RTW SERIES

Unit type power supply

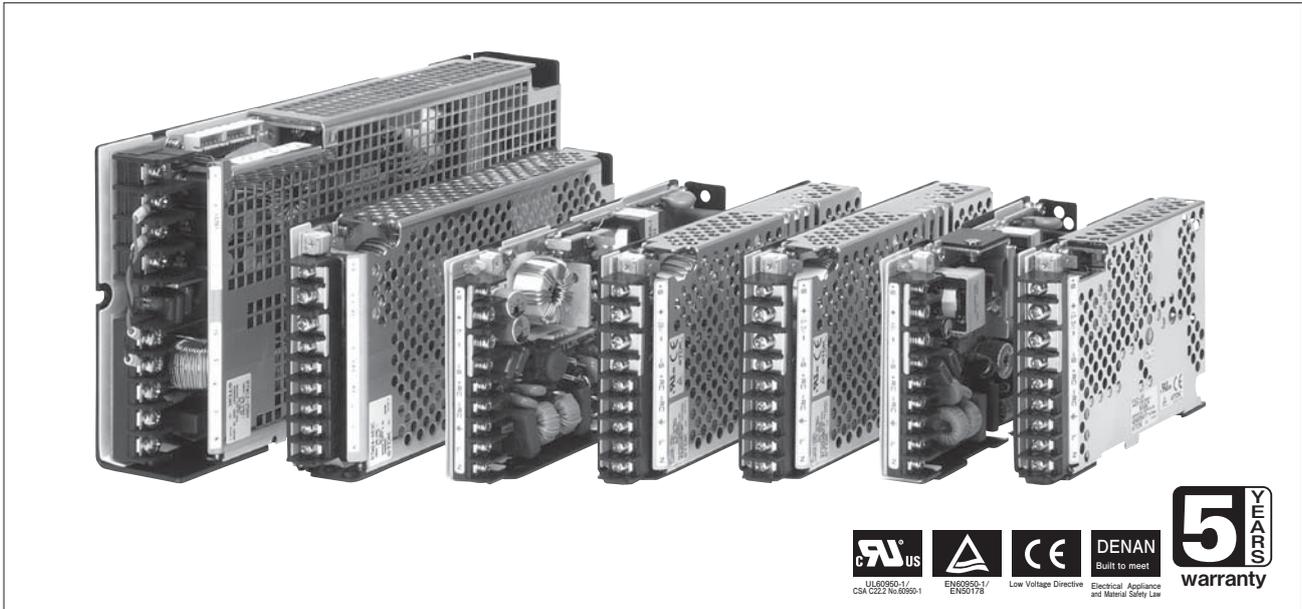UL60950-1/ CSA C22.2 No.60950-1 | EN60950-1/ EN50178 | CE Low Voltage Directive | DENAN Built to meet Electrical Appliance and Material Safety Law | 5 YEARS warranty
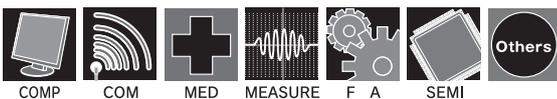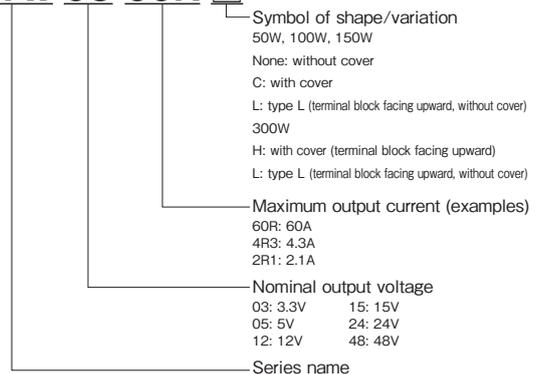
■ Features

● Worldwide-applicable input, super-slim type (1U/2U rack size)
● Meeting the standard of the harmonics current limiter EN61000-3-2
● Approved by safety standards (UL, C-UL, TÜV), complying with Electrical Appliance and Material Safety Law, CE marking applicable
● EMS standard complying with EN61000-4-2/3/4/5/6/8/11
● Complying with radiation noise and conduction noise regulations FCC-B and VCCI-B
● Remote On/Off function incorporated (use and nonuse can be switched by the internal switch)
● Electrolytic capacitor lifetime: 60,000H or over

■ Applications

COMP   COM   MED   MEASURE   F A   SEMI   Others

■ Model-naming method

RTW 05-60R □

Symbol of shape/variation
50W, 100W, 150W
None: without cover
C: with cover
L: type L (terminal block facing upward, without cover)
300W
H: with cover (terminal block facing upward)
L: type L (terminal block facing upward, without cover)

Maximum output current (examples)
60R: 60A
4R3: 4.3A
2R1: 2.1A

Nominal output voltage
03: 3.3V   15: 15V
05: 5V   24: 24V
12: 12V   48: 48V

Series name

■ Conformity to RoHS Directive

This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

■ Product Line up

	50W				100W		
Output voltage	Output current	Without cover	With cover	Type L	Output current	Without cover	With cover	Type L
3.3	12.5	RTW03-12R	RTW03-12RC	RTW03-12RL	25	RTW03-25R	RTW03-25RC	RTW03-25RL
5	10	RTW05-10R	RTW05-10RC	RTW05-10RL	20	RTW05-20R	RTW05-20RC	RTW05-20RL
12	4.3	RTW12-4R3	RTW12-4R3C	RTW12-4R3L	8.4	RTW12-8R4	RTW12-8R4C	RTW12-8R4L
15	3.5	RTW15-3R5	RTW15-3R5C	RTW15-3R5L	6.7	RTW15-6R7	RTW15-6R7C	RTW15-6R7L
24	2.2	RTW24-2R2	RTW24-2R2C	RTW24-2R2L	4.2	RTW24-4R2	RTW24-4R2C	RTW24-4R2L
28	1.8	RTW28-1R8	RTW28-1R8C	RTW28-1R8L	3.6	RTW28-3R6	RTW28-3R6C	RTW28-3R6L
48	1.1	RTW48-1R1	RTW48-1R1C	RTW48-1R1L	2.1	RTW48-2R1	RTW48-2R1C	RTW48-2R1L

	150W				300W		
Output voltage	Output current	Without cover	With cover	Type L**	Output current	With cover	Type L
3.3	35	RTW03-35R	RTW03-35RC	RTW03-35RL	70	RTW03-70RH	RTW03-70RL
5	30	RTW05-30R	RTW05-30RC	RTW05-30RL	60	RTW05-60RH	RTW05-60RL
12	12.5	RTW12-12R	RTW12-12RC	RTW12-12RL	25	RTW12-25RH	RTW12-25RL
15	10	RTW15-10R	RTW15-10RC	RTW15-10RL	20	RTW15-20RH	RTW15-20RL
24	6.3	RTW24-6R3	RTW24-6R3C	RTW24-6R3L	13	RTW24-13RH	RTW24-13RL
28	5.4	RTW28-5R4	RTW28-5R4C	RTW28-5R4L	11	RTW28-11RH	RTW28-11RL
48	3.2	RTW48-3R2	RTW48-3R2C	RTW48-3R2L	6.5	RTW48-6R5H	RTW48-6R5L

* Contact us separately for coating variations.   ** Planning to get approval of safety standards

· All specifications are subject to change without notice.

RTW50W Specifications

ITEMS/UNITS		MODEL		RTW03-12R	RTW05-10R	RTW12-4R3	RTW15-3R5	RTW24-2R2	RTW28-1R8	RTW48-1R1
Input	Voltage Range (Nominal: 100-240VAC)	V		AC85-265						
	Frequency (Nominal: 50-60 single phase)	Hz		47-66						
	Power Factor (100/240VAC)(typ)			0.99/0.94						
	Efficiency (100VAC)(typ)	%		75	80	81	82			
	Efficiency (200VAC)(typ)	%		77	82	83	85			
	Current (100-120/200-240VAC) (max)	A		0.7/0.4 (3.3V: 0.6/0.3)						
	Inrush Current (100/200VAC)(typ) (*1)	A		14/28						
	Leakage Current (100/240VAC) (max)	mA		0.45/0.6						
Output	Nominal Voltage	VDC		3.3	5	12	15	24	28	48
	Maximum Current (*2)	A		12.5	10	4.3	3.5	2.2	1.8	1.1
	Maximum Power	W		41.2	50	51.6	52.5	52.8	50.4	52.8
	Maximum Line Regulation (Within input voltage range) (max/typ)			0.2%/0.1%						
	Maximum Load Regulation (0-100% load) (max/typ)			0.4%/0.2%						
	Temperature Coefficient (Ambient temperature -10℃ to +71℃) (max/typ)	%		1.0/0.5						
	Warm Up Drift (max/typ) (*3)	%		0.5/0.2						
	Max Power Total Regulation (max/typ)	%		± 1.8/ ± 0.9						
	Maximum Ripple Voltage (max) (*4)	mVp-p		80		100		150		200
	Maximum Ripple & Noise (max) (*4)	mVp-p		120		150		200		300
	Start Up Time (100/240VAC)(typ) (*5)	ms		400/200						
	Hold-up Time (100/240VAC)(typ)	ms		55	30				35	30
	Voltage Adjustable Range	VDC		2.6-4.0	4.0-5.8	9.6-13.2	12.0-16.5	19.2-26.4	22.4-30.8	38.4-52.8
Function	Over Current Protection (*6)	A		13.2-15.6	10.5-12.5	4.5-5.4	3.68-4.38	2.3-2.75	1.9-2.25	1.15-1.38
	Over Voltage Protection (*7)	VDC		4.2-5.2	6.0-6.9	13.7-15.7	17.0-19.0	27.0-30.5	32.0-35.0	55.0-60.0
	Over Temperature Protection			Not available						
	Remote Sensing			Available						
	Remote ON/OFF Control (*8)			Available						
	Parallel Operation			Not available						
	Series Operation			Applicable						
	Operation Indicator			Available (green LED)						
	Variable Output Voltage			Not available						
	Monitoring Signal			Not available						
Environment	Operating Temperature	℃		-10 to +71						
	Storage Temperature	℃		-30 to +75						
	Operating Humidity	% RH		10-95 (the conditions of maximum 35℃ in wet bulb temperature and non-condensation should be ensured.)						
	Storage Humidity	% RH		10-95 (the conditions of maximum 35℃ in wet bulb temperature and non-condensation should be ensured.)						
	Vibration			5-10Hz, 10 minutes sweep, 10mmp-p total amplitude, 3 directions, 1h for each, in non-operation 10-200Hz, 10 minutes sweep, 19.6m/s² (2G) acceleration, 3 directions, 1h for each, in non-operation						
	Shock			Mounting A: 196m/s² (20G), Mounting B/C: 588m/s² (60G), 11 ± 5ms, 3 directions, 3 times for each, in non-operation						
Isolation	Withstand Voltage			For 1 minute at ordinary temperature and humidity Between input terminal and ground terminal: 2.0kVAC, 10mA cutout current Between input terminal and output terminal: 3.0kVAC, 10mA cutout current Between output terminal and ground terminal: 500VAC, 20mA cutout current						
	Isolation Resistance			In 500VDC and 100MΩ or over at ordinary temperature and humidity Between input terminal and ground terminal, between input terminal and output terminal, and between output terminal and ground terminal						
Standards	Safety Standards			Approved by UL60950-1, CSA C22.2 No.60950-1 (C-UL), EN60950-1 (TÜV), complying with Electrical Appliance and Material Safety Law (meeting the regulations of creepage surface and spacial distance in item 8 of the appendix table)						
	PFHC			Complying with EN61000-3-2						
	EMI			Complying with FCC-Class B / VCCI-Class B / EN55011-B / EN55022-B						
	Immunity			Complying with EN61000-4-2 Level2, 3, -3 Level3, -4 Level3, -5 Level3, 4, -6 Level3, -8 Level4, -11						
Mechanical	Weight without cover / with cover / type L (max)	g		250/290/250						
	Size (W x H x D) without cover / with cover / type L	mm		22 x 82 x 124/22 x 82 x 124/22 x 82 x 134.5						
Models of different	Detailed product name1 with cover			RTW03-12RC	RTW05-10RC	RTW12-4R3C	RTW15-3R5C	RTW24-2R2C	RTW28-1R8C	RTW48-1R1C
	Detailed product name2 type L			RTW03-12RL	RTW05-10RL	RTW12-4R3L	RTW15-3R5L	RTW24-2R2L	RTW28-1R8L	RTW48-1R1L

