# INSTRUCTION MANUAL

# REGULATED DC POWER SUPPLY

# MODEL PAA35-60T



KIKUSUI ELECTRONICS CORPORATION

# Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.
(Revision should be applied to items indicated by a check mark ☑.)

☐ Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

☐ Input fuse

The rating of this product's input fuse is _____A, _____VAC, and _____.

**WARNING**

- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

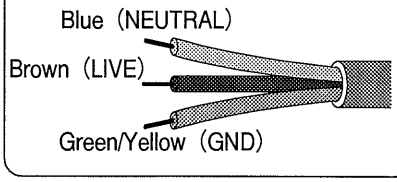
☐ AC power cable

The product is porvided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

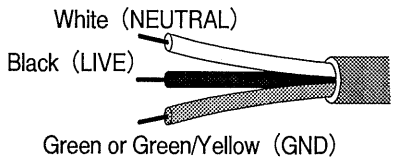
**WARNING**

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.

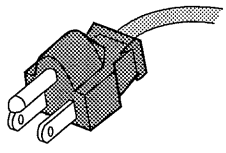
☐ Without a power plug



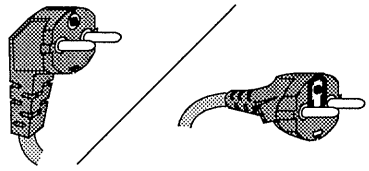

☐ Without a power plug




☐ Plugs for USA



☐ Plugs for Europe



☐ Provided by Kikusui agents

Kikusui agents can provide you with suitable AC power cable.
For further information, contact your Kikusui agent.

☐ Another Cable _____

 Kikusui Part No. Z9-000-027 IB001681

KIKUSUI

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# 1. GENERAL

## 1.1 Outline

Model PAA35-60T Regulated DC Power Supply is an automatic constant-voltage/constant-current cross over type of power supply with output ratings of 35 V, 60 A, and 2.1 kW.

The PAA35-60T is featured by high efficiency (80% or better), low output ripple, good temperature coefficient, and high stability and reliability. It is as compact in size as one-half of that of Kikusui PAD-L Series Power Supply.

The PAA35-60T employs 3-phase AC phase-controlled type and choke input type of rectifying and smoothing circuits. Due to this, response of the PAA35-60T to transient load change is slower and its output volrage recovery period is longer than that of an equivalent power supply of a series regulator type. (For a load which sharply changes and calls for rapid response to such transient changes, a PAD-L Series Power Supply is more recommendable than a PAA Series Power Supply is.)

The PAA35-60T is an industrial power supply which may be used for various types of loads (except those which call for rapid response to transient load changes). The PAA35-60T may be used as a fixed power supply for long-term aging test or as a variable power supply for experiments and other purposes.

The PAA35-60T is incorporated with the various protective provisions, namely, an overvoltage protector, an overcurrent protector, an overheat protector, and a phase dropout Protector of the 3-phase input.

The line phases are free. That is, the three core wires of the input power cable can be connected to any ones of the input terminals of the PAA35-60T.

The PAA35-60T allows you to remote-control its output voltage or current by using an external voltage or resistance control signal.

The PAA35-60T can be installed on a standard instrument EIA or JIS rack.

NOTE: Be sure to read this manual before starting operating the PAA35-60T.

## 1.2 Specifications

| | |
|---|---|
| Instrument Name | Model PAA35-60T Regulated DC Power Supply |
| **AC Input Requirements** | |
| Voltage and Frequency: | 200 V ±10%, 50/60 Hz 3-phase AC |
| Power Consumption: | Approximately 3 kVA (operated with input voltage 200 VAC, output voltage 35 V and output current 60 A) |
| **DC Output Ratings** | |
| Output Voltage: | 1 - 35 VDC (10-turn potentiometer) |
| Voltage Resolution: | Approx. 6 mV (theoretical value) |
| Output Current: | 1 - 60 A (1-turn potentiometer) |
| Current Resolution: | Approx. 240 mA (theoretical value) |
| **Constant-voltage MODE** | |
| Voltage Stability | |
| Line effect: (Line Regulation) | 0.01% +5 mV (±10% change of input line voltage) (*1) |
| Load effect: (Load Regulation) | 0.01% +5 mV (0 - 100% change of output current) |
| Ripple and Noise: | 10 mV rms (for 5 Hz - 1 MHz) (*2) |
| Transient Response: | 100 msec typical (50 - 100% change) (*3) |
| Temperature Coefficient: | 100 ppm/$^{o}$C typical |
| Remote Control Resistance/Output Voltage Ratio: | 10 kΩ/35 V |
| **Constant-Current Mode** | |
| Current Stability | |
| Line effect: (Line Regulation) | 100 mA (±10% change of input line voltage) |
| Load effect: (Load Regulation) | 100 mA (1 - 35 V change of output voltage) |

| | |
|---|---|
| Ripple and Noise: | 100 mA rms, for 5 Hz - 1 MHz (for output voltage 1 - 35 V) (*2) |
| Operating Temperature Range: | 0 to 40°C (32 to 104°F) |
| Operating Humidity Range: | 10 to 90% RH |
| Cooling System: | Forced air cooling with fan |
| Output Polarity: | Positive or nigative grounded. |
| Isolation from ground: | ±150 V DC. |

