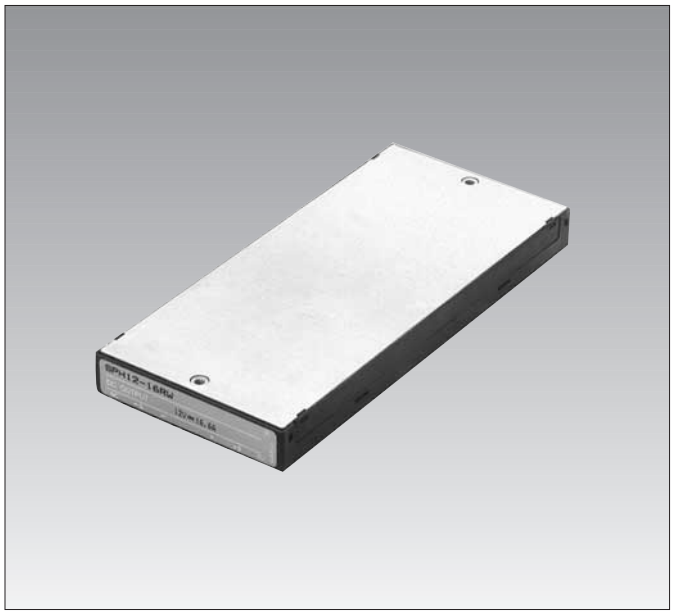
Ultra-thin type DC.48V wide-input power supply

TDK Switching Power Supply

# S SERIES SPH-W

**[FEATURES]**

- DC.48V input ultra-thin type single output power supply
- Wide input (DC.36 to 72V).
- Onboard conduction cooling method.
- Remote ON-OFF function.
- Remote sensing function.
- Synchronous operation supported.
- Parallel operation supported.



**[SUMMARY]**

The S series SPH-W products are compact thin-type onboard power supplies. The range of input voltages is wide such as DC.36 to 72V (rated DC.48V) and the output depends upon 150 to 200W output power. The product lineup has been enhanced by combinations with SPU, SPB, SPL, SPM, and SPH already put on sale.

**PART NUMBERS AND RATINGS**

| Output voltage(V) | 150W Type | | 200W Type | |
|---|---|---|---|---|
| | Current(A) | Part No. | Current(A) | Part No. |
| 5 | 30 | SPH05-30RW | | |
| 12 | | | 16.6 | SPH12-16RW |
| 24 | | | 8.3 | SPH24-8R3W |