With nominal input/output voltage, maximum output current, and Ta=25°C, if not specified separately.
(*1) In primary surge current, 25°C, and cold starting.
(*2) The maximum output current value is between -10°C and +40°C. For use in outside this temperature range, derating is needed.
(*3) 30min to 8h after the start of input voltage application.
(*4) 1.5 times the value in 100MHz and at between -10°C and 0°C.
(*5) In cold starting at between -20°C and 0°C, lowering of output voltage can occur. It may take 3 seconds or so until the voltage becomes stable.
(*6) Fixed current reduction system and automatically resumes when the causes are removed.
(*7) Output voltage shutdown system and resumes by restarting input (approximately 30s interval).
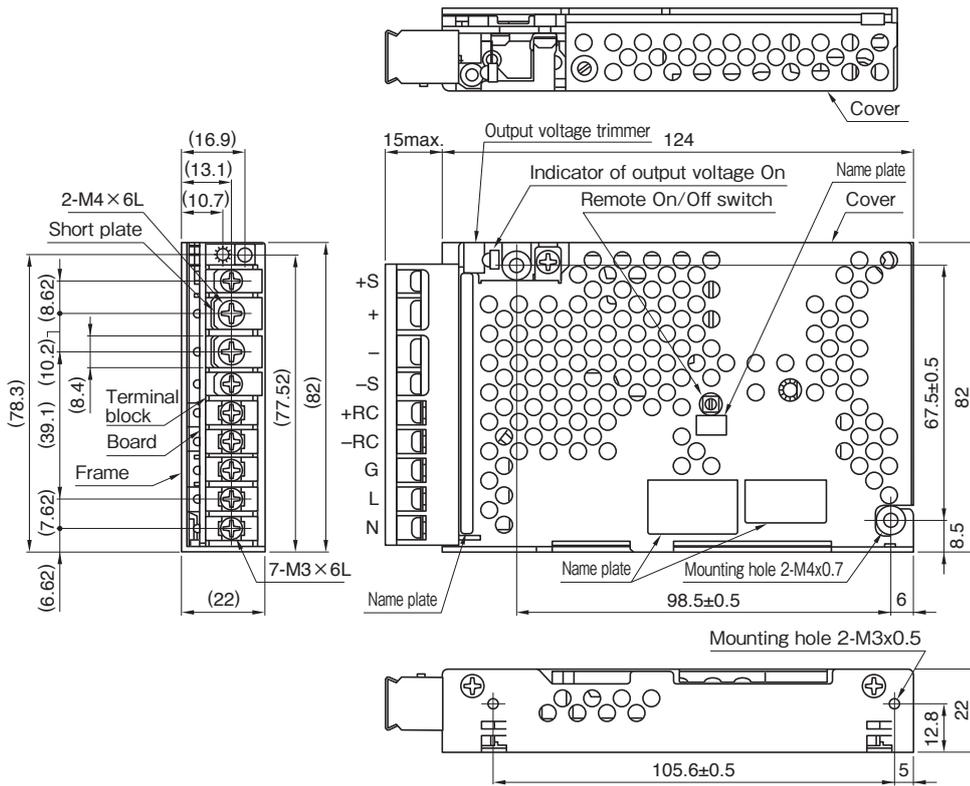(*8) Use and nonuse can be switched by the internal switch.
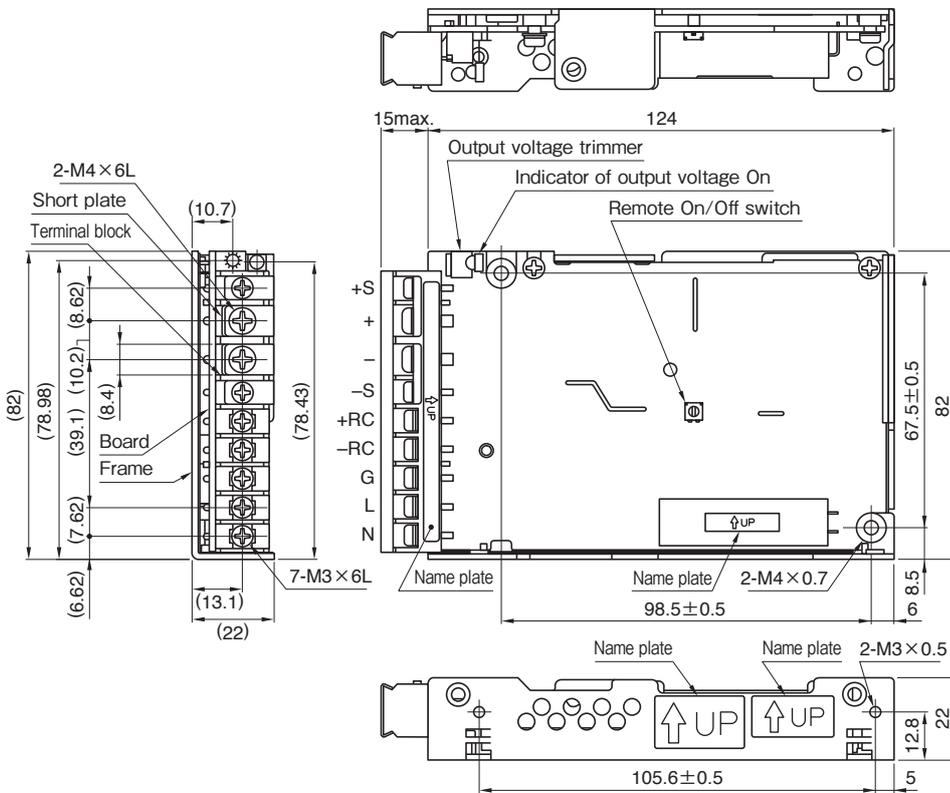
● Recommended EMC Filter

RSEL-2003W
Please refer to "TDK-Lambda EMC Filters" catalog.

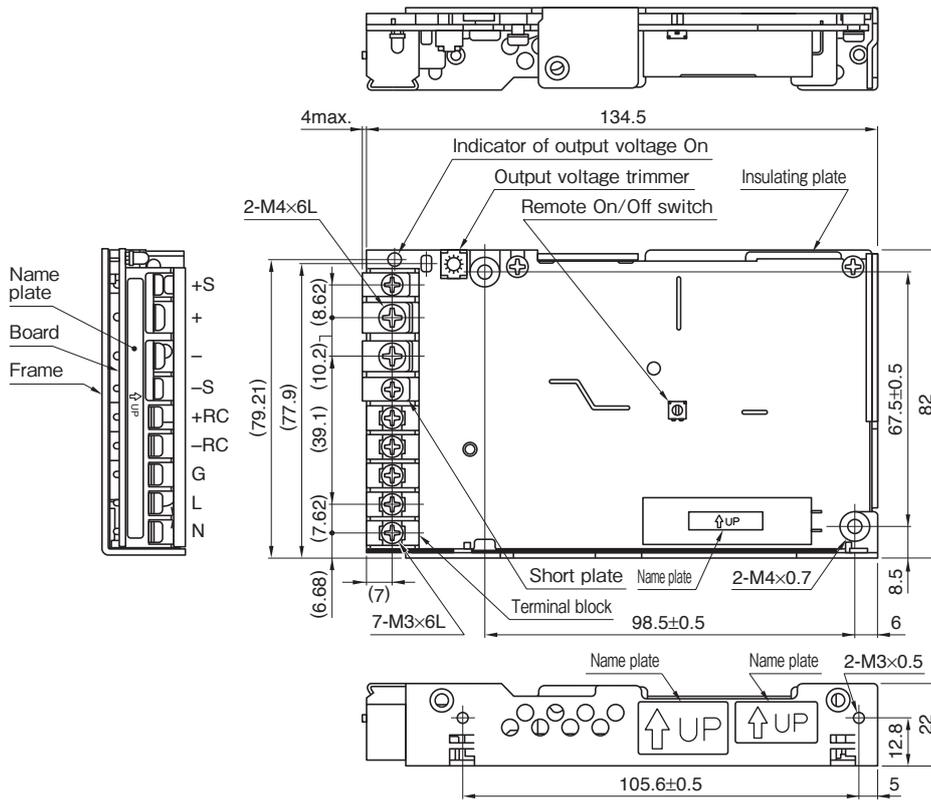· All specifications are subject to change without notice.

Outline Drawing

Type with cover

(16.9)
(13.1)
(10.7)
2-M4×6L
Short plate
(78.3)
(39.1)
(10.2)
(8.62)
(8.4)
Terminal block
Board
Frame
(7.62)
(6.62)
(77.52)
(82)
7-M3×6L
(22)

15max.
Output voltage trimmer
124
Indicator of output voltage On
Remote On/Off switch
Name plate
Cover
Cover

+S
+
−
−S
+RC
−RC
G
L
N

67.5±0.5
82
8.5

Name plate
Mounting hole 2-M4x0.7
98.5±0.5
6

Name plate

Mounting hole 2-M3x0.5
12.8
22
105.6±0.5
5

Type without cover

2-M4×6L
Short plate
Terminal block
(10.7)
(82)
(78.98)
(39.1)
(10.2)
(8.62)
(8.4)
Board
Frame
(7.62)
(6.62)
(78.43)
7-M3×6L
(13.1)
(22)

15max.
124
Output voltage trimmer
Indicator of output voltage On
Remote On/Off switch

+S
+
−
−S
+RC
−RC
G
L
N

UP

67.5±0.5
82

Name plate
Name plate
2-M4×0.7
98.5±0.5
8.5
6

Name plate
Name plate
2-M3×0.5
UP
UP
12.8
22
105.6±0.5
5

Unit: mm
Allowable tolerance is ±1mm if not specified separately.
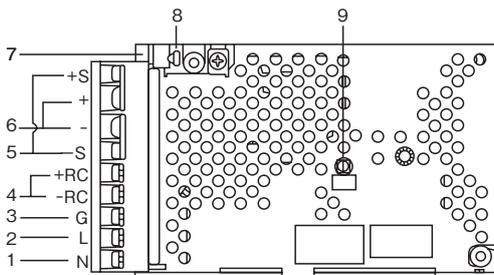
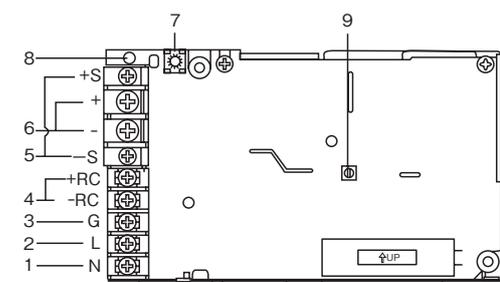* The insertion length of screws used for mounting the power supply should be within 6mm from the product surface.

· All specifications are subject to change without notice.

Type L (terminal block facing upward, without cover)

4max.   134.5

Indicator of output voltage On
Output voltage trimmer
Remote On/Off switch
Insulating plate

2-M4×6L

Name plate
Board
Frame

+S
+
−
−S
+RC
−RC
G
L
N

(79.21)
(77.9)
(39.1) (10.2) (8.62)
(7.62)
(6.68)
(7)

67.5±0.5
82

Short plate
Name plate
Terminal block
Name plate
2-M4×0.7
8.5

98.5±0.5
6

7-M3×6L

Name plate   Name plate   2-M3×0.5

⬆UP   ⬆UP

12.8
22

105.6±0.5
5

Unit: mm

* The insertion length of screws used for mounting the power supply should be within 6mm from the product surface.

Allowable tolerance is ±1mm if not specified separately.

Terminals

Type with cover/without cover

8   9

7
+S
6 +
5 −
−S
4 +RC
−RC
3 G
2 L
1 N

Type L

7   9

8
+S
6 +
5 −
−S
4 +RC
−RC
3 G
2 L
1 N

⬆UP

Terminal No.	Name and function	
1	AC input terminal (N)	Connects to AC.100-120V or AC.200-240V input line.
2	AC input terminal (L)	Connects to AC.100-120V or AC.200-240V input line.
3	Ground terminal (G)	Connects to the ground line. This is connected to the case.
4	Remote On/Off terminal (+RC, -RC)	By inputting external signals between terminals, the output voltage can be switched on and off from outside the power supply. Output is not generated if voltage is not applied to RC terminal. The RC terminal is floated.
5	Remote sensing terminal (+S, -S)	Used to compensate for a voltage drop to load. The line between the remote sensing terminal and DC output terminal is short-circuited with a short piece.
6	DC output terminal (+, -)	Connects to the load line.
7	Output voltage trimmer (V.ADJ)	Output voltage can be varied. Voltage increases by turning the trimmer in a clockwise direction.
8	LED output indicator (green)	The LED is lit green when output voltage is generated.
9	Switch for use/nonuse of Remote On/Off function	Remote On/Off function is activated by setting the switch for use/nonuse of Remote On/Off function, located in the center of the power supply, to Y (turning in a clockwise direction).