Protections

| | |
|---|---|
| Overvoltage Protection: | Turns off input power switch if output voltage exceeds set voltage. 6 - 38 V (typical). |
| Overcurrent Protection: | Turns off input power switch if input current becomes abnormally large. |
| Overheat Protection: | Turn off input power switch if semiconductor cooling package fin temperature exceeds 100°C (212°F) or power transformer temperature exceeds 130°C (266 °F). |
| Phase dropout Protection: | Cuts off the output if any one of the three phases of input power is loss. |
| Alarm Lamp: | Indicates trip of overvoltage, overcurrent or overheat protector. Can be reset by turning on power switch again. |
| Input Fuses: | 10 A (6.4 mm dia.) |
| CC Lamp: | Indicates constant-current output mode (red LED) |

Meters

| | |
|---|---|
| Voltmeter: | Full scale 35 VDC (±2.5% of F.S) |
| Ammeter: | Full scale 60 ADC (±2.5% of F.S) |

Insulation Resistances

| | |
|---|---|
| Between Input Terminal and Chassis: | More than 30 MΩ, 500 VDC (at ambient humidity 70% RH or lower) |

| | |
|---|---|
| Between Output Terminal and Chassis: | More than 20 MΩ, 500 VDC (at ambient humidity 70% RH or lower) |
| Dimensions | |
| | 425 W × 160 H × 520 D mm<br>(16.73 W × 6.30 H × 20.5 D in.) |
| Including Extrusions: (*4) | 443 W × 214 H × 620 D mm<br>(17.44 W × 8.43 H × 24.4 D in.) |
| Weight: | Approx. 64 kg (141 lbs) |
| Accessories (in Packing): | One copy of instruction manual |
| | Three input power fuses (replacement spares), 10 A |
| | One input power cable, 4-core type (2 $mm^2$), approx. 4 meters |

*1. As measured making use of the remote sensing terminals.

*2. As measured keeping the AC input voltage constant.

*3. Period before recovering to within 0.5 V of set voltage.

*4. Can be installed on standard EIA or JIS rack by using rack mount brackets (optional).

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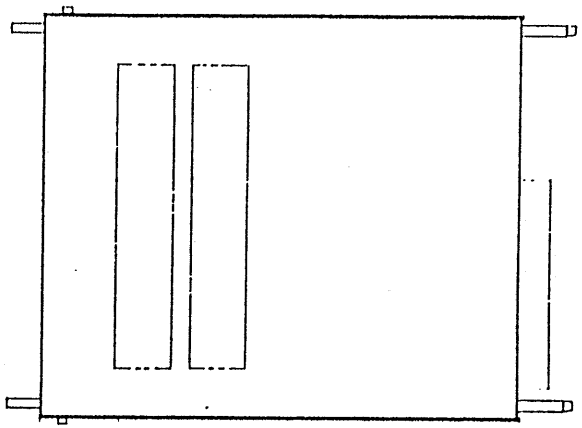
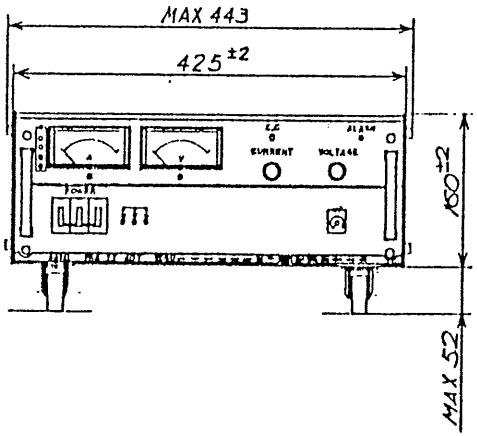
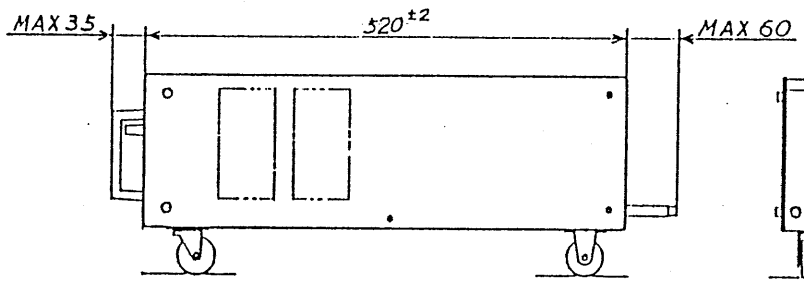
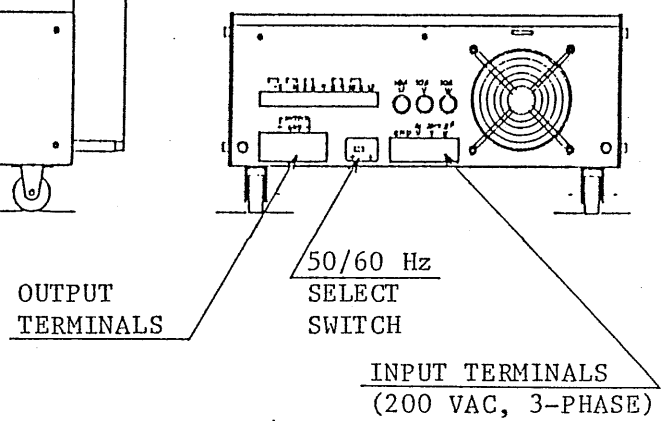