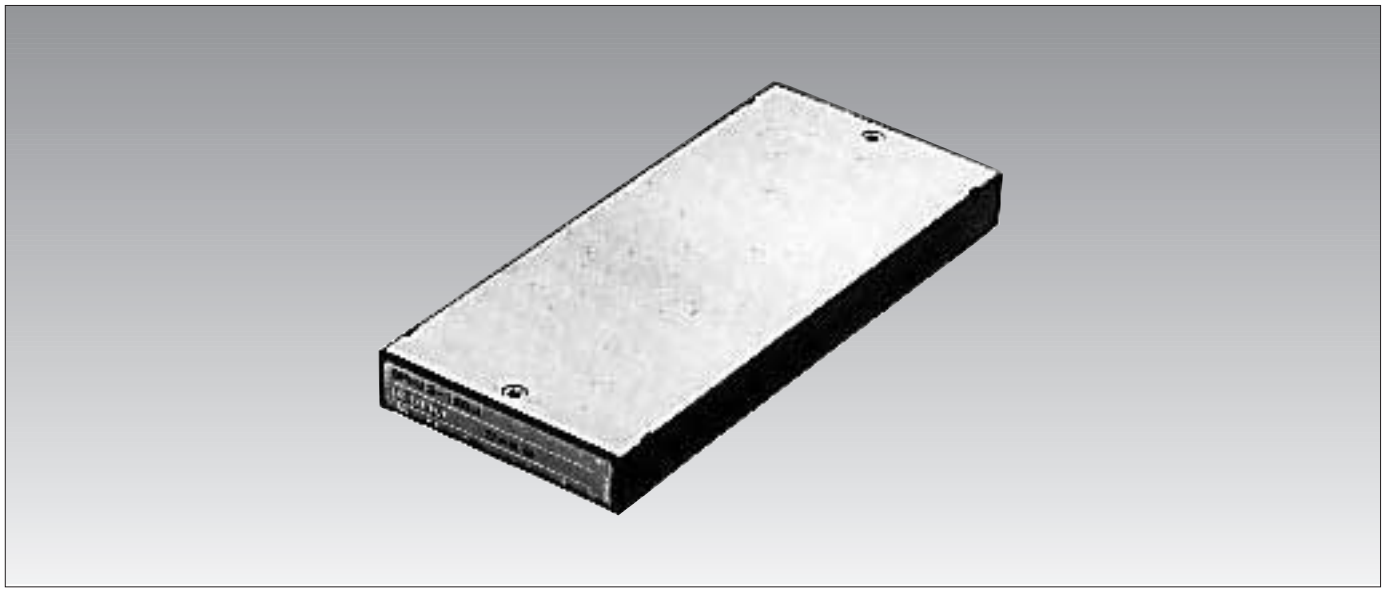
# S SERIES SPH200W-W TYPE

## SPECIFICATIONS AND STANDARDS

| PART NO. | | | SPH05-30RW | SPH12-16RW | SPH24-8R3W |
|---|---|---|---|---|---|
| Rated output voltage and current*1 | | | 5V • 30A | 12V • 16.6A | 24V • 8.3A |
| Maximum output power | | W | 150 | 199.2 | 199.2 |
| **INPUT CONDITIONS** | | | | | |
| Input voltage Edc | | V | 36 to 72[Rating: 48] | | |
| Input current | | A | 7max.(5typ.)[DC.36/48V] | | |
| | | A | 5V:6max.(3.9typ.)[DC.36/48V] | | |
| Efficiency | | % | 80typ. | 81typ. | 83typ. |
| **OUTPUT CHARACTERISTICS** | | | | | |
| Output voltage Edc | | V | 5 | 12 | 24 |
| Voltage variable range Edc | | V | 4.5 to 5.5 | 7.2 to 13.2 | 14.4 to 26.4 |
| Maximum output current | | A | 30 | 16.6 | 8.3 |
| Overvoltage threshold Edc | | V | 5.8 to 6.9 | 13.7 to 15.7 | 27 to 30.5 |
| Overcurrent threshold | | A | 33 to 40.5 | 17.4 to 22.4 | 8.7 to 11.2 |
| Voltage stability | Input variation | % | 0.2max.(0.1typ.)[Within the input voltage range] | Total variation 2.5max.(1.2typ.) | |
| | Load variation | % | 0.3max.(0.1typ.)[10 to 100% load] | | |
| | Temperature variation | % | 2max.(1typ.)[Case temperature: –20 to +85°C] | | |
| | Drift | % | 2max.(1typ.)[25°C, input and output ratings, after input voltage ON for 30min to 8h] | | |
| | Dynamic load | %/ms | ±4max./2ms[75 to 100% sudden load change] | | |
| Ripple Ep-p | | mV | 100max. | 150max. | 150max. |
| Ripple noise Ep-p | | mV | 200max. | 250max. | 300max. |
| **AUXILIARY FUNCTIONS** | | | | | |
| Indicator display | | | No | | |
| Overvoltage protection | | | Voltage shut-down type, recovers upon reset. | | |
| Overcurrent protection | | | Fixed current and voltage threshold type, automatic recovery, set value fixed. | | |
| Overheat protection | | | Yes | | |
| Remote ON-OFF | | | Yes | | |
| Remote sensing | | | Yes | | |
| Current balance | | | Yes | | |
| Synchronous operation | | | Yes | | |
| Output voltage external variable function | | | Yes | | |
| **STANDARDS** | | | | | |
| Safety standards | | | — | | |
| **CONSTRUCTIONS** | | | | | |
| External dimensions | | mm | 12.7×58×130[H×W×L] | | |
| Weight | | g | 200max. | | |
| Mounting method | | | Can be attached to terminal side (soldered and screwed). | | |
| Case material | | | Nonflammable resin[UL94-V0] | | |
| Heat sink | | | Sold separately(Part No.: 3JR0AB163) | | |

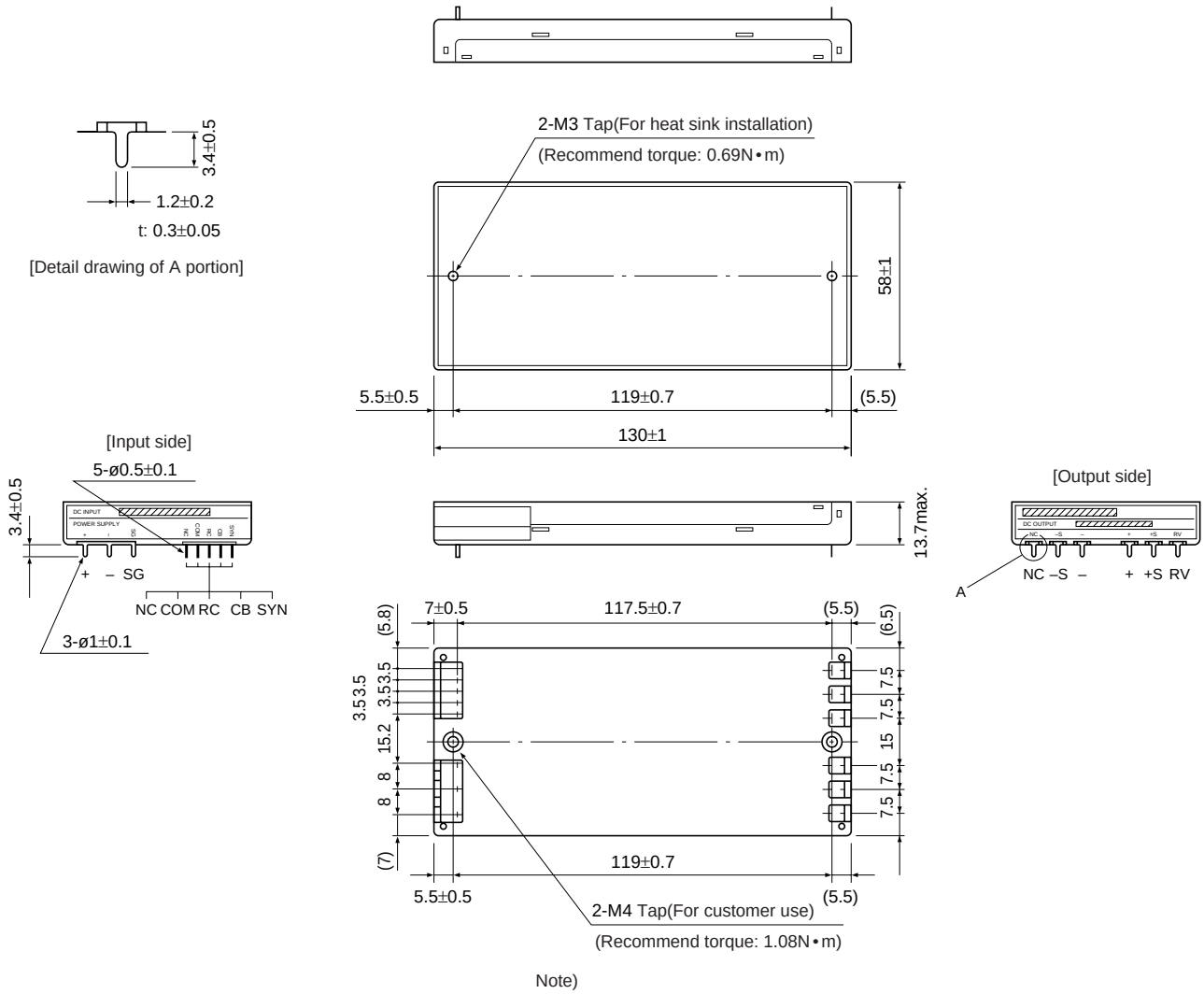
*1 Radiant heating and forced air cooling should be considered. Sufficient space should be provided so that the base plate(aluminum surface) temperature is below 85°C when the surrounding environment is less than 60°C.

