

INSTRUCTION MANUAL

REGULATED DC POWER SUPPLY

MODEL PWC 0620

KIKUSUI ELECTRONICS CORPORATION

802853

On Power Supply Source, it is requested to replace the related places in the instruction manual with the following items.

(Please apply the item of mark.)

- Power Supply Voltage: to \_ \_ \_ \_ \_ V AC
- Line Fuse: to \_ \_ \_ \_ \_ A
- Power Cable: to 3-core cable (See Fig. 1 for the colors.)

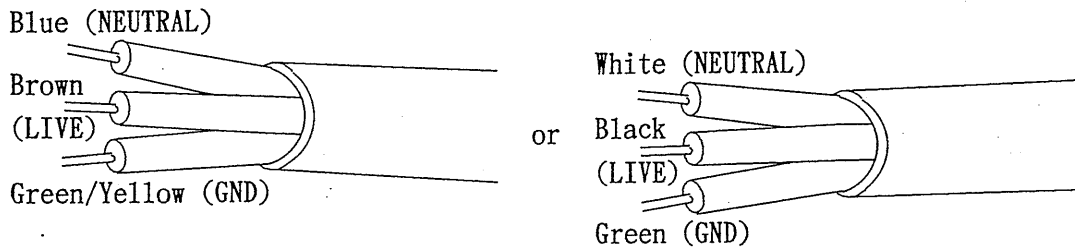


Fig. 1

Please be advised beforehand that the above matter may cause some alteration against explanation or circuit diagram in the instruction manual.

\* AC Plug: In case of Line Voltage 125V AC or more, AC Plug is in principle taken off and delivered, in view of the safety.

(AC Plug on 3-core cable is taken off in regardless of input voltages.)

TO connect the AC plug to the AC power cord, connect the respective pins of the AC plug to the respective core-wires (LIVE, NEUTRAL, and GND) of the AC power cord by referring to the color codes shown in Fig. 1.

Before using the instrument, it is requested to fix a suitable plug for the voltage used.

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## 1. GENERAL

The PWC 0620 is a multiple-output regulated DC power supply which provides three supply powers of 6 V, 3 A, and  $\pm 20$  V, 1 A. This instrument employs ICs and silicon semiconductors throughout, realizing high reliability and excellent electrical performances.

The  $\pm 20$  V, 1 A supply powers employ such system that the negative power follows the positive power. The voltage of the negative supply power is adjustable for a range of 50 - 100% of the set voltage of the positive supply power. The 6 V, 3 A power has an overvoltage protecting circuit to ensure a high operation safety.

Each power supply circuit is incorporated with a constant current type overload protection circuit and the protecting point (crossover point) can be set independently for each power supply circuit. When the crossover point is exceeded, an LED lamp turns on to indicate that the current has exceeded the limiting value.

A 10-turn potentiometer is used for output voltage setting of each of the 0 - 6 V and 0 -  $\pm 20$  V supply powers.

The instrument dimensions are for 1/2-rack mounting and two units can be installed on a 19-inch or 500-mm standard rack.

The outputs are available also at the instrument rear.

## 2. SPECIFICATIONS

Instrument name: Regulated DC Power Supply

Model No.: PWC 0620

Input power: 100 V  $\pm$ 10%, 50/60 Hz AC

Input fuse rating: 3 A (slow blow)

Power consumption: Approx. 170 VA (at rated output, with 100 V AC input)

Ambient temperature: 0 to 40°C (32 to 104°F)

Dimensions: 210 W  $\times$  140 H  $\times$  310 D mm  
(8.27 W  $\times$  5.52 H  $\times$  12.21 D in.)

Maximum dimensions: 217 W  $\times$  167 H  $\times$  363 D mm  
(8.55 W  $\times$  6.58 H  $\times$  14.29 D in.)

Weight: Approx. 9 kg (20 lbs)

### Supply voltages

(1) 0 - 6 V, 10-turn potentiometer

(2) 0 -  $\pm$ 20 V (dual tracking type), 10-turn potentiometer  
(0 - 40 V ..... series connection of 0 -  $\pm$ 20 V outputs)

o Adjustable tracking range:

Setting of negative voltage output is adjustable  
for 50 - 100% of setting of positive voltage output.

o Tracking accuracy:

$\pm$ 2% of maximum output voltage

### Output currents

(1) 6 V output: 0.6 - 3 A

(2)  $\pm$ 20 V outputs: 0.02 - 1 A

### Regulation

Line regulation (for  $\pm$ 10% line voltage change)

(1) 6 V output: 2 mV

(2)  $\pm$ 20 V output: 2 mV

Load regulation (for 0 - 100% output current change)

(1) 6 V output: 3 mV

(2)  $\pm 20$  V output: 3 mV

Ripple noise (5 Hz - 1 MHz)

(1) 6 V output: 0.5 mVrms

(2)  $\pm 20$  V output: 0.5 mVrms

Residual voltage

(1) 6 V output: Not greater than 50 mV

(2)  $\pm 20$  V outputs: Not greater than 50 mV

Overload protection: Automatic constant-current crossover type

When either one of the  $\pm 20$  V outputs is subjected to the current limit operation, the voltage of the other output follows that of the current-limited output.