UNIT: mm

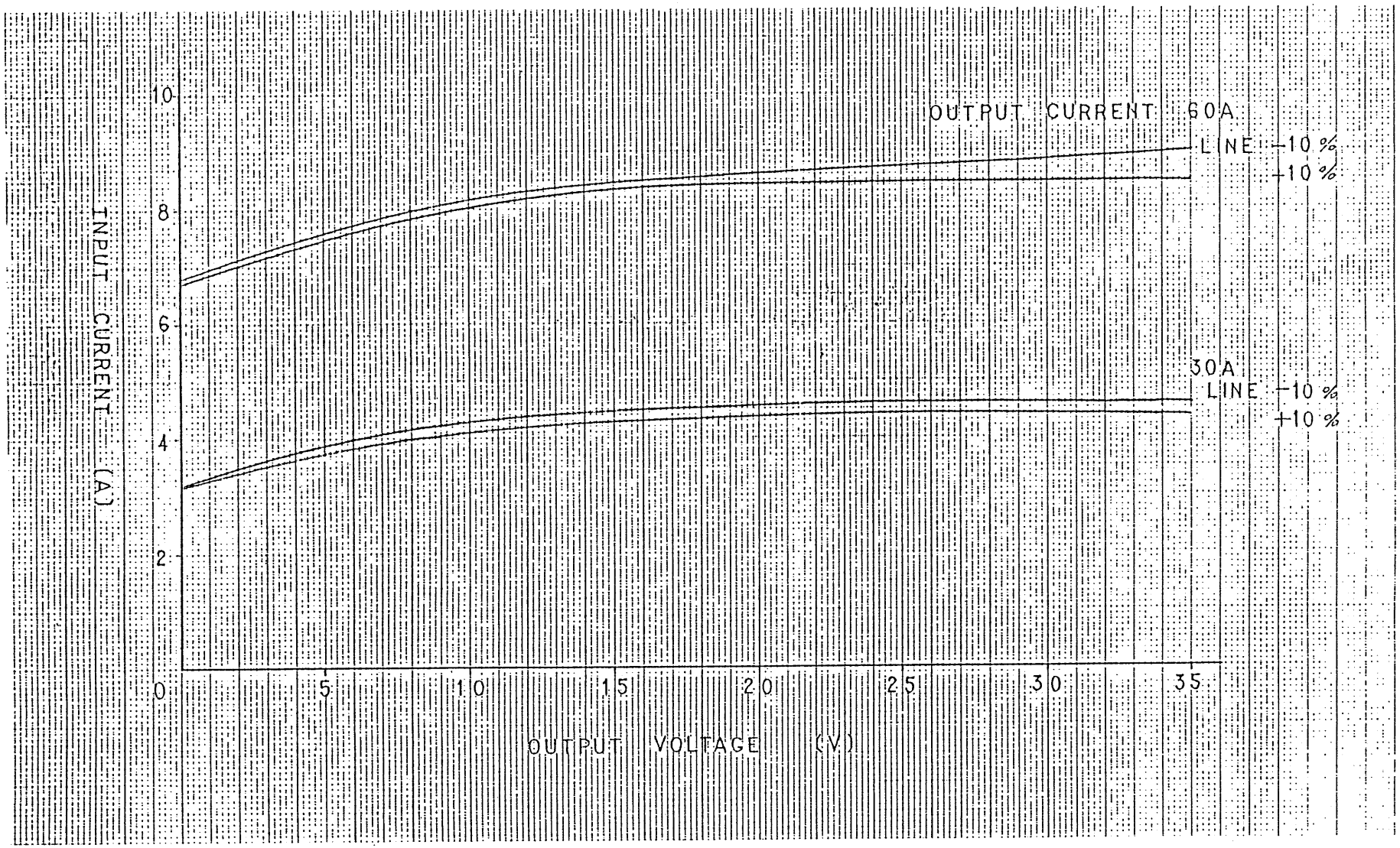



External Views and Dimensions of PAA35-60T

OUTPUT VOLTAGE V.S. INPUT CURRENT CHARACTERISTICS OF PAA35-60T

WITH OUTPUT CURRENT AND LINE VOLTAGE AS PARAMETERS

NOMINAL LINE VOLTAGE: 200V (3ø, 50Hz)



## 2. OPERATING INSTRUCTIONS

### 2.1 General Precautions

(1) Line Requirements

The AC input power line must be 180 - 220 V, 3-phase 48 - 62 Hz.

No attention is required to be paid regarding phase rotation. The input power cable cores can be connected in any phases to the input terminals of the PAA35-60T.

(2) Input Power Cable

The input power cable of the PAA35-60T is a 4-core type (cross section 2 $mm^2$). The green core is for grounding. Be sure to connect the green core to a good earth line.

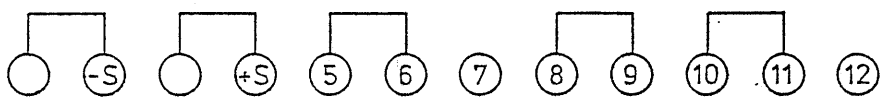
(3) Output

The PAA35-60T has a slow start circuit and it takes a period of 1 - 2 seconds before its output is delivered after its power switch is turned on. (When the output power is required to be frequently turned on and off, the method described in Section 3.4 may be used.)

To connect the output to a load, use sufficiently large wires (cross section 22 $mm^2$ or more). Note that, if small wires are used, voltage regulation at the load end may become poor due to voltage drop in the wires, which may become hot or be burnt in an extreme case.

(4) REMOTE Terminals

Make sure that the jumpers of the REMOTE terminals on the rear panel are securely connected as shown below.