# S SERIES SPH200W-W TYPE



## SHAPES AND DIMENSIONS
## SPH200W-W TYPE

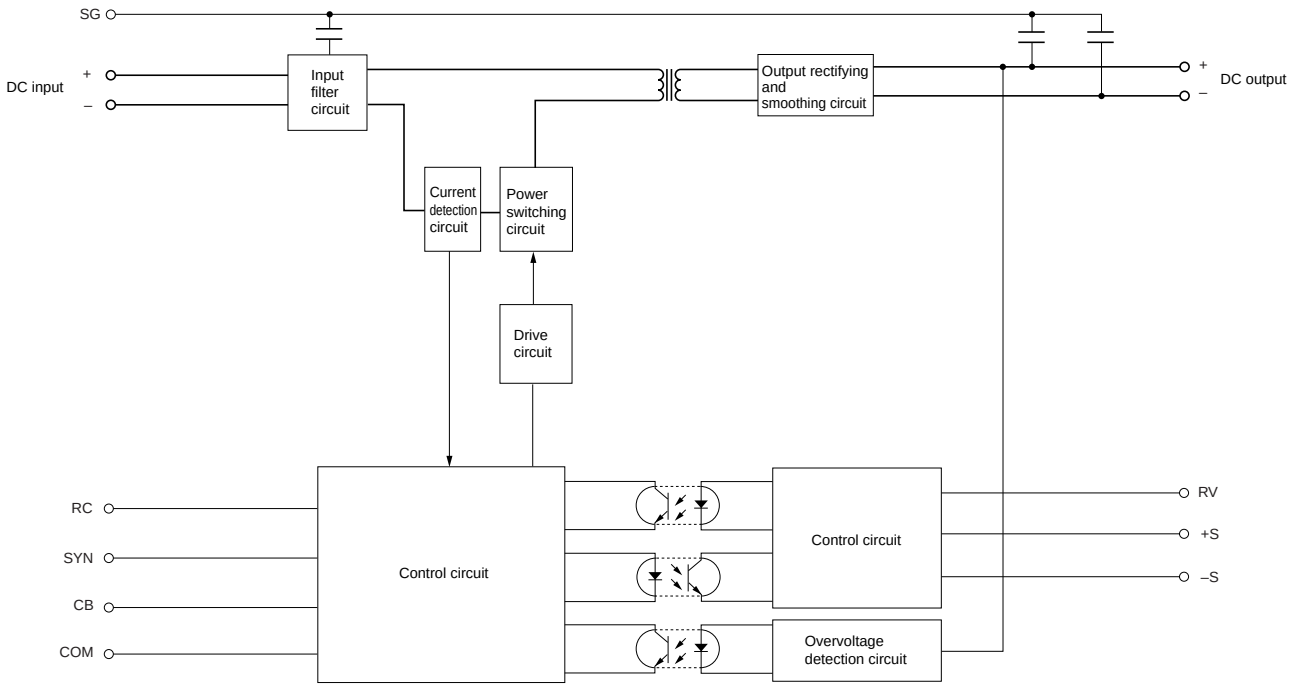
Dimensions in mm
±0.3mm : without specified dimensions




Note)
• Do not insert M3 and M4 installation screws more than 6mm from surface of power supply.