RTW 100W

TDK·Lambda

RTW100W Specifications

ITEMS/UNITS		MODEL	RTW03-25R	RTW05-20R	RTW12-8R4	RTW15-6R7	RTW24-4R2	RTW28-3R6	RTW48-2R1
Input	Voltage Range (Nominal: 100-240VAC)	V	AC85-265 (90% load derating in 90VAC or lower)						
	Frequency (Nominal: 50-60 single phase)	Hz	47-66						
	Power Factor (100/240VAC)(typ)		0.99/0.93						
	Efficiency (100VAC)(typ)	%	79	83	84	85			
	Efficiency (200VAC)(typ)	%	81	85	86	87			88
	Current (100-120/200-240VAC) (max)	A	1.5/0.75 (3.3V: 1.2/0.6)						
	Inrush Current (100/200VAC)(typ) (*1)	A	14/28						
	Leakage Current (100/240VAC) (max)	mA	0.45/0.6 (100VAC (Electrical Appliance and Material Safety Law) / 240VAC (UL, IEC))						
Output	Nominal Voltage	VDC	3.3	5	12	15	24	28	48
	Maximum Current (*2)	A	25	20	8.4	6.7	4.2	3.6	2.1
	Maximum Power	W	82.5	100	100.8	100.5	100.8		
	Maximum Line Regulation (Within input voltage range) (max/typ)		0.2%/0.1% (3.3V: 10mV/5mV)						
	Maximum Load Regulation (0-100% load) (max/typ)		0.4%/0.2% (3.3V: 20mV/10mV)						
	Temperature Coefficient (Ambient temperature -10℃ to +71℃) (max/typ)	%	1.0/0.5						
	Warm Up Drift (max/typ) (*3)	%	0.5/0.2						
	Max Power Total Regulation (max/typ)	%	± 1.8/ ± 0.9						
	Maximum Ripple Voltage (max) (*4)	mVp-p	80		100		150		200
	Maximum Ripple & Noise (max) (*4)	mVp-p	120		150		200		300
	Start Up Time (100/240VAC)(typ) (*5)	ms	400/200						
	Hold-up Time (100/240VAC)(typ)	ms	35						
Function	Voltage Adjustable Range	VDC	2.6-4.0	4.0-5.8	9.6-13.2	12.0-16.5	19.2-26.4	22.4-30.8	38.4-52.8
	Over Current Protection (*6)	A	26.2-33.7	21-25	8.82-10.5	7.03-9.04	4.41-5.25	3.78-4.86	2.2-2.62
	Over Voltage Protection (*7)	VDC	4.2-5.2	6.0-6.9	13.7-15.7	17.0-19.0	27.0-30.5	32.0-35.0	55.0-60.0
	Over Temperature Protection		Not available						
	Remote Sensing		Available						
	Remote ON/OFF Control (*8)		Available						
	Parallel Operation		Not available						
	Series Operation		Applicable						
	Operation Indicator		Available (green LED)						
	Variable Output Voltage		Not available						
	Monitoring Signal		Not available						
Environment	Operating Temperature	℃	-10 to +71						
	Storage Temperature	℃	-30 to +75						
	Operating Humidity	% RH	10-95 (the conditions of maximum 35℃ in wet bulb temperature and non-condensation should be ensured.)						
	Storage Humidity	% RH	10-95 (the conditions of maximum 35℃ in wet bulb temperature and non-condensation should be ensured.)						
	Vibration		5-10Hz, 10 minutes sweep, 10mmp-p total amplitude, 3 directions, 1h for each, in non-operation 10-200Hz, 10 minutes sweep, 19.6m/s² (2G) acceleration, 3 directions, 1h for each, in non-operation						
	Shock		Mounting A: 196m/s² (20G), Mounting B/C: 588m/s² (60G), 11 ± 5ms, 3 directions, 3 times for each, in non-operation						
Isolation	Withstand Voltage		For 1 minute at ordinary temperature and humidity Between input terminal and ground terminal: 2.0kVAC, 10mA cutout current Between input terminal and output terminal: 3.0kVAC, 10mA cutout current Between output terminal and ground terminal: 500VAC, 20mA cutout current						
	Isolation Resistance		In 500VDC and 100MΩ or over at ordinary temperature and humidity Between input terminal and ground terminal, between input terminal and output terminal, and between output terminal and ground terminal						
Standards	Safety Standards		Approved by UL60950-1, CSA C22.2 No.60950-1 (C-UL), EN60950-1 (TÜV), complying with Electrical Appliance and Material Safety Law (meeting the regulations of creepage surface and spacial distance in item 8 of the appendix table)						
	PFHC		Complying with EN61000-3-2						
	EMI		Complying with FCC-Class B / VCCI-Class B / EN55011-B / EN55022-B						
	Immunity		Complying with EN61000-4-2 Level2, 3, -3 Level3, -4 Level3, -5 Level3, 4, -6 Level3, -8 Level4, -11						
Mechanical	Weight without cover / with cover / type L (max)	g	380/450/380						
	Size (W x H x D) without cover / with cover / type L	mm	25 x 82 x 160/25 x 82 x 160/25 x 82 x 171.5						
Models of different	Detailed product name1 with cover		RTW03-25RC	RTW05-20RC	RTW12-8R4C	RTW15-6R7C	RTW24-4R2C	RTW28-3R6C	RTW48-2R1C
	Detailed product name2 type L		RTW03-25RL	RTW05-20RL	RTW12-8R4L	RTW15-6R7L	RTW24-4R2L	RTW28-3R6L	RTW48-2R1L

With nominal input/output voltage, maximum output current, and Ta=25°C, if not specified separately.

(*1) In primary surge current, 25°C, and cold starting.
(*2) The maximum output current value is between -10°C and +40°C. For use in outside this temperature range, Derating is needed.
(*3) 30min to 8h after the start of input voltage application.
(*4) 1.5 times the value in 100MHz and at between -10°C and 0°C.
(*5) In cold starting at between -20°C and 0°C, lowering of output voltage can occur. It may take 3 seconds or so until the voltage becomes stable.
(*6) Intermittent operation system and automatically resumes when the causes are removed.
(*7) Output voltage shutdown system and resumes by restarting input (approximately 30s interval).
(*8) Use and nonuse can be switched by the internal switch.
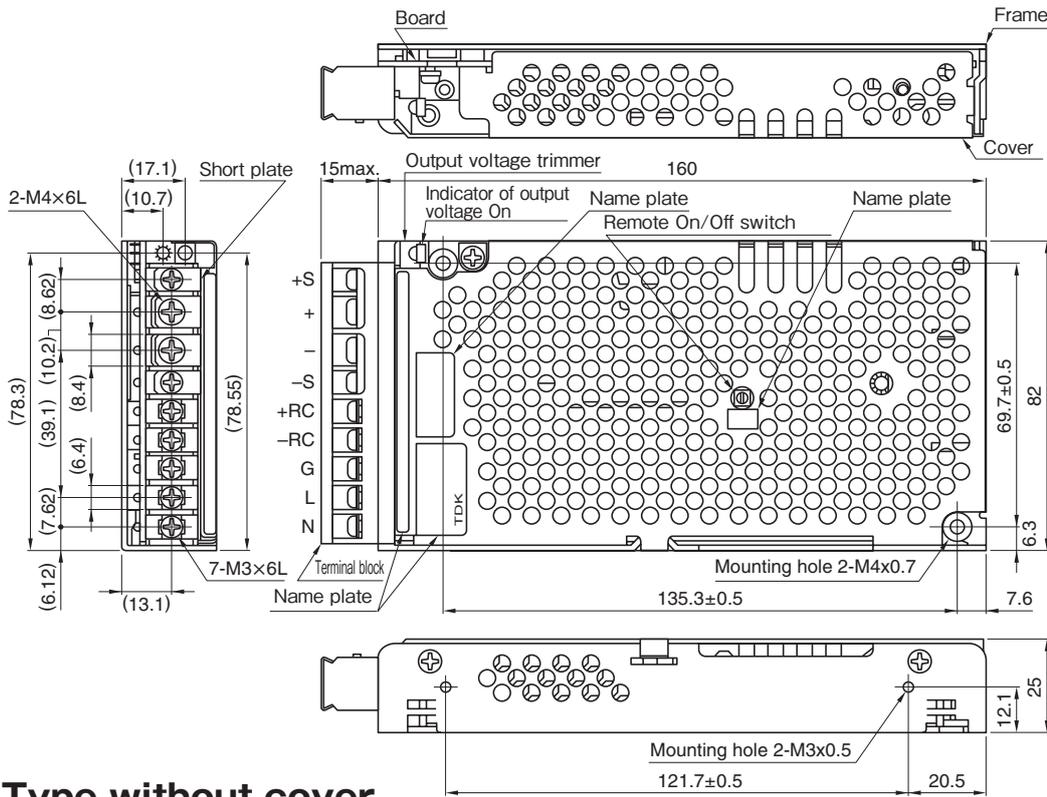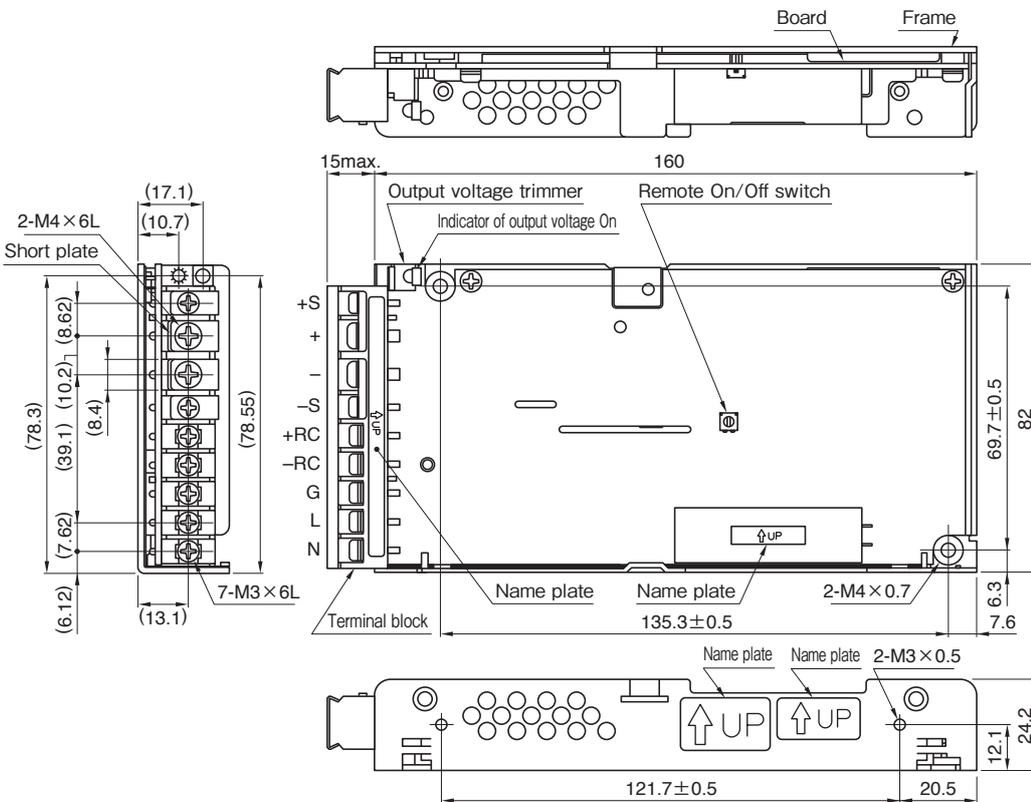
●Recommended EMC Filter

RSEL-2002W
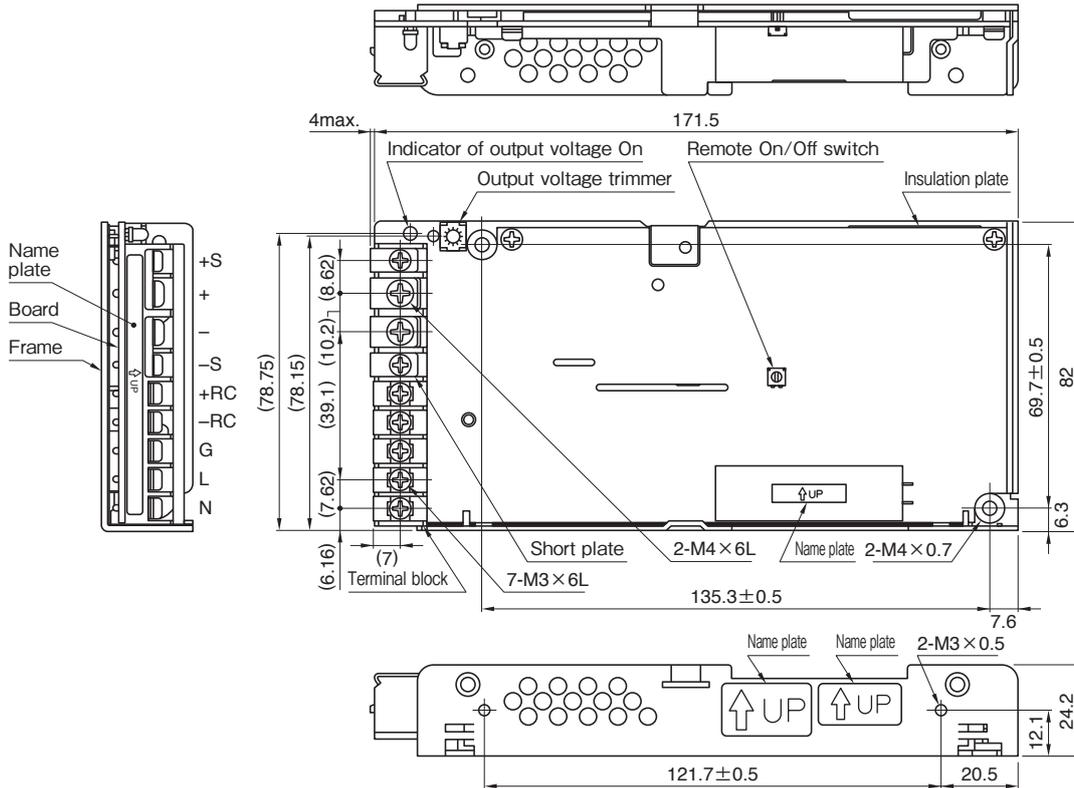Please refer to "TDK-Lambda EMC Filters" catalog.