(5) Conditions of Use

Pay attention so that the ventilation ports (top and sides) and the fan air outlet are not blocked.

Hot air comes out of the fan air outlet. Do not place near the outlet any object which is not heat resistant.

Do not use the power supply in a highly humid or dusty place since such may cause failures.

The power supply must not be used in metal-corrosive atmosphere, such as in sulfuric acid mist.

The power supply must be installed at a place resonably free from mechanical vibration.

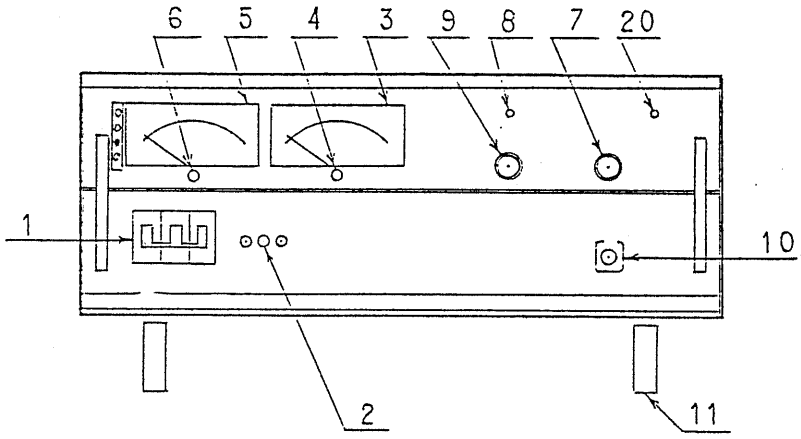
Do not place any high sensitivity instruments near the power supply which produces strong electric and magnetic fields.

(6) To Carry the Power Supply

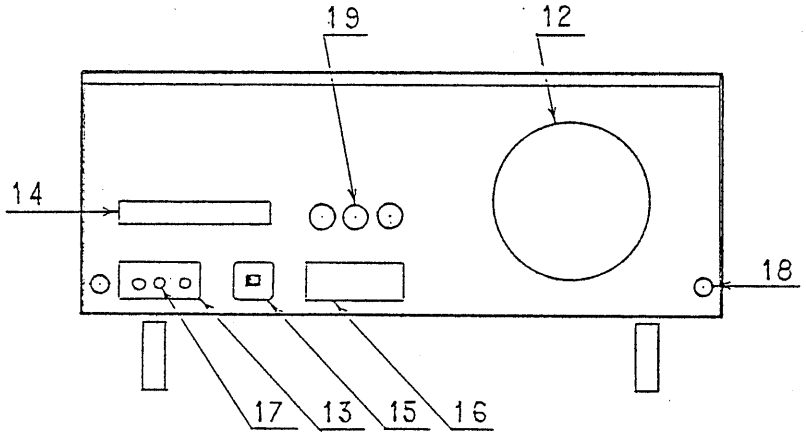
Exercise care when carrying the power supply, which weighs 64 kg (141 lbs) and whose center of gravity is at a forward position. Do not attempt to raise the power supply by holding it by its rear stoppers.

## 2.2 Layout and Description of Panel Items

Layout of Panel Items




Layout of Front Panel Items




Layout of Rear Panel Items

Description of Panel Items

(1) POWER Switch: Main input power switch. The top position is for on (the POWER lamp illuminates).

If the overvoltage, overcurrent or overheat protector trips, the POWER switch is automatically turned off.

(2) POWER Indicator Lamps: Illuminate (green) to indicate that main power is on.

(3) Voltmeter: Monitors output voltage. Full scale 35 V, ±2.5% of F.S

(4) Voltmeter zero-adjustment: To adjust voltmeter to mechanical zero.

(5) Ammeter: Monitors output current. Full scale 60 A, ±2.5% of F.S

(6) Ammeter zero-adjustment: To adjust ammeter to mechanical zero.

(7) Voltage Setting knob: To set the output voltage when in constant-voltage mode. (10-turn potentiometer)

(8) Current Setting knob: To set the output current when in constant-current mode. (1-turn potentiometer)

(9) CC Lamp: Illuminates (red) to indicate the constant-current mode.

(10) OVP Setting Control: To set the overvoltage protector trip voltage.

To set the OVP trip voltage, proceed as follows:

(1) Turn the OVP setting control to the full clockwise position.

(2) Set the output voltage at the required voltage with the output voltage setting knob.

(3) Slowly turn counterclockwise the OVP setting control to the point where the overvoltage protector trips and the POWER switch is turned off.

(4) Lower the output voltage setting. Turn on the POWER switch and gradually raising the output voltage, check that the overvoltage protector trips at the required voltage.

(11) Casters: For moving the instrument.

(12) Fan exhanst area: To expel hot air. Keep a clearance of 30 cm or more from wall.

(13) OUTPUT Terminals: Delivers the output of up to 35 V, 60 A.

(14) REMOTE Terminals: Terminals for remote sensing and remote control. (For details, see Section 3.)

(15) Line Frequency Selector: To select the line frequency. (Either 50 or 60 Hz can be selected simply by turning over the mark plate.)

(16) INPUT Terminals: Terminals for 3-phase AC input, with GND. Any phase lines can be connected to any phase terminals taking no heed of phase rotation. Be sure to connect the GND terminal to a good earth line.

(17) GND Terminal: This terminal is connected to the chassis of the power supply.

(18) Stopper: To protect the rear panel section of the power supply.