# Characteristics, Functions, and Applications

## BLOCK DIAGRAM

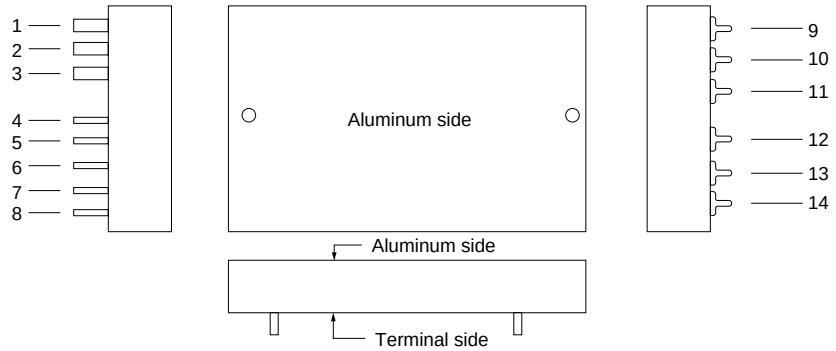



## COMMON SPECIFICATIONS

| | | |
|---|---|---|
| **Temperature and humidity** | | |
| Temperature range | Operating(°C) | –20 to +85 Derating is necessary when operating environment temperature exceed 60°C. (Case temperature: +85°C max.) |
| | Storage(°C) | –40 to +105 |
| Humidity range | Operating(%)RH | 20 to 95[Maximum wet-bulb temperature: 35°C, without dewing] |
| | Storage(%)RH | |
| **Amplitude and vibration** | | |
| Amplitude | 5 to 10Hz | All amplitude 16mm[3 directions, each 1h] |
| | 10 to 500Hz | Acceleration 49.0m/s$^2$ [5G, 3 directions, each 1h] |
| Vibration | Acceleration | 490m/s$^2$ [50G, 3 directions, each 3 times] |
| | Vibration time | 11±5ms |
| **Withstand voltage and insulation resistance** | | |
| Withstand voltage | Input terminal to output terminal | Edc(V)500, 1min(25°C, 65(%)RH) |
| | Input terminal to signal ground terminal | |
| Insulation resistance | Input terminal to output terminal | Edc(V)500, 100MΩ min.(25°C, 65(%)RH) |
| | Input terminal to signal ground terminal | |
| | Output terminal to signal ground terminal | |

# Characteristics, Functions, and Applications

## TERMINAL DESIGNATIONS AND FUNCTIONS




**1 DC input terminal(+)** ..... Connect these terminals to DC input power supply.
**2 DC input terminal(–)**

**3 Signal ground terminal(SG)** ..... Connected to a case (aluminum side). Connect this terminal to the DC input terminal (-) or (+). Can be connected to FG in the unit side.

**5 Common terminal(COM)** ..... Connected to the DC input terminal (–) via an input filter. Use it for the common mode of the signal system (OC1.RC) in the input side.

**6 Remote control terminal(RC)** ..... By externally transmitting a signal between this RC terminal and the COM terminal, the output voltage can be controlled to be turned on or off. The output voltage is turned off when a signal at a high level is transmitted between the RC and COM terminals or when the circuit is open and it is turned on when a signal at a low level is transmitted between them or when the circuit is shorted.

**7 Current balance terminal(CB)** ..... Used for a parallel operation of the power supplies. In this operation, respective CB and COM terminals are connected in parallel.

**8 Synchronous operation terminal(SYN)** ..... Used for synchronizing oscillation frequencies of the power supplies. In this operation, respective SYN and COM terminals are connected in parallel.

**9 Output voltage adjustment terminal(RV)** ..... By connecting a resistance between the +S and RV terminals, the output voltage can be adjusted externally. Release this terminal unless it is in use.

**10 Remote sensing terminal(+S)** ..... Connect these terminals at load ends in remote sensing. Unless the remote sensing is used, connect them to respective DC output terminals.
**13 Remote sensing terminal(–S)**

**11 DC output terminal(+)** ..... Power supply output terminals. Connect them to a load line.
**12 DC output terminal(–)**

# Characteristics, Functions, and Applications

## BASIC CONNECTION

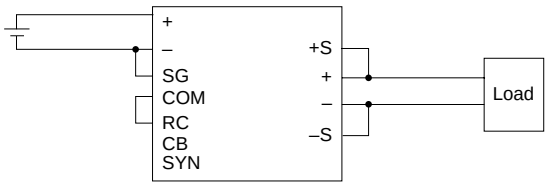



Fig.1

- Unless the remote control function is used, cause a short circuit between the RC and COM terminals.
- When not using the synchronous operation, the current balance, and the output variable function, release the terminals.
- When not using the remote sensing function, cause short circuits between the +S and + terminals and between the –S and – terminals.

## INPUT FUSE CONNECTION

No input fuse is incorporated. To improve safety, use an external fuse (normal melting type: 15 to 20A).

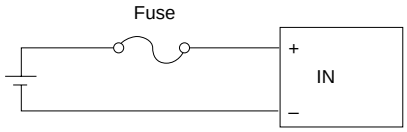



Fig.2

## INPUT REVERSE CONNECTION COUNTERMEASURES

No protection circuit is incorporated against input reverse connection. If there is a possibility of a reverse connection, add diodes and a protection fuse (normal melting type: 15 to 20A) to the input terminal. As for a selection of diodes, select ones having current characteristics twice or three times the fuse rated current with taking into consideration fuse melting characteristics.

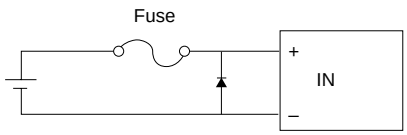



Fig.3

## CONNECTION FOR INPUT ELECTROLYTIC CAPACITOR

When the input is turned on, a resonance may be caused by inductance components of a wire on the input line or the maximum input voltage is exceeded when the input line is turned on or off directly by a relay or the like. In this condition, mount an electrolytic capacity of approx. 220µF between the input lines to prevent the maximum input voltage from being exceeded (Connect them at a place as close as possible to the input terminal). Since large ripple current may flow into the electrolytic capacitor, however, use this product within a range of the standard value of the allowable ripple current of the electrolytic capacitor. If the ripple current exceeds the standard value, connect a film capacitor to the electrolytic capacitor in parallel as shown below to cause high-frequency ripple current to flow into the film capacitor or connect an input inductor to suppress the ripple current.