· All specifications are subject to change without notice.

RTW 100W

TDK·Lambda

Outline Drawing

Type with cover

Board

Frame

Output voltage trimmer

160

Indicator of output voltage On

Name plate

Name plate

Remote On/Off switch

2-M4×6L

(17.1)

(10.7)

Short plate

15max.

+S
+
−
−S
+RC
−RC
G
L
N

(78.3)

(39.1)

(10.2)

(8.62)

(8.4)

(6.4)

(7.62)

(78.55)

(6.12)

(13.1)

7-M3×6L

Terminal block

Name plate

TDK

69.7±0.5

82

6.3

Mounting hole 2-M4x0.7

135.3±0.5

7.6

25

12.1

Mounting hole 2-M3x0.5

121.7±0.5

20.5

Cover

Type without cover

Board

Frame

15max.

160

Output voltage trimmer

Remote On/Off switch

Indicator of output voltage On

2-M4×6L

(17.1)

(10.7)

Short plate

+S
+
−
−S
+RC
−RC
G
L
N

(78.3)

(39.1)

(10.2)

(8.62)

(8.4)

(7.62)

(78.55)

(6.12)

(13.1)

7-M3×6L

Terminal block

UP

69.7±0.5

82

Name plate

Name plate

2-M4×0.7

135.3±0.5

6.3

7.6

UP

Name plate

Name plate

2-M3×0.5

UP

UP

24.2

12.1

121.7±0.5

20.5

Unit: mm

Allowable tolerance is ±1mm if not specified separately.

* The insertion length of screws used for mounting the power supply should be within 6mm from the product surface.

Type L (terminal block facing upward, without cover)

4max.

171.5

Indicator of output voltage On   Remote On/Off switch   Insulation plate

Output voltage trimmer

Name plate
Board
Frame

+S
+
−
−S
+RC
−RC
G
L
N

(78.75)
(78.15)
(8.62)
(10.2)
(39.1)
(7.62)
(6.16)
(7)

Terminal block

Short plate

7-M3×6L

2-M4×6L   Name plate   2-M4×0.7

69.7±0.5   82

6.3

135.3±0.5

7.6

Name plate   Name plate   2-M3×0.5

↑UP   ↑UP

24.2
12.1

121.7±0.5   20.5

Unit: mm

* The insertion length of screws used for mounting the power supply should be within 6mm from the product surface.

Allowable tolerance is ±1mm if not specified separately.

Terminals

Type with cover/without cover

Type L

Terminal No.	Name and function	
1	AC input terminal (N)	Connects to AC.100-120V or AC.200-240V input line.
2	AC input terminal (L)	Connects to AC.100-120V or AC.200-240V input line.
3	Ground terminal (G)	Connects to the ground line. This is connected to the case.
4	Remote On/Off terminal (+RC, -RC)	By inputting external signals between terminals, the output voltage can be switched on and off from outside the power supply. Output is not generated if voltage is not applied to RC terminal. The RC terminal is floated.
5	Remote sensing terminal (+S, -S)	Used to compensate for a voltage drop to load. The line between the remote sensing terminal and DC output terminal is short-circuited with a short piece.
6	DC output terminal (+, -)	Connects to the load line.
7	Output voltage trimmer (V.ADJ)	Output voltage can be varied. Voltage increases by turning the trimmer in a clockwise direction.
8	LED output indicator (green)	The LED is lit green when output voltage is generated.
9	Switch for use/nonuse of Remote On/Off function	Remote On/Off function is activated by setting the switch for use/nonuse of Remote On/Off function, located in the center of the power supply, to Y (turning in a clockwise deirection).

RTW 150W

TDK·Lambda

RTW150W Specifications

ITEMS/UNITS		MODEL		RTW03-35R	RTW05-30R	RTW12-12R	RTW15-10R	RTW24-6R3	RTW28-5R4	RTW48-3R2
Input	Voltage Range (Nominal: 100-240VAC)	V		AC85-265						
	Frequency (Nominal: 50-60 single phase)	Hz		47-66						
	Power Factor (100/240VAC)(typ)			0.99/0.96						
	Efficiency (100VAC)(typ)	%		80	83	84		86		
	Efficiency (200VAC)(typ)	%		83	86	87		88		89
	Current (100-120/200-240VAC) (max)	A		1.9/1.0 (3.3V: 1.6/0.85)						
	Inrush Current (100/200VAC)(typ) (*1)	A		14/28						
	Leakage Current (100/240VAC) (max)	mA		0.45/0.65						
Output	Nominal Voltage	VDC		3.3	5	12	15	24	28	48
	Maximum Current (*2)	A		35	30	12.5	10	6.3 (peak 10)	5.4	3.2
	Maximum Power	W		115.5		150		151.2		153.6
	Maximum Line Regulation (Within input voltage range) (max/typ)			0.2%/0.1%						
	Maximum Load Regulation (0-100% load) (max/typ)			0.4%/0.2%						
	Temperature Coefficient (Ambient temperature -10℃ to +71℃) (max/typ)	%		1.0/0.5						
	Warm Up Drift (max/typ) (*3)	%		0.5/0.2						
	Max Power Total Regulation (max/typ)	%		± 1.8/ ± 0.9						
	Maximum Ripple Voltage (max) (*4)	mVp-p		80		100		150		200
	Maximum Ripple & Noise (max) (*4)	mVp-p		120		150		200		300
	Start Up Time (100/240VAC)(typ) (*5)	ms		220/120						
	Hold-up Time (100/240VAC)(typ)	ms		50/55	35/40					
	Voltage Adjustable Range	VDC		2.85-4.0	4.0-5.8	9.6-13.2	12.0-16.5	19.2-26.4	22.4-30.8	38.4-52.8
Function	Over Current Protection (*6)	A		38.5-45.5	33-39	13.7-16.3	11-13	10.5-13.5	5.94-7.02	3.52-4.16
	Over Voltage Protection (*7)	VDC		4.2-5.2	6.0-6.9	13.7-15.7	17.0-19.0	27.0-30.5	32.0-35.0	55.0-60.0
	Over Temperature Protection			Not available						
	Remote Sensing			Available						
	Remote ON/OFF Control (*8)			Available						
	Parallel Operation			Not available						
	Series Operation			Applicable						
	Operation Indicator			Available (green LED)						
	Variable Output Voltage			Not available						
	Monitoring Signal			Not available						
Environment	Operating Temperature	℃		-10 to +71						
	Storage Temperature	℃		-30 to +75						
	Operating Humidity	% RH		10-95 (the conditions of maximum 35℃ in wet bulb temperature and non-condensation should be ensured.)						
	Storage Humidity	% RH		10-95 (the conditions of maximum 35℃ in wet bulb temperature and non-condensation should be ensured.)						
	Vibration			5-10Hz, 10 minutes sweep, 10mmp-p total amplitude, 3 directions, 1h for each, in non-operation 10-200Hz, 10 minutes sweep, 19.6m/s² (2G) acceleration, 3 directions, 1h for each, in non-operation						
	Shock			588m/s² (60G), 11 ± 5ms, 3 directions, 3 times for each, in non-operation						
Isolation	Withstand Voltage			For 1 minute at ordinary temperature and humidity Between input terminal and ground terminal: 2.0kVAC, 10mA cutout current Between input terminal and output terminal: 3.0kVAC, 10mA cutout current Between output terminal and ground terminal: 500VAC, 20mA cutout current						
	Isolation Resistance			In 500VDC and 100MΩ or over at ordinary temperature and humidity Between input terminal and ground terminal, between input terminal and output terminal, and between output terminal and ground terminal						
Standards	Safety Standards			Approved by UL60950-1, CSA C22.2 No.60950-1 (C-UL), EN60950-1 (TÜV), complying with Electrical Appliance and Material Safety Law (meeting the regulations of creepage surface and spacial distance in item 8 of the appendix table)						
	PFHC			Complying with EN61000-3-2						
	EMI			Complying with FCC-Class B / VCCI-Class B / EN55011-B / EN55022-B						
	Immunity			Complying with EN61000-4-2 Level2, 3, -3 Level3, -4 Level3, -5 Level3, 4, -6 Level3, -8 Level4, -11						
Mechanical	Weight without cover / with cover / type L (max)	g		520/600/520						
	Size (W x H x D) without cover / with cover / type L	mm		30 x 92 x 180/30 x 92 x 180/30 x 92 x 191.5						
Models of different	Detailed product name1 with cover			RTW03-35RC	RTW05-30RC	RTW12-12RC	RTW15-10RC	RTW24-6R3C	RTW28-5R4C	RTW48-3R2C
	Detailed product name2 type L			RTW03-35RL	RTW05-30RL	RTW12-12RL	RTW15-10RL	RTW24-6R3L	RTW28-5R4L	RTW48-3R2L

With nominal input/output voltage, maximum output current, and Ta=25℃, if not specified separately.
(*1) In primary surge current, 25℃, and cold starting.
(*2) The maximum output current value is between -10℃ and +30℃. For use in outside this temperature range, Derating is needed.
(*3) 30min to 8h after the start of input voltage application.
(*4) 1.5 times the value in 100MHz and at between -10℃ and 0℃.
(*5) Fixed current reduction system and automatically resumes when the causes are removed.
(*6) Output voltage shutdown system and resumes by restarting input (approximately 30s interval).
(*7) Use and non-use can be switched by the internal switch.
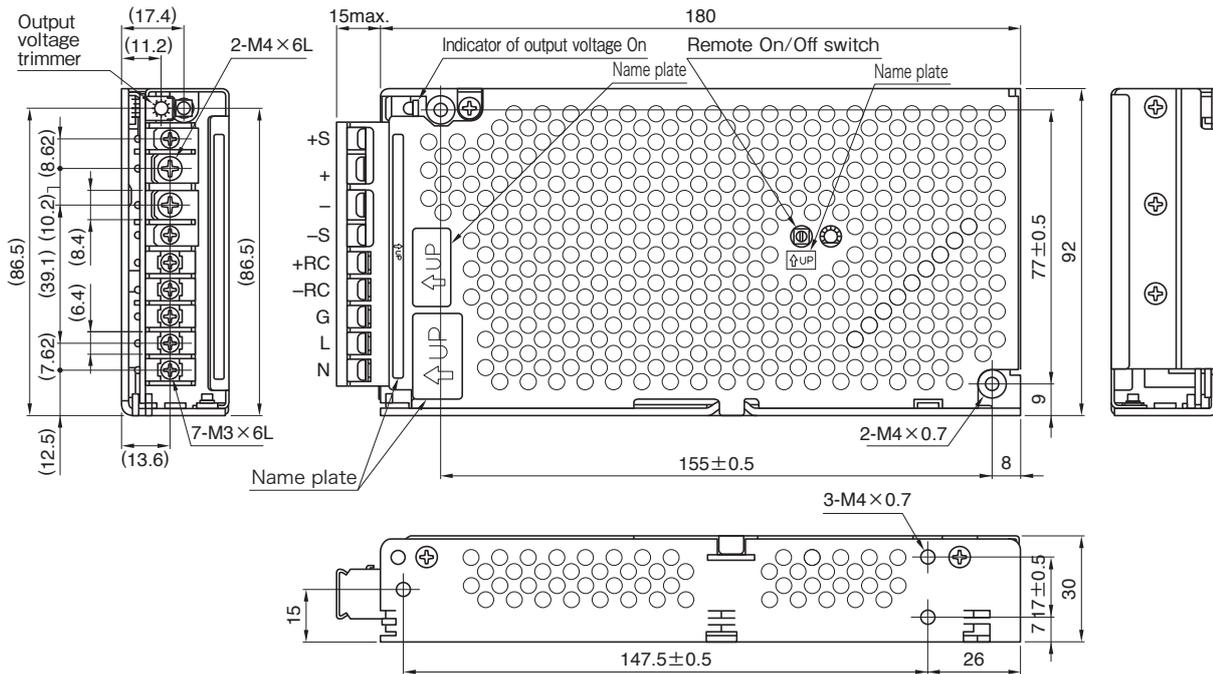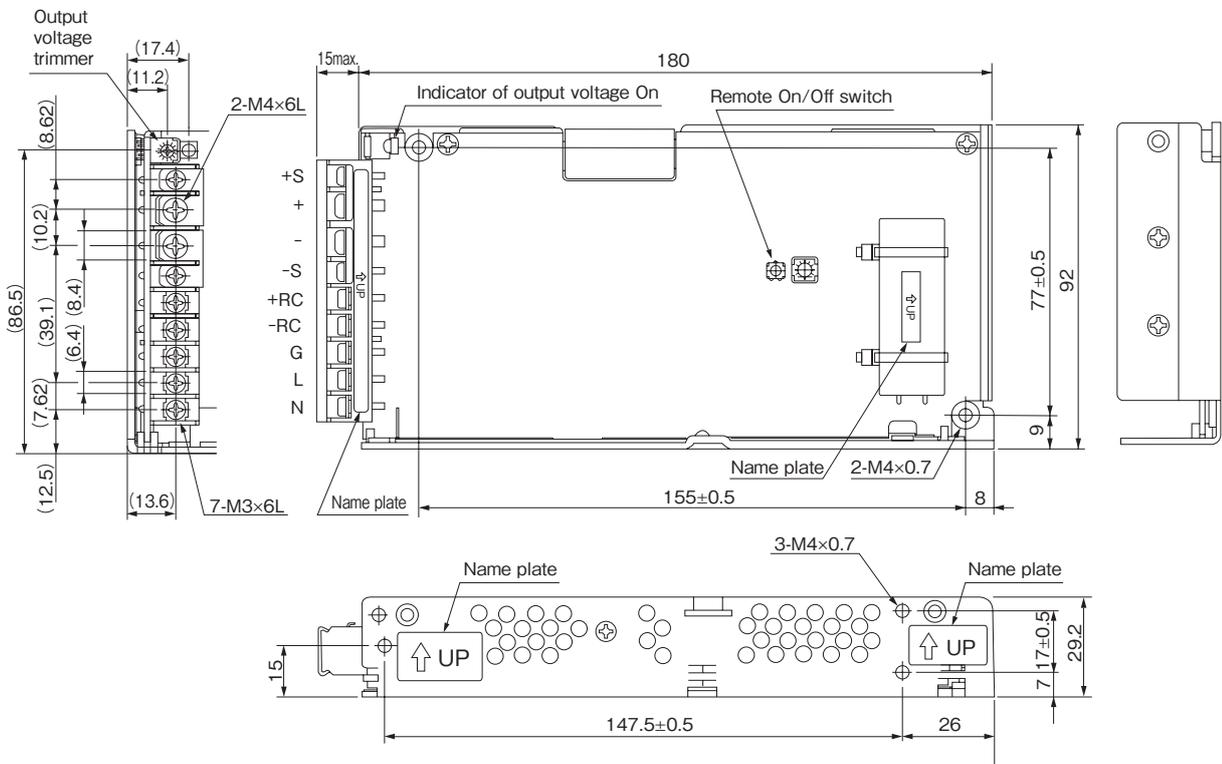
●Recommended EMC Filter