Note: Never attempt to raise the power supply by holding it by its stoppers.

(19) Input Power Fuses: AC main power fuses

(20) ALARM Lamps: Illuminates (red) to indicate that over-voltage, overcurrent or overheat protector has tripped. (See Section 4.)

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## 2.3 Operation Method

(1) Make sure that the frequency indicated on the frequency mark plate on the rear panel conforms with that of the AC line on which the power supply is to be used.

(2) Check that the AC line voltage is 200 V ±10%.

(3) Turn on the POWER switch, and the POWER lamps will illuminate to indicate that the power supply is in operation.

Notes: (1) When the overvoltage protector (OVP) is not used, set the OVP setting control at the full clockwise position. Note that the POWER switch is turned off if the OVP trips.

(2) The power supply has a large electrolytic capacitor connected in the output circuit. Note that a very large discharge current will flow if the output is shorted with a low impedance.

(3) Notes for special types of loads

(a) When the load is of such nature that it draws a current with peaks, even though the meter indication (average value) may be not greater than the set output current, the power supply may be driven into the constant-current mode for short periods at peaks and the output voltage may drop thereby degrading the output stability. You may find this state by carefully observing the CC lamp which will become dim. (See Figure 1.) When this state has occurred, make the output current setting larger or use a power supply or supplies of larger output rating.

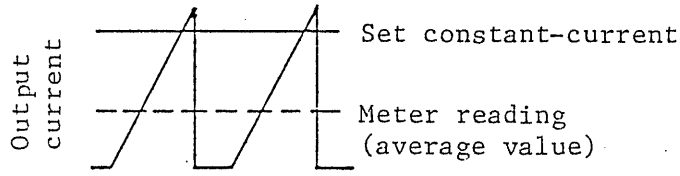


Figure 1

(b) When the load is of such a nature that it feeds a reverse current into the power supply (typical examples of this type of loads are inverters, converters, and transformers), the output voltage of the power supply may rise since the reverse current cannot be sunk by the power supply. To prevent such output voltage rise, connect a resistor in the output circuit of the power supply to sink the reverse current fed from the load. The resistance of the load may be calculated as follows:

$$R\ [\Omega] = \frac{Eo\ [V]}{I_{RP}\ [A]}$$

Where, R: Resistance of sink resistor
Eo: Output voltage
$I_{RP}$: Peak value of reverse current

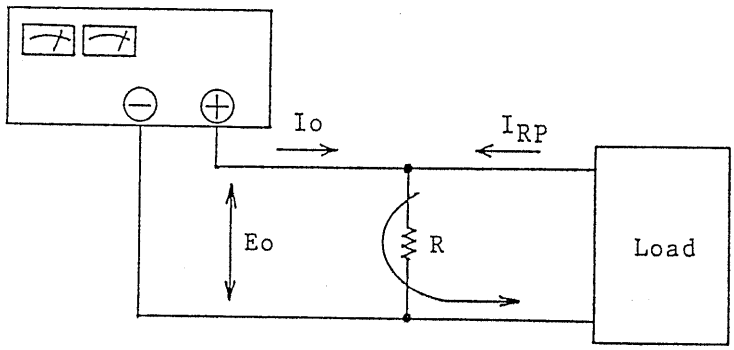


Figure 2

## 3. REMOTE SENSING AND REMOTE CONTROL

### 3.1 Remote Sensing

The remote sensing mode of operation is to stabilize the voltage at the load end by detecting the voltage there and feeding it back to the power supply to compensate for voltage drops caused in wiring from the power supply to the load. For this mode of operation, proceed as follows:

(1) Confirm that the POWER switch is OFF.

Note: Whenever connecting or disconnecting wires to or from the rear terminals, make sure that the POWER switch is OFF.

(2) Disconnect the jumpers from between terminals ○ -S and between terminals ○ -S.

(3) Connect the +S and -S terminals to the point (load end) where the voltage is to be stabilized. (For this connection, use a shielded cable or a pair of stranded wires to prevent induction noise.)

(4) When the wiring distance from the power supply to the load is long, oscillation may occur due to the inductance and capacitance of the wires. To prevent oscillation, connect capacitors C1 and C2 as shown below.

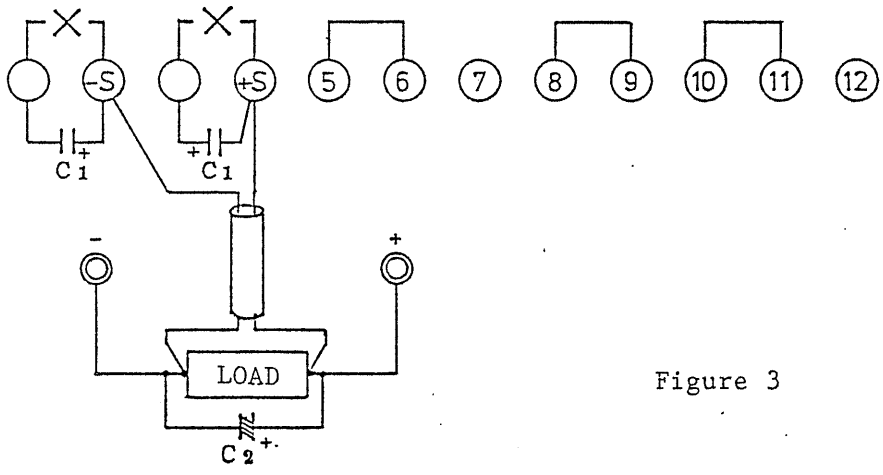


Figure 3

Notes: (a) Voltage of up to approximately 1.2 V can be compensated for with the above method. (The maximum available output voltage becomes lower by the amount of the compensating voltage.)