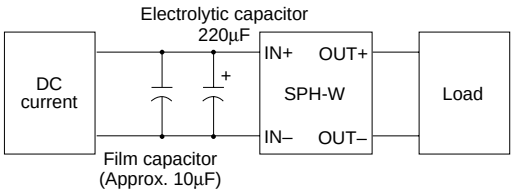



Fig.4a Film capacitor connection

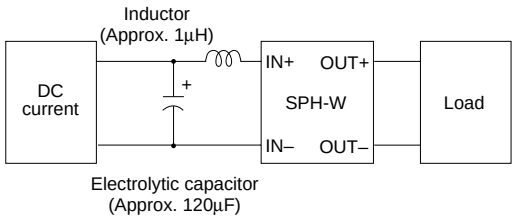



Fig.4b Inductor connection

## VARIOUS FUNCTIONS

**• Protection function**

**1) Overcurrent protection function**

An overcurrent protection circuit of the fixed current threshold type is incorporated. Current automatically recovers by removing a cause of the overcurrent. This setting value is fixed and cannot be adjusted externally. Note that continuous overcurrent condition may cause a trouble according to heat dissipation conditions.

**2) Overvoltage protection function**

This product contains an overvoltage protection circuit for shutting down output in case of an abnormal rise of the output voltage. If this circuit is activated, the voltage recovers only by shutting down the input and then turning on the input again after a certain time interval. This setting value is fixed and cannot be adjusted externally.

**3) Overheat protection function**

The overheat protection function operates at an abnormal rise of an ambient temperature or at an abnormal rise of a temperature inside the power supply to shut down output. The output recovers by turning on the input again.

# Characteristics, Functions, and Applications

## AUXILIARY FUNCTIONS

### REMOTE ON-OFF FUNCTION

The output voltage can be turned on or off by sending a signal from the outside of the power supply.
Between RC and COM: Turned off at high level (4.5 to 24V) or in open circuit.
Between RC and COM: Turned on at low level (0 to 0.4V) or in short circuit (Source current: 1mA max.).
Since the remote ON-OFF circuit is connected to a primary circuit inside the power supply, it is recommended to use an element having an insulation function such as a relay, a photo coupler, or the like as the external control circuit. If a non-insulation circuit is compelled to be used, use an input (–) terminal without a COM terminal. A use of the COM terminal will damage the filter function inside the power supply. In addition, in case of the minus input terminal released by mistake, the pattern may be damaged.

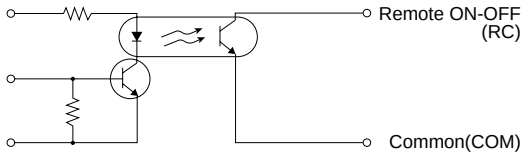



Fig.5a Recommended input circuit for RC signal (Insulation type)

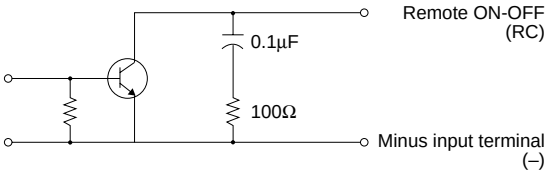



Fig.5b Input circuit for RC signal (Non-insulation type)

### REMOTE SENSING

If there is a problem of stability at a load end caused by an effect of a line drop from the power supply to a load, the stability is improved by remote sensing. Remote sensing is available at a single side for a line drop between the output terminal and the load terminal up to 0.25V for a 5V output and up to 0.4V for a 12 to 24V output (Attention, however, should be paid to output power). By using a shielded wire or a stranded wire as a remote sensing wire, an effect of noise can be reduced. If the overvoltage protection easily operates or oscillation easily occurs, attach a capacitor of 0.1µF or higher between (+) and (–) terminals to check the output voltage. In using an electrolytic capacitor, be careful with the polarity. Note that the output rise time is extended due to a capacity of the electrolytic capacitor. In remote sensing, be careful not to disconnect the output line of the (–) terminal. The line may be burned and damaged due to a flow of large current into the (–) line or the pattern inside the power supply. Unless the remote sensing is used, cause short circuits between the (+) and (+S) terminals and between (–) and (–S) terminals (Refer to Fig. 6).

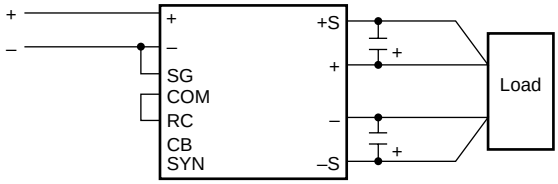



Fig.6 Remote sensing connection diagram

### OUTPUT VOLTAGE ADJUSTMENT

While this product can be used without any external resistance, connecting a trimmer between the RV and output (+) terminals enables the output voltage to be externally adjusted by approx. ±10% of the rated output voltage for a 5V output or by –40 to +10% for a 12 or 24V output. Use this product, however, within the rated current and rated power. Unless the output voltage is adjusted, open the RV terminal.