RSEL-2003W
Please refer to "TDK-Lambda EMC Filters" catalog.

・ All specifications are subject to change without notice.

RTW 150W

Outline Drawing

Type with cover

Type without cover

Unit: mm

Allowable tolerance is ±1mm if not specified separately.
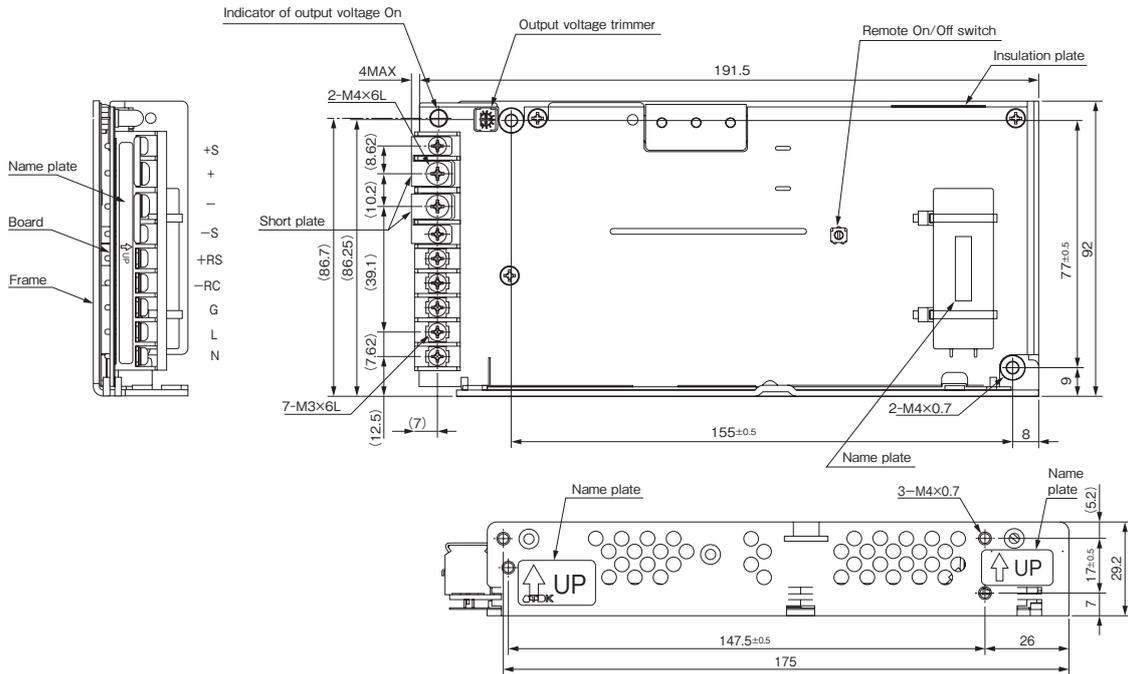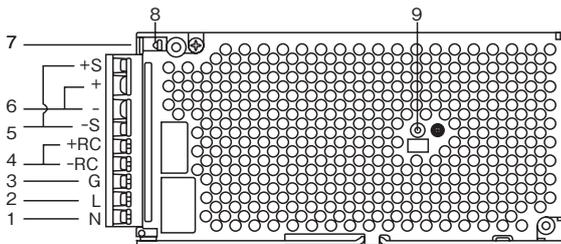
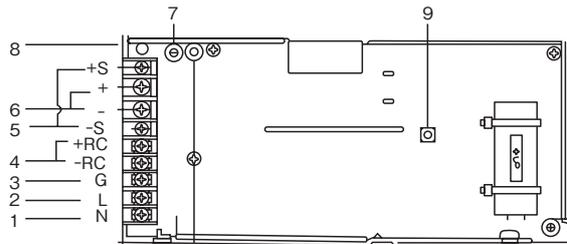* The insertion length of screws used for mounting the power supply should be within 6mm from the product surface.

· All specifications are subject to change without notice.

RTW 150W

TDK·Lambda

Outline Drawing

Type L (terminal block facing upward, without cover)

Unit: mm

* The insertion length of screws used for mounting the power supply should be within 6mm from the product surface.

Allowable tolerance is ±1mm if not specified separately.

Terminals

Type with cover/without cover

Type L

Terminal No.	Name and function	
1	AC input terminal (N)	Connects to AC.100-120V or AC.200-240V input line.
2	AC input terminal (L)	Connects to AC.100-120V or AC.200-240V input line.
3	Ground terminal (G)	Connects to the ground line. This is connected to the case.
4	Remote On/Off terminal (+RC, -RC)	By inputting external signals between terminals, the output voltage can be switched on and off from outside the power supply. Output is not generated if voltage is not applied to RC terminal. The RC terminal is floated.
5	Remote sensing terminal (+S, -S)	Used for compensating for voltage drop to load. The line between the remote sensing terminal and DC output terminal is short-circuited with a short piece.
6	DC output terminal (+, -)	Connects the load line.
7	Output voltage trimmer (V.ADJ)	Output voltage can be varied. Voltage increases by turning the trimmer in a clockwise direction.
8	LED output indicator (green)	The LED is lit green when output voltage is generated.
9	Switch for use/nonuse of Remote On/Off function	Remote On/Off function is activated by setting the switch for use/nonuse of Remote On/Off function, located in the center of the power supply, to Y (turning in a clockwise deirection).

· All specifications are subject to change without notice.

RTW 300W

TDK·Lambda

RTW300W Specifications

ITEMS/UNITS		MODEL		RTW03-70RH	RTW05-60RH	RTW12-25RH	RTW15-20RH	RTW24-13RH	RTW28-11RH	RTW48-6R5H
Input	Voltage Range (Nominal: 100-240VAC)	V					AC85 - 265			
	Frequency (Nominal: 50-60 single phase)	Hz					47 - 66			
	Power Factor (100/240VAC)(typ)						0.99/0.93			
	Efficiency (100VAC)(typ)	%		83	84	83		85		86
	Efficiency (200VAC)(typ)	%		86	87	86		88		89
	Current (100/200VAC) (max)	A					4.0/2.0(3.3V:3.6/1.8) max			
	Inrush Current (100/200VAC)(typ) (*1)	A					15/30			
	Leakage Current (100/240VAC) (max)	mA					0.5/0.7			
Output	Nominal Voltage	VDC		3.3	5	12	15	24	28	48
	Maximum Current (*2)	A		70	60	25	20	13（ピーク20）	11	6.5
	Maximum Power	W		231		300		312	308	312
	Maximum Line Regulation (Within input voltage range) (max/typ)						0.2%/0.1%			
	Maximum Load Regulation (0-100% load) (max/typ)						0.4%/0.2%			
	Temperature Coefficient (Ambient temperature -10℃ to +71℃) (max/typ)	%					1.0/0.5			
	Warm Up Drift (max/typ) (*3)	%					0.5/0.2			
	Max Power Total Regulation (max/typ)	%					± 1.8/ ± 0.9			
	Maximum Ripple Voltage (max) (*4)	mVp-p		80		100		150		200
	Maximum Ripple & Noise (max) (*4)	mVp-p		120		150		200		300
	Start Up Time (100/240VAC)(typ) (*5)	ms					220/120			
	Hold-up Time (100/240VAC)(typ)	ms		30/40	25/30	30/40	25/30	30/40		
	Voltage Adjustable Range	VDC		1.8 - 3.6	3.5 - 5.6	7.2 - 14.4	10.5 - 18.0	16.8 - 26.4	19.6 - 33.6	33.6 - 55.0
Function	Over Current Protection (*6)	A		73.5 - 84.0	63.0 - 72.0	26.3 - 30.0	21.0 - 24.0		11.5 - 13.2	6.8 - 7.8
	Over Voltage Protection (*7)	VDC		Vo+0.66 - 1.32	Vo+1.0 - 2.0	Vo+2.4 - 4.8	Vo+3.0 - 6.0	Vo+4.8 - 9.6	Vo+5.6 - 10.4	Vo+1.0 - 10
	Over Temperature Protection						Not available			
	Remote Sensing						Available			
	Remote ON/OFF Control (*8)						Available			
	Parallel Operation					Applicable (current balance function and master/slave operation are supported; synchronized operation is not supported)				
	Series Operation						Available (green LED)			
	Operation Indicator						Available			
	Variable Output Voltage						Available (power fail signal)			
	Low Output Voltage Dectation (*7)						Available			
Environment	Operating Temperature	℃					-10 to +71			
	Storage Temperature	℃					-30 to +75			
	Operating Humidity	% RH				10-95 (the conditions of maximum 35℃ in wet bulb temperature and non-condensation should be ensured.)				
	Storage Humidity	% RH				10-95 (the conditions of maximum 35℃ in wet bulb temperature and non-condensation should be ensured.)				
	Vibration					5-10Hz, 10 minutes sweep, 10mmp-p total amplitude, 3 directions, 1h for each, in non-operation 10-200Hz, 10 minutes sweep, 19.6m/s² (2G) acceleration, 3 directions, 1h for each, in non-operation				
	Shock					588m/s² (60G), 11 ± 5ms, 3 directions, 3 times for each, in non-operation				
Isolation	Withstand Voltage					For 1 minute at ordinary temperature and humidity Between input terminal and ground terminal: 2.0kVAC, 10mA cutout current Between input terminal and output terminal: 3.0kVAC, 10mA cutout current Between output terminal and ground terminal: 500VAC, 40mA cutout current				
	Isolation Resistance					In 500VDC and 100MΩ or over at ordinary temperature and humidity Between input terminal and ground terminal, between input terminal and output terminal, and between output terminal and ground terminal				
Standards	Safety Standards					Approved by UL60950-1, CSA C22.2 No.60950-1 (C-UL), EN60950-1 (TÜV), complying with Electrical Appliance and Material Safety Law (meeting the regulations of creepage surface and spacial distance in item 8 of the appendix table)				
	PFHC						Complying with EN61000-3-2			
	EMI					Complying with FCC-Class B / VCCI-Class B / EN55011-B / EN55022-B				
	Immunity					Complying with EN61000-4-2 Level2, 3, -3 Level3, -4 Level3, -5 Level3, 4, -6 Level3, -8 Level4, -11				
Mechanical	Weight without cover / with cover / type L (max)	g					1300/1200			
	Size (W x H x D) without cover / with cover / type L	mm					40 x 120 x 250/40 x 120 x 250			
Models of different	Detailed product name1 with cover			RTW03-70RL	RTW05-60RL	RTW12-25RL	RTW15-20RL	RTW24-13RL	RTW28-11RL	RTW48-6R5L

With nominal input/output voltage, maximum output current, and Ta=25°C, if not specified separately.

