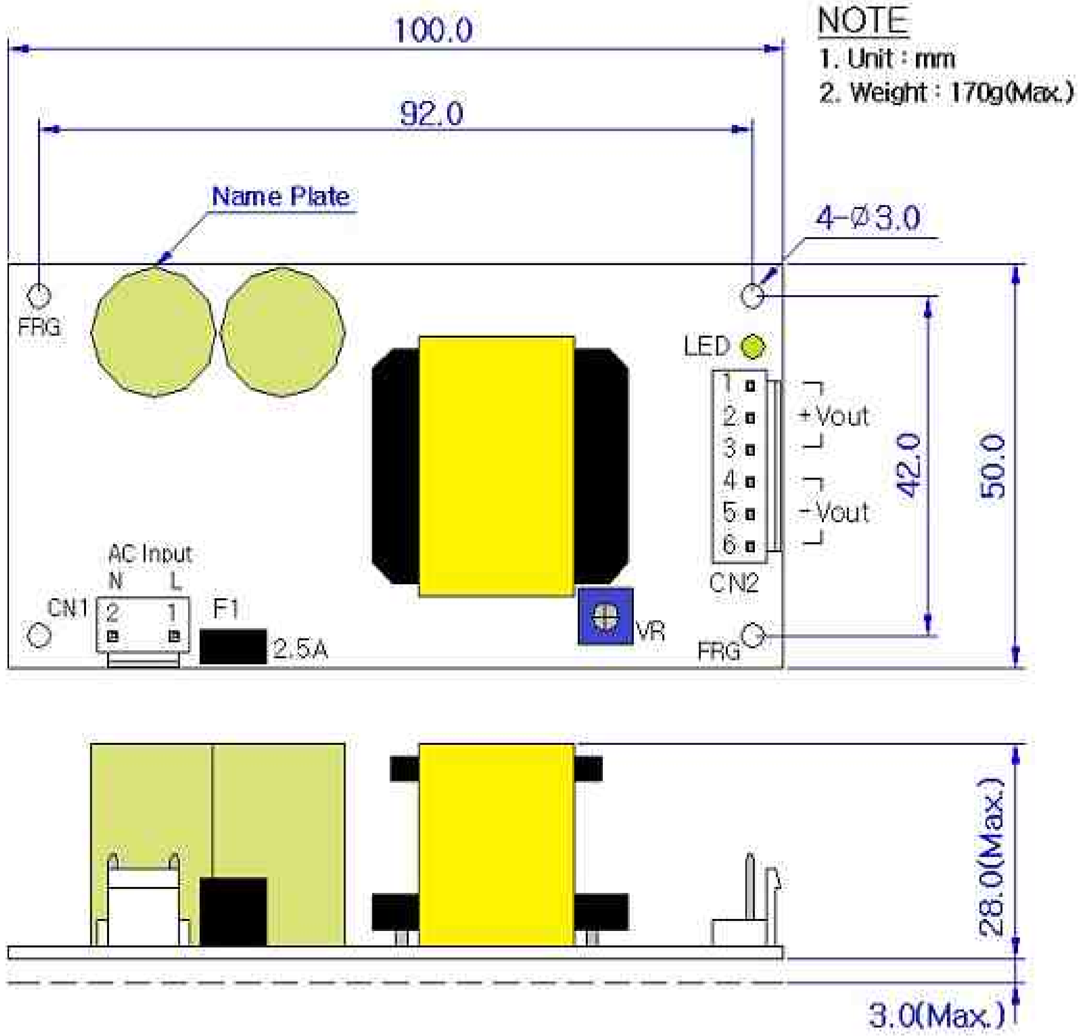
2kVAC (10mA) 1minute

< OUTPUT - FRG>



0.5kVAC (10mA) 1minute

8. Outline Dimensions (Unit : [mm])



Matching Crimp Housing & TerminalsPin assignments

	Crimp Housings	Terminals
CN1	Yeonho YH396-03V or equivalent	Yeonho YT396 or equivalent
CN2	Yeonho YH396-06V or equivalent	

Pin assignments

	Pin No.	Function
CN1	1	AC Input L
	2	AC input N
CN2	1, 2, 3	DC Output +V
	4, 5, 6	DC Output -V(GND)