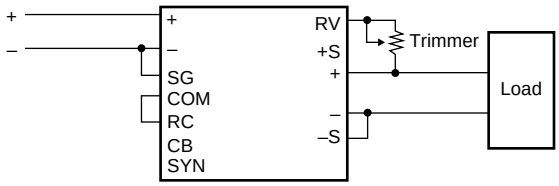



Fig.7 Connection diagram for output voltage adjustment

**Recommended external resistance value**

| Output voltage (V) | 5 | 12 | 24 |
|---|---|---|---|
| Trimmer (Ω) | 10k | 5k | |

### CURRENT BALANCE FUNCTION

If two or more power supplies are connected in parallel, equalize output current of respective power supplies by mutually connecting the CB terminals and the COM terminals of the power supplies. It should be noted that, however, the power supplies must be of the same type.

(1) Equalization conditions

- Dispersion of output voltage of respective power supplies: (Maximum voltage–Minimum voltage) ÷ Rated voltage=2% max.
- Output current: 20 to 80% for total output rated current

(2) Equalization performance (for two units)

- Dispersion of output current of respective power supplies under the above equalization conditions: (Maximum current–Minimum current) ÷ (Rated current×Number of units in parallel)=10% max.

### SYNCHRONOUS OPERATION FUNCTION

For a serial connection of two or more units, a parallel connection, or a multi-connection, oscillation frequencies can be synchronized by mutually connecting the SYN terminals and the COM terminals of respective units. The synchronous frequency is the fastest frequency among frequencies of the connected power supplies. This function is available concurrently with the current balance function.

# Characteristics, Functions, and Applications

## PARALLEL OPERATION

A parallel operation (a parallel connection of output terminals of power supplies) is available for increasing output current. To perform this operation, connect the current balance terminals (CB) and the common terminals (COM) of respective units with each other. In the parallel operation, use the power supplies within 80% of the rated power. It should be noted that, however, the power supplies must be of the same type and it should be checked that no incorrect output operation is caused by a mutual interference before use. Wiring impedance should be equalized as completely as possible from each power supply to a load. Output beat noise can be reduced by connecting synchronous operation terminal (SYN).

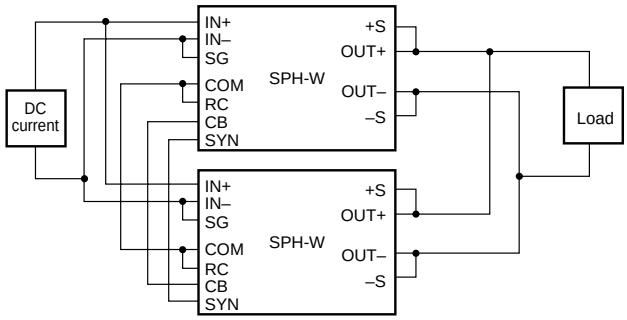



Fig.8 Connection for parallel operation

Note) In case of malfunction, attach a capacitor of 0.01µF between the CB and COM terminals.

## PARALLEL REDUNDANCY OPERATION

For a system required to have higher reliability, it is possible to increase reliability of the system by using N+1 units of power supplies for N required number of power supplies. In case of a trouble in one of the power supplies, another power supply automatically divides the output current equally, thus enabling continuously supplying power of the N units of power supplies. Mount electrolytic capacitor and diodes at output ends. As for a selection of diodes, select ones having current and voltage characteristics twice or more times the power supply rated current and twice or more the rated voltage and having the minimum forward voltage loss.

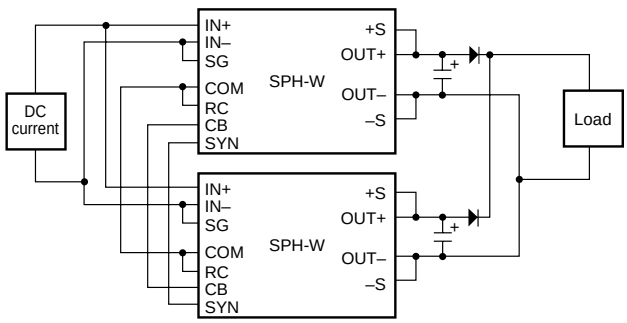



Fig.9 Connection for parallel redundancy operation

## SERIAL OPERATION

In case of an insufficient output voltage, a predetermined voltage is secured by connecting power supplies in serial. It should be noted that, however, the maximum current is equal to a smaller output current value of the output current values of the power supplies connected in serial. In addition, attach diodes D to outputs of the power supplies for preventing reverse voltage application. As for a selection of the diodes D, select ones having current and voltage characteristics twice or more times the power supply rated current and twice or more the rated voltage and having the minimum forward voltage loss. Beat noise can be reduced by connecting respective synchronous operation terminals (SYN) and the common terminals (COM) of the power supplies (Refer to Fig. 10).