(*1) In primary surge current, 25°C, and cold starting.
(*2) The maximum output current value is between -10°C and +40°C. For use in outside this temperature range, Derating is needed.
(*3) 30min to 8h after the start of input voltage application.
(*4) 1.5 times the value in 100MHz and at between -10°C and 0°C.
(*5) Fixed current reduction system; current is shut down if overload condition continues 15 seconds or over. Restarting input
　　 Resumes after (approximately 30s interval) or resetting remote control. (Shutdown by low output voltage detection in 3/5/28V models)
(*6) The detection value tracks the set output voltage (Vo). Output voltage shutdown system,
　　 Resumes by restarting input (approximately 30s interval) or resetting remote control.
(*7) Output is shut down in the condition of 60% or lower of the nominal voltage for 3.3V and 5V models. For 28V models, Output
　　 is shut down in the when the nominal voltage is 20% or lower. Other models do not have this function.

・ All specifications are subject to change without notice.
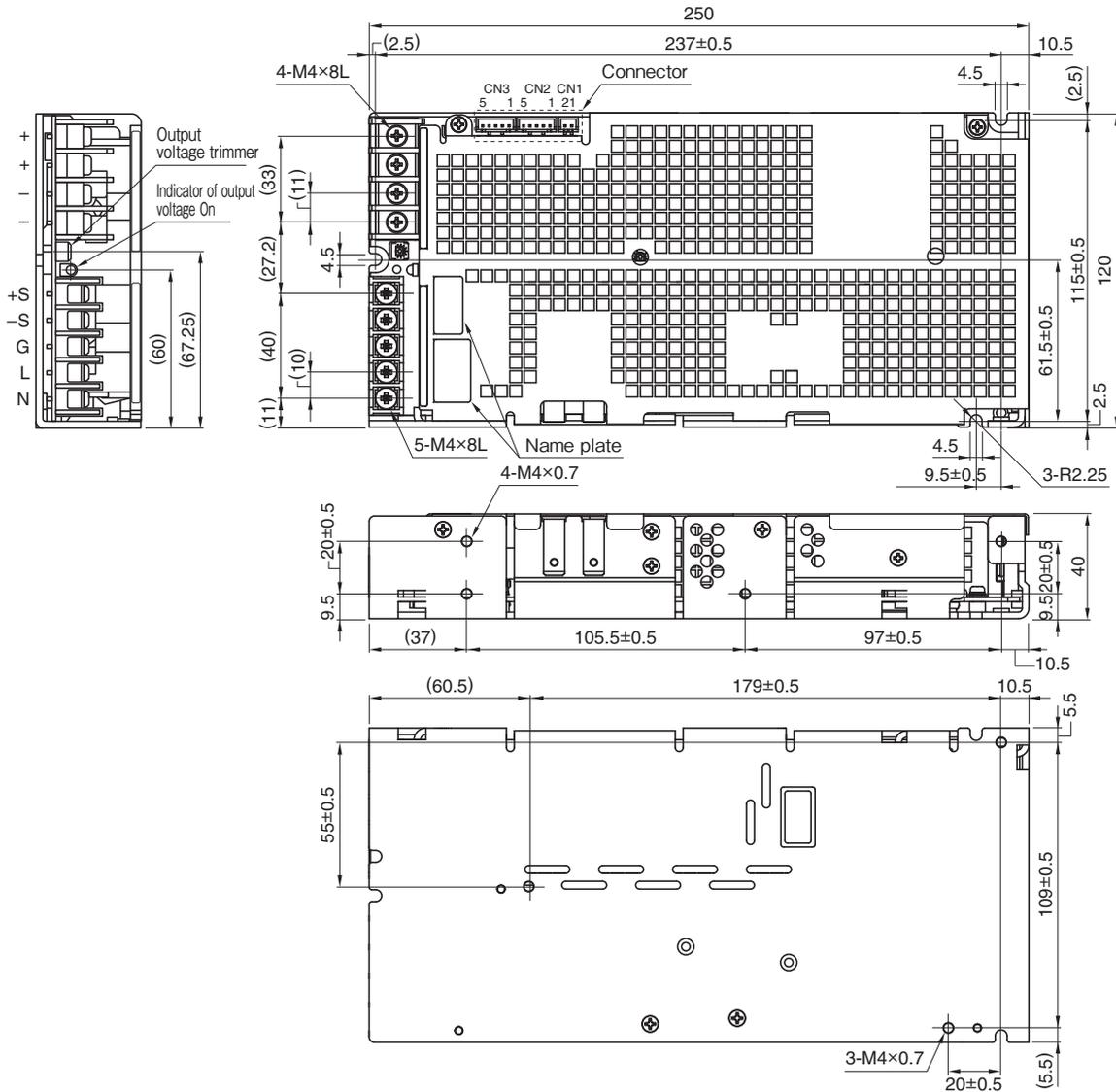
●Recommended EMC Filter

RSEN-2006W

Please refer to "TDK-Lambda
EMC Filters" catalog.

Outline Drawing

Type with cover

Output voltage trimmer
Indicator of output voltage On

Connector

4-M4×8L
5-M4×8L
Name plate
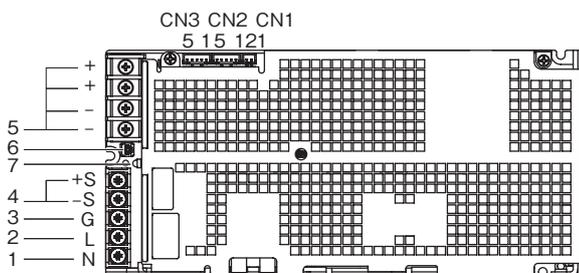4-M4×0.7
3-R2.25
3-M4×0.7

Unit: mm

* The insertion length of screws used for mounting the power supply should be within 6mm from the product surface.

Allowable tolerance is ±1mm if not specified separately.
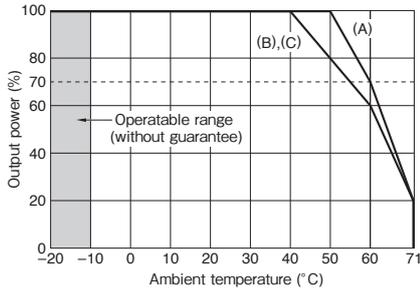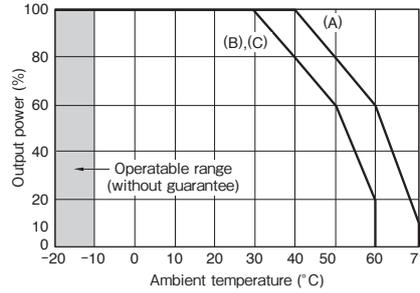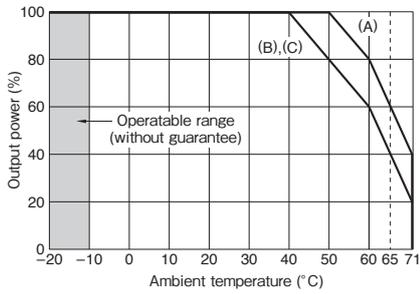
Terminals

Type with cover/Type L

	CN1		CN2		CN3
1	−PF	1	−RC	1	−RC
2	+PF	2	+RC	2	+RC
		3	CB	3	CB
		4	RV	4	RV
		5	−S	5	−S

Terminal No.	Name and function
1	AC input terminal (N)
2	AC input terminal (L)
3	Ground terminal (G)
4	Remote sensing terminal (+S, -S)
5	DC output terminal (+, -)
6	Output voltage trimmer (V.ADJ)
7	LED output indicator (green)

· All specifications are subject to change without notice.

Outline Drawing

Type L (terminal block facing upward, without cover)
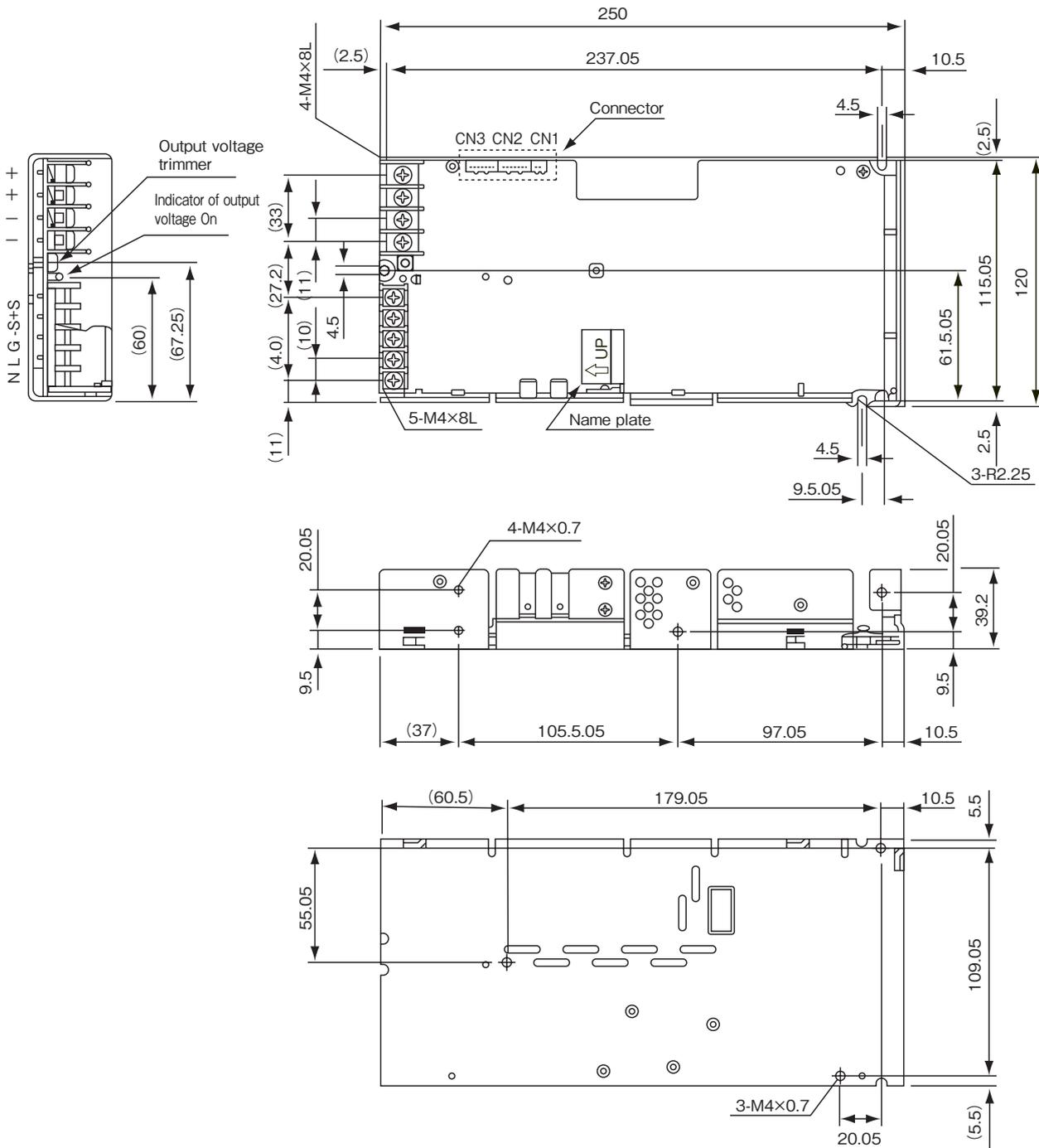
* The insertion length of screws used for mounting the power supply should be within 6mm from the product surface.

Allowable tolerance is ±1mm if not specified separately.