(b) When voltage changes at the load end are transient, they may be more effectively compensated for by raising the output voltage by an amount corresponding to voltage drops and connecting a large electrolytic capacitor at the load end instead of employing the remote sensing mode of operation.

3.2 Remote Control of Constant-voltage Output (Remote Programming)

(A) Remote Control with Resistance Signal

The constant-voltage output of the power supply can be remote-controlled with an external resistance signal. For this mode of operation, proceed as follows:

(1) Make sure that the POWER switch is OFF.

(2) Disconnect the jumper from between terminals (5) (6).

(3) Connect a control resistor between terminals (5) and (7) as illustrated below.

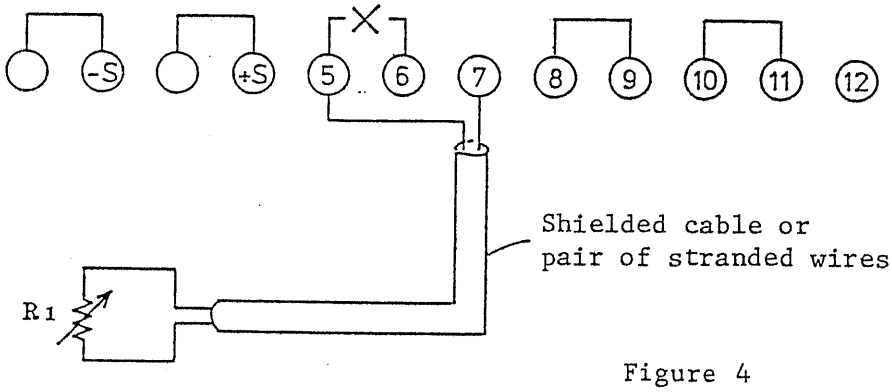


Figure 4

Output voltage Eo [V] ≒ 0.0035 $R_1$

Where, R1: Control resistor (≦ 10 kΩ)

(B) Remote Control with Voltage Signal

The constant-voltage output of the power supply can be remote-controlled with an external voltage signal. For this mode of operation, proceed as follows:

(1) Make sure that the POWER switch is OFF.

(2) Disconnect the jumper from between terminals (8) (9).

(3) Connect a control voltage between terminals (-S) and (8) as illustrated below. (As an external control voltage of -9 V is applied to terminal (8) with the common line connected to terminal (-S), an output voltage of -9 V is delivered.)

(4) Set the output voltage setting dial at the full clockwise position.

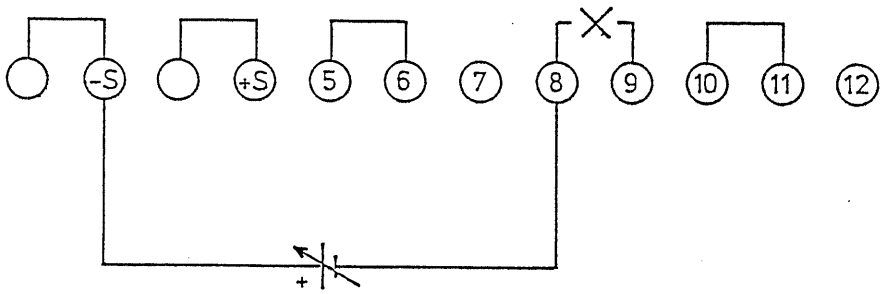


Figure 5

Output voltage $Eo \fallingdotseq \frac{35}{9} E1$

Where, E1 [V]: Control voltage ($\leq$ 9.2 V)

Note: If $E_1$ has a ripple voltage, it is reflected onto the output voltage being multiplied by a factor of approximately 4.

## 3.3 Remote Control of Constant-current Output (Remote Programming)

### (A) Remote Control with Resistance Signal

The constant-current output of the power supply can be remote-controlled with an external resistance signal. For this mode of operation, proceed as follows:

(1) Make sure that the POWER switch is OFF.

(2) Disconnect the jumper from between terminals (10) (11).

(3) Connect a control resistor between terminals (11) and (12).

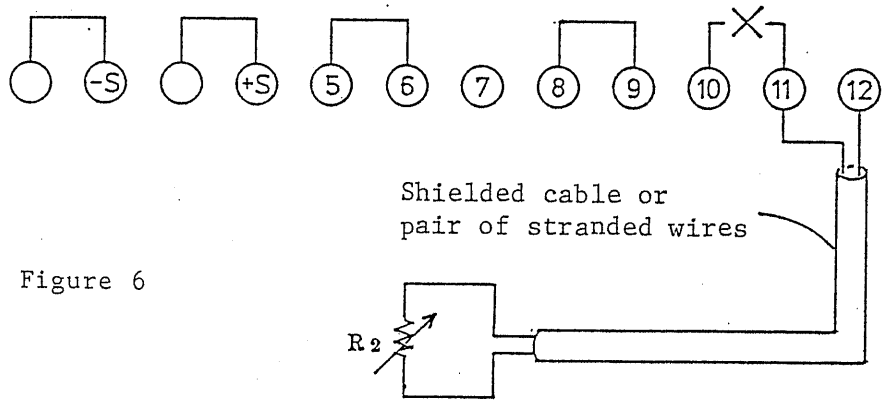


Figure 6

Output current Io [A] ≒ 0.6 R

Where, R[Ω]: Control resistance (≦ 100Ω)

### (B) Remote Control with Voltage Signal

The constant-current output of the power supply can be remote-controlled with an external voltage signal. For this mode of operation, proceed as follows:

(1) Make sure that the POWER switch is OFF.