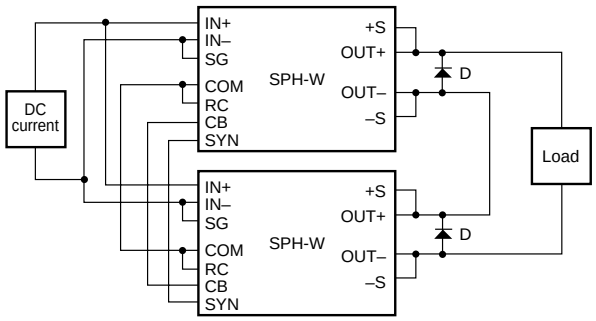



Fig.10 Connection for serial operation

## ±OUTPUT OPERATION

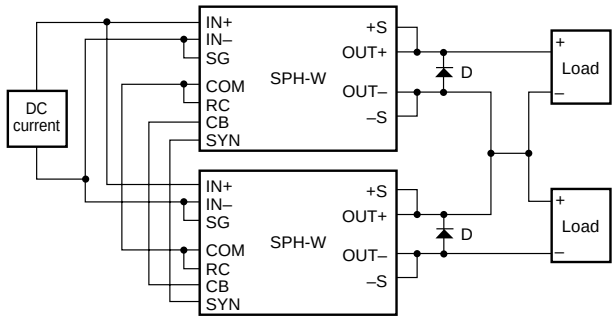



Fig.11 Connection for serial operation

# Characteristics, Functions, and Applications

## HEAT DISSIPATION DESIGN

The S series applies a case temperature management system. Keep the case temperature at 85°C or lower or within the derating curve. The system reliability depends upon at what degree (°C) the case is kept.

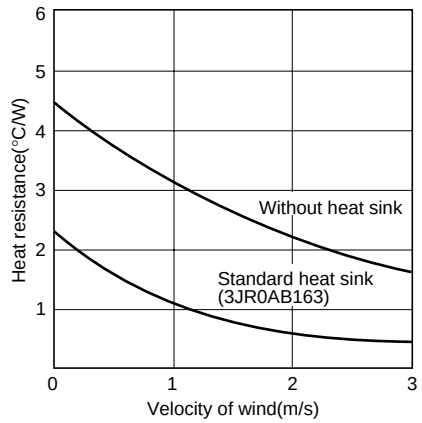
### Heat dissipation designing method

1) Calculate internal loss.
   Internal loss=Output power/Efficiency–Output power ·····Ploss
2) Determine a temperature rise of the case based on an ambient temperature taking into consideration reliability. ···· $\Delta t$
3) Calculate a heat resistance value required for heat dissipation.
   $T\theta = \Delta t/Ploss$
4) Determine a shape of a heat sink and a cooling method taking into consideration a mounting space.
5) Check the above. Is it OK?

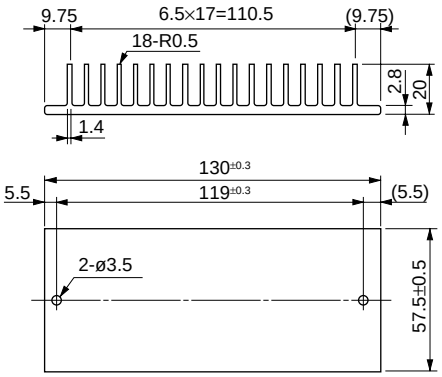
### Calculation example

1) If output power is defined as 150W and efficiency as 83%, the following relation obtains:
   Ploss=150/0.83–150 = 30.72W
2) If the highest ambient temperature is defined as 50°C and the case temperature (max.) as 70°C, the following relation obtains:
   $\Delta t$=70–50=20°C
3) Heat resistance $T\theta$=20/30.72=0.651(°C/W)
4) An air speed is defined as 2.5m as a result of a calculation based on a graph of an air speed and a heat resistance using a standard heat sink.

### Relationship between air speed and heat resistance




### Standard heat sink (3JR0AB163)

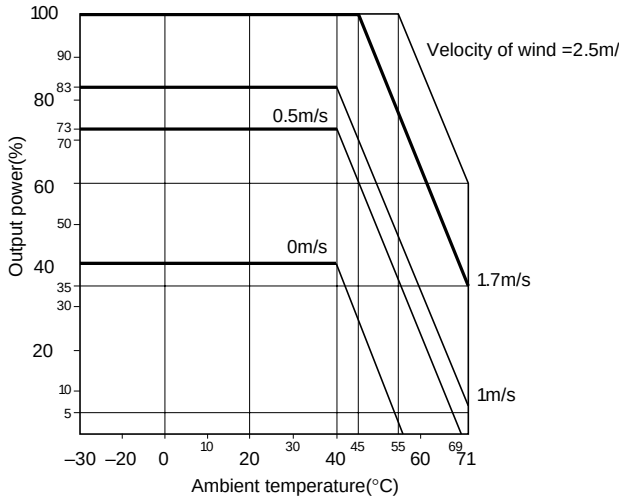



Dimensions in mm

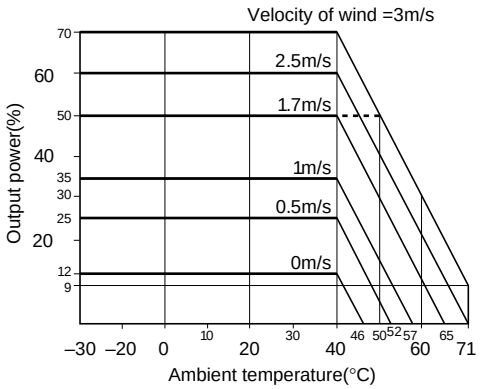
## OUTPUT POWER-AMBIENT TEMPERATURE(DERATINGS)