Unit: mm

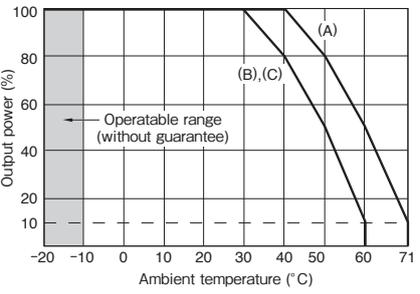# Derating Curve

50W

Type without cover/Type L

Output power (%) vs Ambient temperature (°C)
(B),(C) (A)
Operatable range (without guarantee)

Type with cover

Output power (%) vs Ambient temperature (°C)
(B),(C) (A)
Operatable range (without guarantee)

100W

Type without cover/Type L

Output power (%) vs Ambient temperature (°C)
(B),(C) (A)
Operatable range (without guarantee)

Type with cover

Output power (%) vs Ambient temperature (°C)
(A)
(B),(C)
Operatable range (without guarantee)

Input voltage derating (for type with cover)
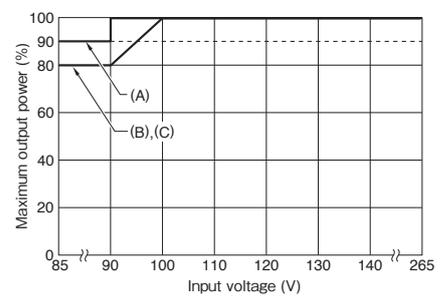
Maximum output power (%) vs Input voltage (V)
(A)
(B),(C)

150W

Type without cover/Type L

Output power (%) vs Ambient temperature (°C)
(A)
(B),(C)
Operatable range (without guarantee)

Type with cover

Output power (%) vs Ambient temperature (°C)
(B),(C) (A)
Operatable range (without guarantee)

300W

Type L

Output power (%) vs Ambient temperature (°C)
(A)
(B),(C)
Operatable range (without guarantee)

Type with cover

Output power (%) vs Ambient temperature (°C)
(A)
(B),(C)
Operatable range (without guarantee)

Input voltage derating

Output power (%) vs Input voltage (V)
(B),(C)
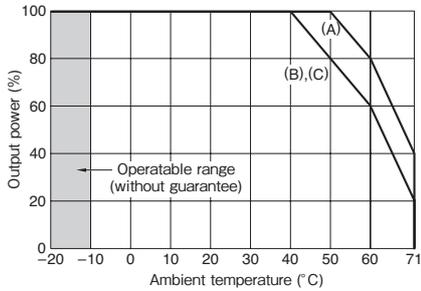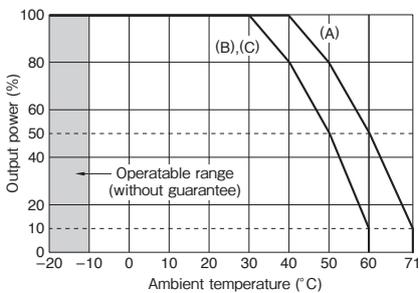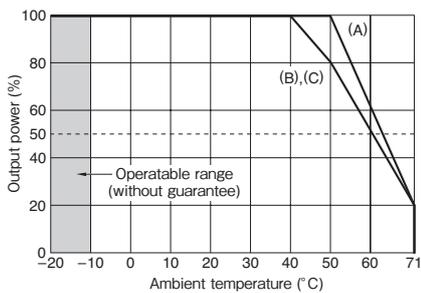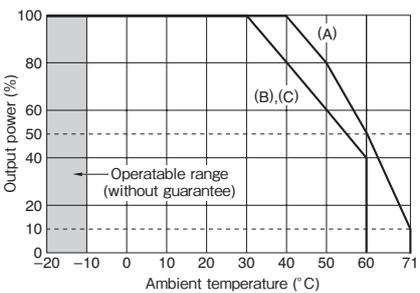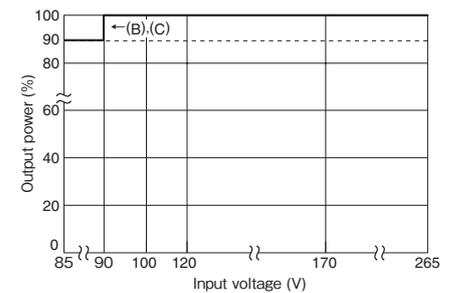
*Refer to the item regarding mounting in the handling instructions for (A), (B), and (C).

· All specifications are subject to change without notice.

RTW

Block Diagram

RTW50-150W
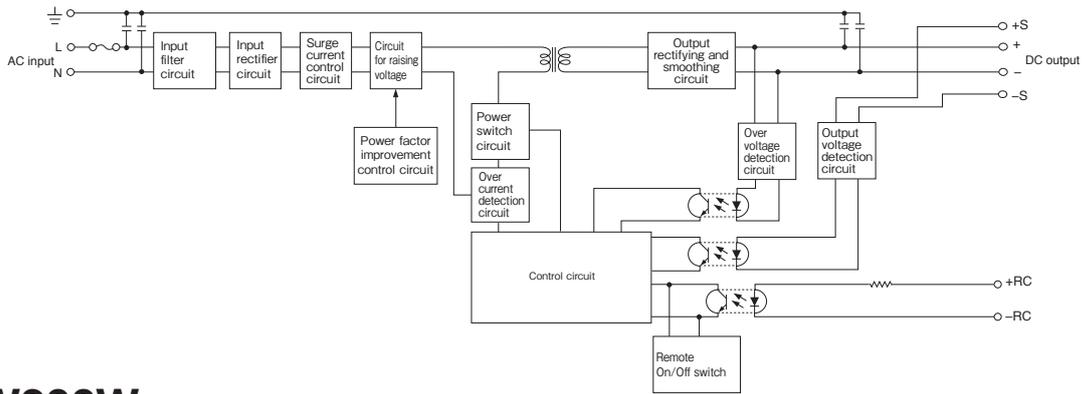
RTW300W
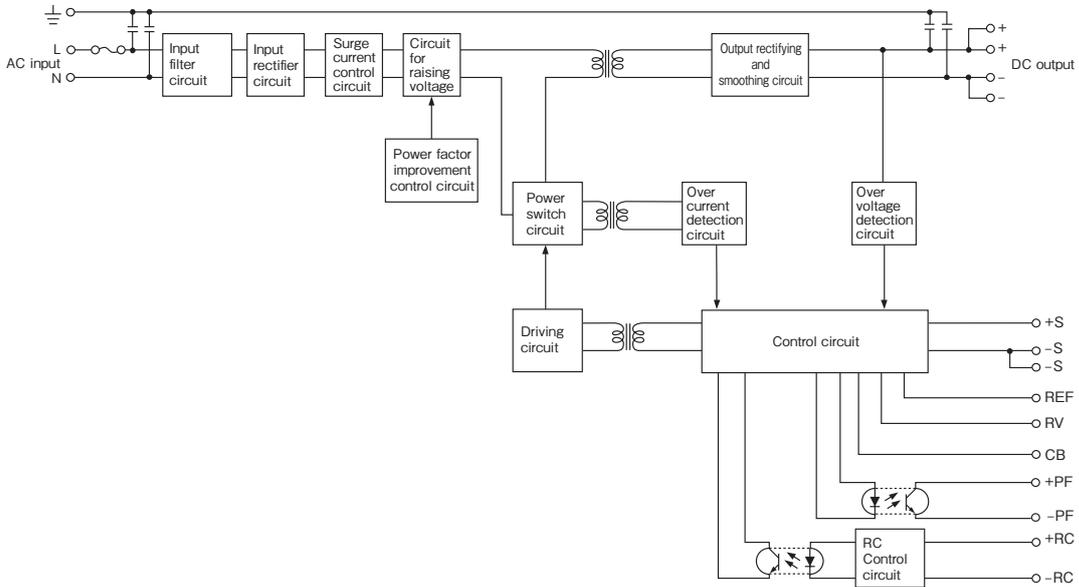
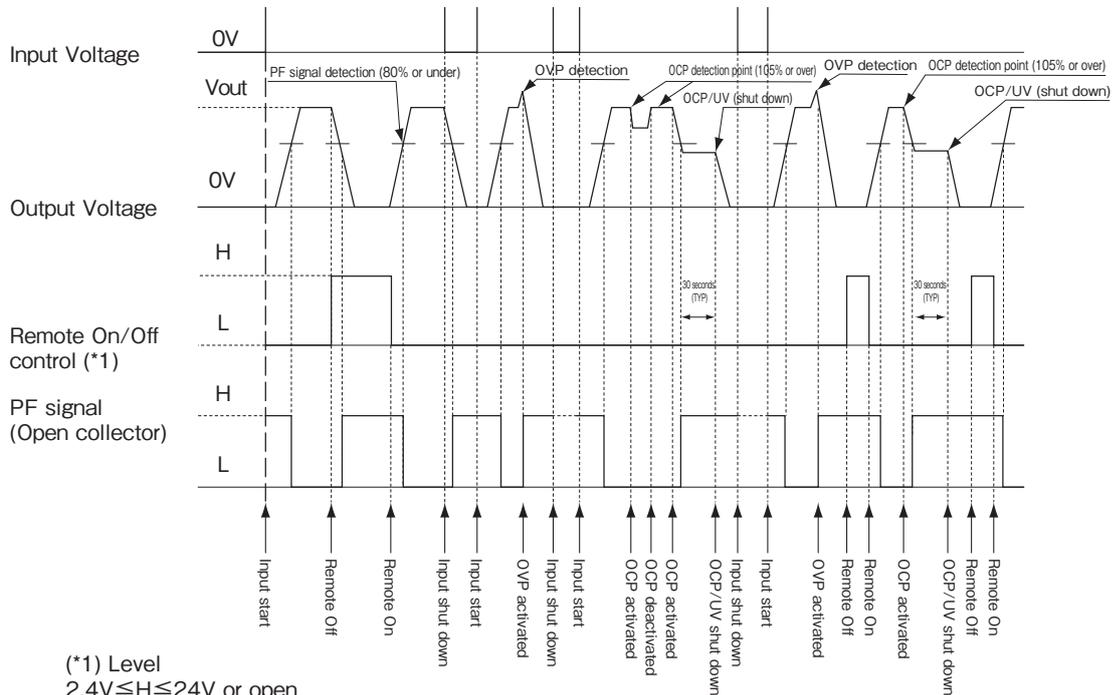## Sequence Time Chart

RTW300W

(*1) Level
2.4V≦H≦24V or open
0V≦L≦0.4V or shorted

· All specifications are subject to change without notice.

RTW Instruction Manual

1. Explanation of functions and notes

❶ Remote sensing function

When the stability at the load terminal is a problem due to the effect of the line-drop from power supply to load, the stability can be improved by remote sensing.

Between output terminal and load terminal and for one side, up to

    3.3V output: 0.15V max.

    5V output: 0.25V max.

    12-48V output: 0.4V max.

remote sensing is possible.

For output voltage and output power of the power supply, use this within the range of output characteristics. When in drastic load changes, specifications for dynamic load change may not be satisfied.

Remove the short plate between +S/+ and -S/- terminals, and make wiring as shown in the figure below. Use shielded wires or twisted wires for sensing line (5m at maximum is recommended).

If the OVP function tends to be activated easily or vibration easily occurs, set an external electrolytic capacitor with 470µF or over between +S and +, and between -S and -.
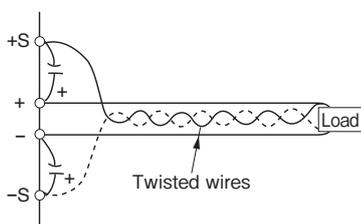
❷ Remote On/Off function (50-150W)

Remote On/Off function is activated by setting the switch for use/nonuse of Remote On/Off function, located in the center of the power supply, to Y (turning in a clockwise direction).

By inputting signals described below to the remote On/Off terminals (+RC, -RC), output voltage can be switched on and off from outside the power supply. Output is not generated if voltage is not applied to RC terminal.

Output voltage is switched on in the condition of H level (4.5-24.5V external voltage application)[*] between +RC and -RC.
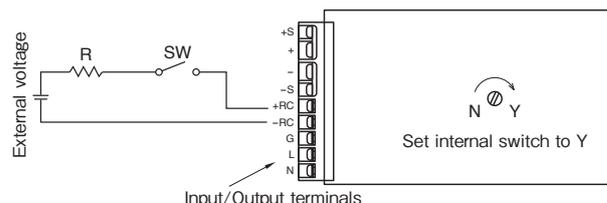
Output voltage is switched off in the condition of L level (shorted or 0-0.8V voltage between terminals) between +RC and -RC.

[*] When in 12.5-24.5V external voltage application, attach an external resistance (1.5kΩ).

±RC terminals are insulated from the AC input terminal and DC output terminal.

The insulation between the ±RC terminals and the out-puts conforms to the specification of insulation resistance (between output terminal and ground terminal), and the withstand voltage of the AC input terminal and the ±RC terminals conforms to the specification (withstand voltage between input terminal and output terminal).

Input/Output terminals

❸ Remote On/Off function (300W)

By inputting signals described below to the remote On/Off terminals (+RC, -RC) of the function connector CN2 or CN3, output voltage can be switched on and off from outside the power supply.

±RC pins are connected by a cable kit when shipped. Remove the cable kit when using Remote On/Off function.

The output voltage is switched off in the condition of H level (open or 2.4-24V external voltage application (1.0mA max. inflowing current)) between +RC and -RC.

The output voltage is switched on in the condition of L level (shorted or 0-0.4V voltage between terminals (1.6mA max. outflowing current)) between +RC and -RC.

±RC terminals are insulated from the AC input terminal and DC output terminal.

The insulation between the ±RC terminals and the out-puts conforms to the specification of insulation resistance (between output terminal and ground terminal), and the withstand voltage of the AC input terminal and the ±RC terminals conforms to the specification (withstand voltage between input terminal and output terminal).

❹ Variable output voltage (RV) (300W)

Output voltage can be varied by external voltage using variable output voltage (RV) of the function connector CN2 or CN3. The nominal output voltage can be generated by approximately 5V RV voltage.

When using this function, use twisted or bundled wires (recommended length is 2m max.) for wiring from RV/-S terminals.

●Set the output voltage to the lower limit value to be varied by turning the output voltage trimmer (V.ADJ).