(2) Disconnect the jumper from between terminals (10) (11).

(3) Connect between terminals (11) and (12) a voltage signal source which can sink a current of up to approximately 2 mA as illustrated below.

8.7.29.6.2

(4) Set the output current setting dial at the full clockwise position.

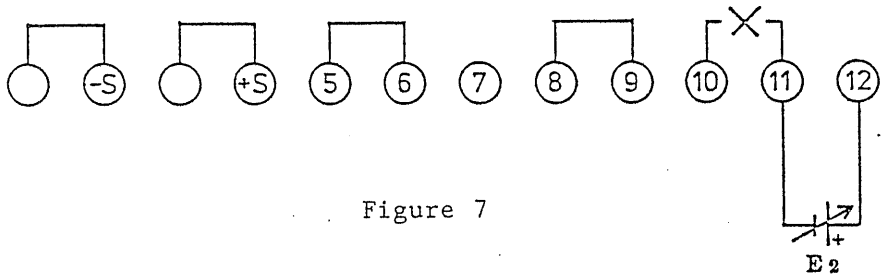


Figure 7

Output current Io [A] ≒ 0.6 $E_2$

Where, $E_2$ [mV]: Control voltage (≦ 110 mV)

3.4 ON/OFF Control of Output with Contact Signal

The constant-voltage output of the power supply can be ON/OFF-controlled with an external contact signal, as a particular case of remote control of the constant-voltage output with an external resistance signal.
For this mode of operation, proceed as follows:

(1) Make sure that the POWER switch is OFF.

(2) Connect an external contact signal between terminals (6) and (7).

The output is ON when the contact is OFF (broken), or the output is OFF when the contact is ON (made).

# 4. PROTECTIVE PROVISIONS

Model PAA35-60T Power Supply incorporates protective provisions as described in this section.

## 4.1 Overvoltage Protector (OVP)

When the output voltage has exceeded the set voltage due to erroneous operation or external noise, the OVP trips to turn off the POWER switch and to turn on the ALARM lamp. The set voltage is adjustable with the voltage setting control at the front panel using a screwdriver. To reset the OVP, eliminate the cause of the trip and then turn on the POWER switch again (allow a period of 10 seconds or more before turning on the POWER switch again).

## 4.2 Overcurrent Protector

When the input current has become abnormally large (when the triac current is detected to be abnormally large) due to a circuit failure or other cause, the overcurrent protector trips to turn off the POWER switch and to turn on the ALARM lamp.

## 4.3 Overheat Protector

When the power supply is overheated (when the semiconductor cooling Package fin temperature has become higher than 100°C (212°F) or the power transformer temperature has become higher than 130°C (266°F), the overheat protector trips to turn off the POWER switch and to turn on the ALARM lamp. To reset the overheat protector, cool off the power supply and then turn of the POWER switch again.

## 4.4 Phase dropout Protector

The power supply operates even when one of the three phases of its input power is missing due to a blown out fuse or other causes. When in this state, Phase dropout Protector turns off the output of the power supply.

# 5. MAINTENANCE

It is most recommendable to clean, inspect and adjust the power supply at certain intervals on a maintenance schedule.

Note: Repair service of the power supply must be done only by qualified parties--only by your Kikusui agent as a general rule.

## 5.1 Cleaning, Inspection and Adjustment

### (1) Cleaning the Power Supply

(a) When the panels have become dirty, wipe them with a cloth moistened with neutral soapsuds or alcohol and then wipe them with a dry cloth.

Note: Do not use benzine, thinner, or other solvent.

(b) Blow away dust collected in the ventilation holes and inside of the power supply by using a clean, dry compressed air (a vacuum cleaner may be used).

### (2) Inspecting the Power Cable, Terminals, and Knobs

(a) Check that the input power cable is not damaged. Check that the screws of the terminals are securely tightened and there are no loose jumpers.

(b) Check that the dials and knobs on the front panel are securely fixed.

### (3) Mechanical Zero Adjustment of Meters

Check the voltmeter and ammeter for mechanical zero and adjust them as required.

### (4) Voltmeter Calibration

Connect an accurate voltmeter (accuracy 0.5% or better) to the output circuit and set the output voltage at 35 V. Adjust R1 shown in Figure 5-1 so that the voltmeter of the power supply reads 35 V.

(5) Ammeter Calibration

Connect an accurate ammeter (accuracy 0.5% or better) to the output circuit and set the output current at 60 A. Adjust R2 shown in Figure 5-1 so that the ammeter of the power supply reads 60 A.

## 5.2 Replacing the Fuses

The input power fuses are located at positions shown in Figure 5-2. Replace them with 10-ampere fuses.

Note: Be sure to disconnect the input power cable from the AC line outlet before replacing the fuses.