**[SPH05-30RW TYPE]**

**With heat sink(3JR0AB163)**



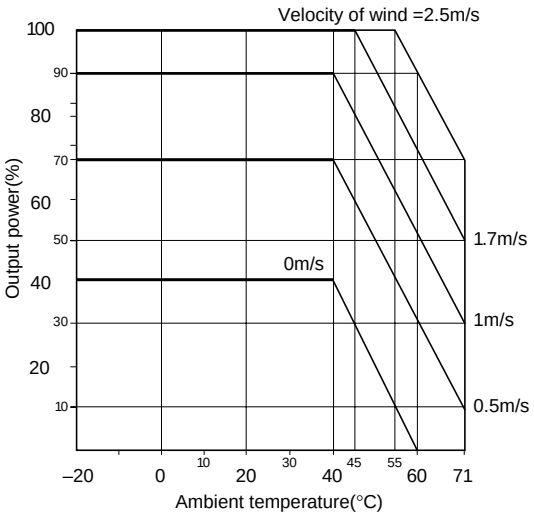

**Without heat sink**



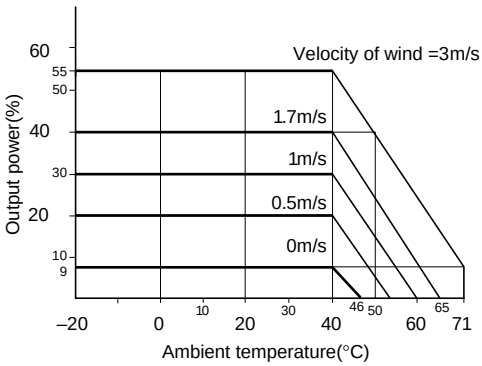
# Characteristics, Functions, and Applications

**[SPH12-16RW/SPH24-8R3W TYPE]**

**With heat sink(3JR0AB163)**




**Without heat sink**




**MOUNTING METHOD**

**• Fixing method**

In fixing to the PC board, use mounting taps at two places in the side of the lower surface (terminal side). Use M4 screws for fixing and pay attention not to insert the screws 6mm or deeper from the surface of the body (Recommended clamping torque: 1.08N • m).

In fixing a radiator, use mounting taps at two places in the upper surface of the case (aluminum plate side). Use M3 screws for fixing and pay attention not to insert the screws 6mm or deeper from the surface of the body (Recommended clamping torque: 0.69N • m).

In addition, it is recommended to use thermal conducting grease to enhance a radiating effect between the radiator and the power supply body (aluminum surface) when mounting.

**• Pattern width**

Large current flows into the input-output pattern. It may cause a voltage drop or heat developed. Be very careful with designing the pattern. The pattern width should be determined on the basis of a reference value of 1mm/A.

A double-sided PC board should be used as a PC board. Solder the terminals with through holes.

**• Recommended soldering conditions**

Solder the terminals under the following condition:

1) For dip soldering sink: 230 to 260°C, 10s

2) For soldering bit: 340 to 360°C, 5s

**• Recommended cleaning conditions**

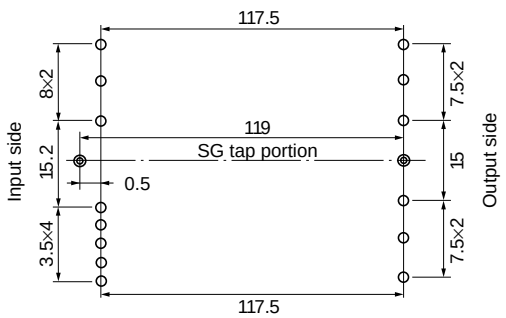
Partially clean the PC board pattern surface. The recommended conditions are as follows:

Cleaning fluid: IPA

Cleaning method: Brush cleaning

∗ See that the cleaning fluid does not permeate into the inside of the power supply. It may cause a trouble.

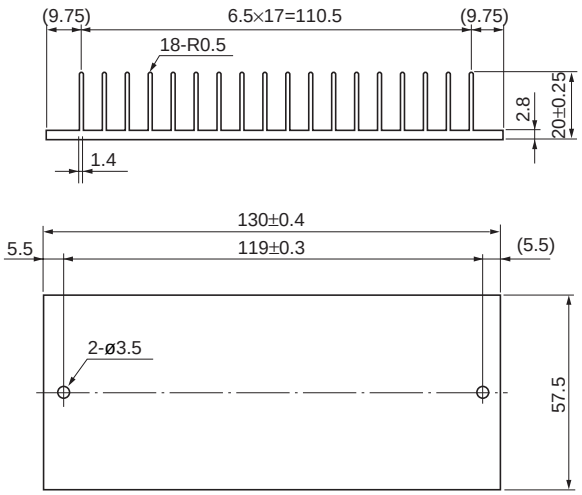
**• Recommended pin pattern(top view)**




(Unit: mm)

| | | | |
|---|---|---|---|
| Input terminal hole dia.: ø1.2 | Function terminal hole dia.: ø0.7 | Output terminal hole dia.: ø1.5 | SG connection tap portion (◎) |
| Round dia.: ø2 | Round dia.: ø1.5 | Round dia.: ø4 to 6 | Hole dia.: ø4.5 |
| | | | Round dia.: ø8.5 to 9.5 |

# Separately-sold Option List

| Product name | Part No. | Applicable device | Shapes and dimensions (mm) |
|---|---|---|---|
| **Heat sink** | **3JR0AB163** | SPH200W-W |  Material: Aluminum<br>∗ Use cooling grease at mounting. |

Please specify the part No. for ordering.