●Output voltage is lowered by turning the trimmer in a

counterclockwise direction.
- Connect "+" of the external variable power supply to RV pin, and its "-" to -S pin.
- Output voltage can be varied by varying the voltage of the external variable power supply.
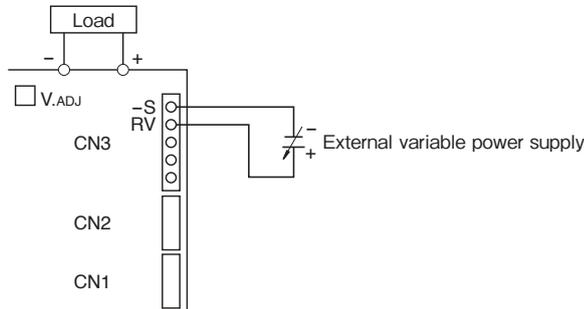
- Over Voltage Protection function may be activated if the output voltage is drastically lowered with less load.

5 Master/slave function (300W)

Master/slave operation is applicable by using RV terminal. Mutually connect RV and -S of each power supply unit using CN2/CN3. Turn the voltage trimmer (V.ADJ) of the slave power supply unit counterclockwise until it stops.
Outputsof all the power supply units can be varied according to V.ADJ of the master power supply unit.
Use twisted or bundled wires for wiring from RV/-S terminals.

- In the case of multiple output loads
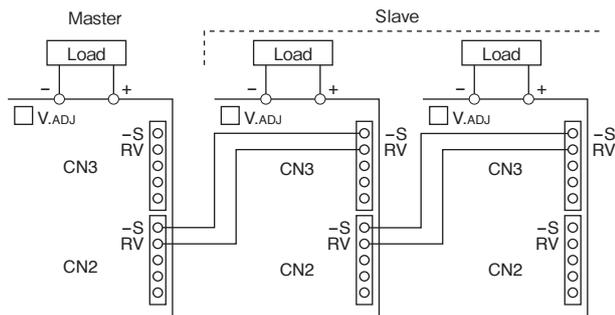
- In the case of one output load
The impedance of load line from each power supply should, if possible, the same.
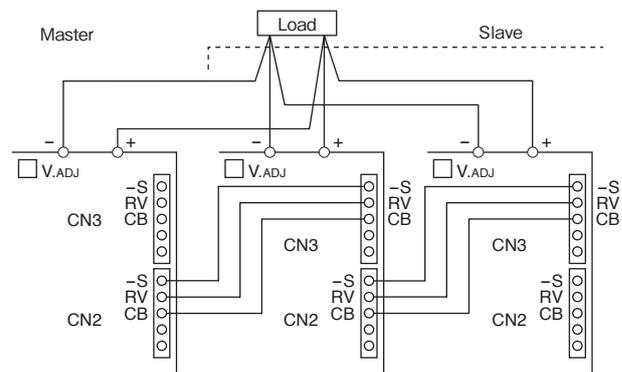
6 Current balance function (CB terminal) (300W)

When multiple power supplies are in parallel operation and their CB terminals and -S terminals are respectively mutually connected, this function controls the output current of the power supplies so that they become equal. Parallel operation should be configured with 4 units at maximum.
(1) Equalization condition
Output voltage fluctuation between power supplies (Maximum voltage - Minimum voltage)/Nominal voltage = 2% max.
Output current: 20-90% of nominal total output current
(2) Equalization performance
Output current fluctuation between power supplies under the equalization conditions described above is 10% max. of nominal output current.
(3) CB terminal connection diagram
Use twisted or bundled wires for wiring from CB/-S terminals.
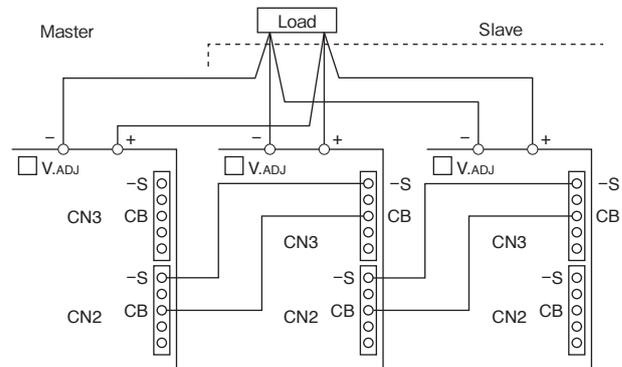
The impedance of load line from each power supply should, if possible, the same.

7 Redundant operation (N+1) (300W)

When in redundant operation of power supply, connect a diode to the end of the power supply's output. The impedance of load line from each power supply should be possibly the same.
Use twisted or bundled wires for wiring from CB/-S terminals.
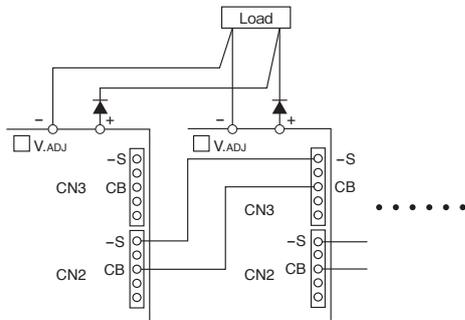
· All specifications are subject to change without notice.

RTW

● Over Voltage Protection function may be activated if the output voltage is drastically lowered with less load.

8 Power fail signal (300W)

It will become open when the output voltage drops to 80% or lower than the set voltage.

Sink current: 50mA max. Voltage between collector and emitter: 40V max. ±P/F terminals are insulated from the AC input terminal and DC output terminal.

The insulation between the ±P/F terminals and the outputs is the same as the insulation resistance between the output and the ground terminal, and the insulation between the AC input terminal and the ±P/F terminals is the same as the insulation resistance between the input terminal and the output terminal.
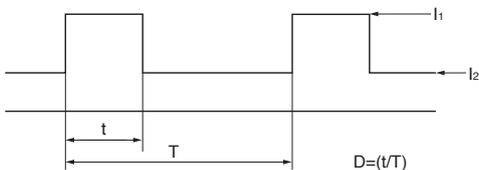
● Output specifications
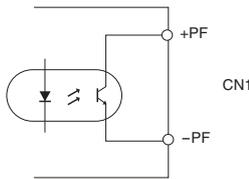
9 Maximum peak current

24V-output products of 150W/300W accommodate peak power.

Observe the conditions shown below for a peak current over the nominal value.

150W
(1) Condition of time
   $t \leqq 10s$

(2) Condition of peak current
   $I_1 \leqq 10A$

(3) Condition in effective current
   $\sqrt{DI_1{}^2+(1-D)I_2{}^2} \leqq 6.3A$

(4) Condition of effective power
   $P \leqq 151.2W$
   (Effective current x output voltage)

300W
(1) Condition of time
   $t \leqq 10s$

(2) Condition of peak current
   $I_1 \leqq 20A$

(3) Condition in effective current
   $\sqrt{DI_1{}^2+(1-D)I_2{}^2} \leqq 13A$

(4) Condition of effective power
   $P \leqq 312W$
   (Effective current x output voltage)

10 CE marking

RTW series meets the EN60950-1 and the CE marking

· All specifications are subject to change without notice.

is applicable to this series, based on 73/23/EEC and 93/68/EEC.

The custom-made power supply units (variation models) modified from this DC power supply device are not basically CE-marking applicable, except when "CE-marking applicable" is specifically declared in their specification document.
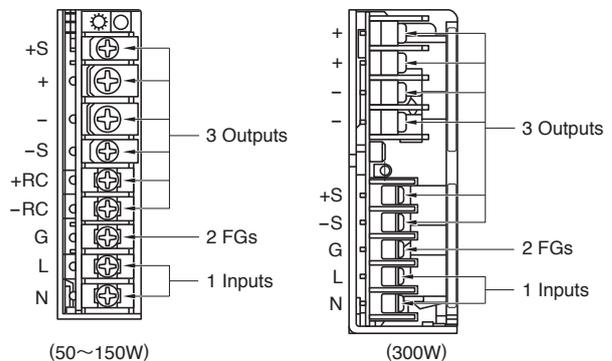
11 Insulation/withstand voltage test

Insulation/withstand voltage test can cause deterioration. Due consideration should be given when implementing a test. It is necessary to keep the electric potential equal within inputs, within outputs, and within FGs (frame grounds), respectively.

As a testing device, if is the type which starts up gradually when in test on and automatically discharges the charged energy when in test off. If discharging after test is conducted manually, it should be conducted via approximately 100kΩ-1MΩ resistance (Note that discharging via low impedance should be avoided because it can cause deterioration).

Due attention should be paid to measures to prevent electric shock in any case.

● **Power supply terminal connections for insulation/ withstand voltage test**

Short-circuit each terminal of outputs and inputs.

● **Connections between testing device and power supply for insulation/withstand voltage test**

Make connections between the testing device and power supply unit as shown in the table below. And then conduct a test.

Test conditions	Insulation testing device		Withstand voltage testing device	
	+terminal	-terminal	+terminal	-terminal
Insulation between Input and FG	1	2	—	—
Insulation between Input and Output	1	3	—	—
Insulation between Output and FG	3	2	—	—
Withstand voltage between Input and Output	—	—	1	3
Withstand voltage between Input and FG	—	—	1	2
Withstand voltage between Output and FG	—	—	3	2

2. Mounting

(A) Standard mounting method   (B)   (C)   (D)

(E)
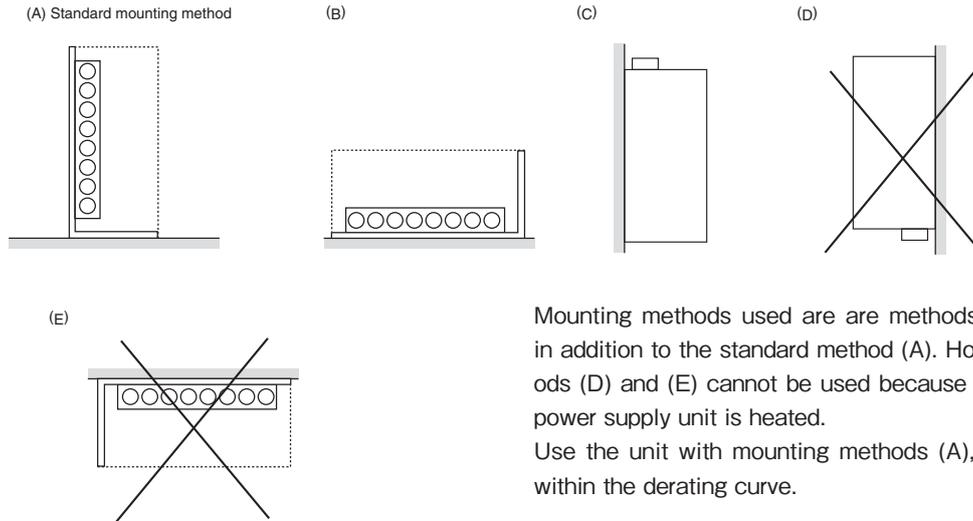
Mounting methods used are are methods (B) through (E) in addition to the standard method (A). However, the methods (D) and (E) cannot be used because the inside of the power supply unit is heated.

Use the unit with mounting methods (A), (B), or (C), and within the derating curve.

3. Precautions in use

● When using this product, confirm that the power supply's ambient temperature is within the range of operating temperatures. The power supply's ambient temperature means the temperature around the power supply unit, causing a temperature rise inside the device.

● For use with natural air cooling, locate the unit so as to generate thermal convection. Also keep a distance of 10mm or over from adjacent devices, for each side of the unit.

● Select input/output wire materials and noise filters, etc. which have enough allowance in their respective current capacity.

● If the power supply unit is not in use for a long period of time, it is recommended to apply input voltage for approximately 1 hour, every 2 years, to keep the quality of the electrolytic capacitor.

● When the power supply units are in a series operation, the nominal current is restricted according to the lowest nominal current value of the units in use. In addition, in order to prevent damage to internal elements and other parts due to reverse voltage applied to the unit, connect a diode (reverse withstand voltage: twice or over the value of total output voltage, forward current: twice or over the value of output current, forward voltage drop: possibly minimum) to prevent reverse voltage to the output terminal of the unit.

● Any materials used in this product do not contain the bromine fire retardant (PBDPEs, PBBs).

● Any ODS is not used in production of this product.

4. Troubleshooting

● Is the specified input voltage applied to the input terminal?

● Are the connections of input/output terminals correct?

● Check that the connecting wires are not too thin.

● Check that the output voltage trimmer (V.ADJ) is not turned up too high. If the output voltage trimmer (V.ADJ) is turned up too high, it causes the OVP function to be activated, and the output is shut down.

● Are the logic of of Remote On/Off function and external voltage application set correcftly?

● Check that the remote sensing terminal is not open. Applying input voltage in its open status may cause the OVP function to be activated, and the output to be shut down.

5. Variation models of power supplies

We prepare variation models to meet various needs of customers.

Variation symbol	50W/100W/150W				300W		
	Without cover	With cover	Type L	Coating	With cover	Type L	Coating
None	○						
B	○			○			
C		○					
G		○		○			
L	○		○		○		
M			○	○	○		○
H					○	○	
N					○	○	○