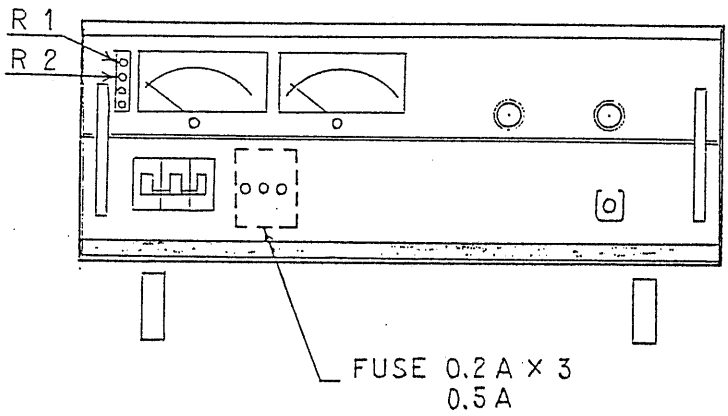


Figure 5-1

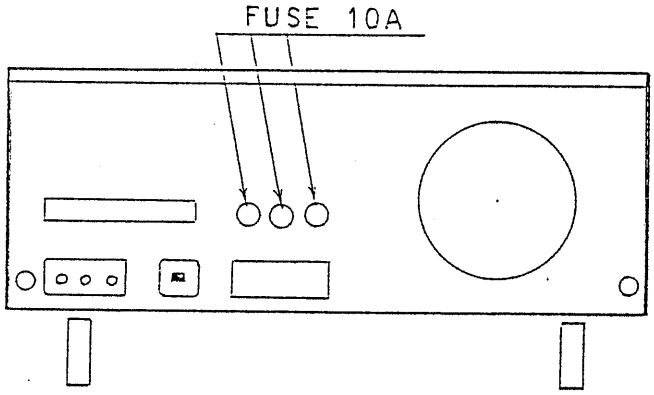


Figure 5-2

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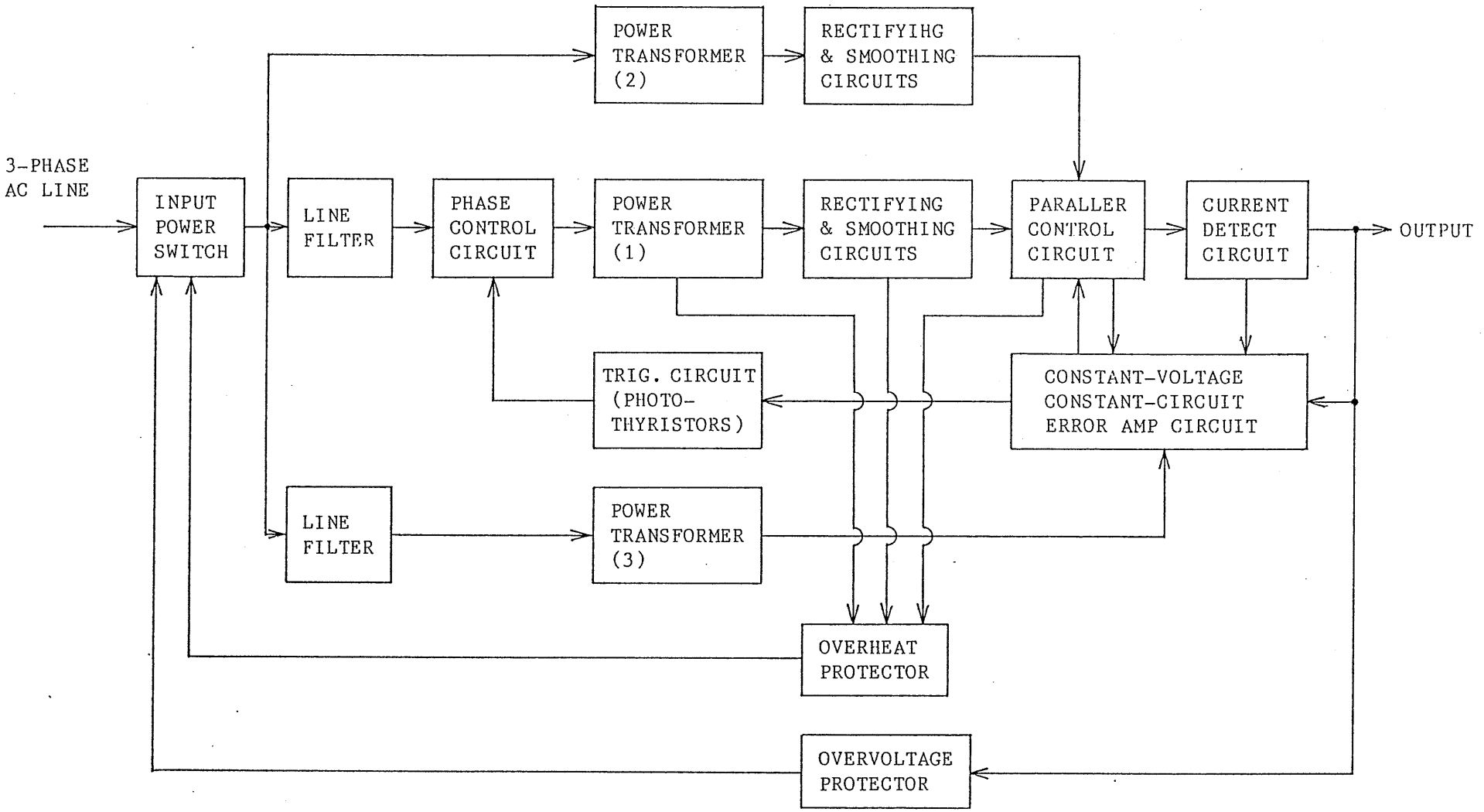


Block Diagram of PAA35-60T Power Supply