Current limit indication: LED light (red)

Overvoltage protection: Output shorting (6 V output only)

Voltage setting range: 4 - 8 V

Voltage rise time: 0.2 - 0.4 sec (time for output voltage to reach 90% of the set output voltage after turning on the input power)

Output terminals

Front panel (binding posts)

6 V output: - (white), GND (black), + (red)

$\pm 20$  V outputs: - (white), COM (black), + (red)

Rear panel

6 V output: -S (1), - (2), GND (3), + (4), +S (5),  
(Sampling possible)

$\pm 20$  V outputs: - (6), COM (7), + (8)

Polarity

6 V output: Positive or negative

$\pm 20$  V outputs: Floating. COM isolated from GND.

Voltage to ground:  $\pm 150$  V maximum

Insulation resistances

Between chassis and input power: More than  $30 \text{ M}\Omega$  , as measured  
with 500 V DC

Between chassis and output terminal: More than  $20 \text{ M}\Omega$  , as measured  
with 250 V DC

Indicating meters

Voltmeter, 7/21 V full scale, class 2.5 (JIS)

Ammeter, 3.5/1.1 A full scale, class 2.5 (JIS)

Accessories:            Instruction manual ..... 1  
                          Input power fuse (replacement  
                          spare), 3 A, slow blow ..... 1

### 3. OPERATION METHOD

#### 3.1 Explanation of Panel Items

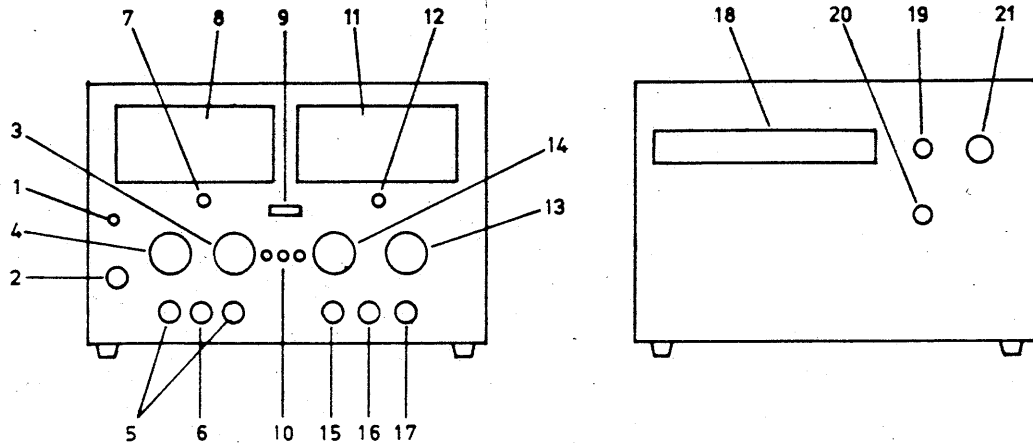


Figure 3.1

- 1 Input power indicator light (LED, green)
- 2 Input power switch
- 3 6 V output constant-voltage setting knob  
(The output voltage increases as this knob is turned clockwise.)
- 4 6 V output current limiting knob  
(The current increases as this knob is turned clockwise.)
- 5 6 V output terminal (binding posts)
- 6 GND terminal (connected to chassis)
- 7 Ammeter zero adjustment
- 8 Ammeter, 2 ranges
- 9 Meter selector switch
- 10 Current limit indicator light (LED, red)
- 11 Voltmeter, 2 ranges
- 12 Voltmeter zero adjustment



- 13  $\pm 20$  V output constant-voltage setting knob  
(The output voltage increases as this knob is turned clockwise.)
- 14  $\pm 20$  output current limiting knobs  
Smaller knob: +20 V output  
Larger knob: -20 V output
- 15  $\pm 20$  V output "-" terminal
- 16  $\pm 20$  V output COM terminal
- 17  $\pm 20$  V output "+" terminal
- 18 Rear panel terminal board
- 19  $\pm 20$  V output tracking ratio adjustment (semi-fixed variable resistor)  
The negative voltage is adjustable for a range of 50 - 100% of the positive voltage. The negative voltage decreases as this variable resistor is turned counterclockwise.
- 20 6 V output overvoltage protection circuit voltage setting adjustment (semi-fixed variable resistor)  
The set voltage increases as this variable resistor is turned clockwise.
- 21 Input power fuse holder, 3 A, slow blow type

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### 3.2 Notes for Use

#### 1. Input AC line power

This instrument operates on an AC line power of 100 V  $\pm$ 10%, 48 - 62 Hz AC. (The instrument normally is shipped from the factory being set for operation on a nominal 100 V AC line. By changing taps of the transformer, the instrument can be modified for operation on a 110 V or 117 V AC line.)

#### 2. Outputs

The output powers are available either from the binding post terminals on the front panel or the terminal board on the rear panel. No load, however, can be operated on the +S and -S terminals. This instrument is completely free of overshoots--no overshoots are produced when the power is turned on or off.

#### 3. Operating ambient temperature range

The operating ambient temperature range of this instrument is 0 to 40°C (32 to 104°F). Use the instrument within this range. When using the instrument at about 40°C, at a low voltage near the rated current, make sure to provide good ventilation for the instrument to prevent its overheat.

#### 4. Environments

Do not use the instrument in the following environments;

- o Highly humid or dusty place
- o Poorly ventilated place
- o Near other power supply or other source of heat.

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### 3.3 Check Before Operation

Before operating the instrument, check the following items:

- o Check that the AC line voltage is correct.
- o Check that the power fuse is of the correct rating.
- o Check that the shorting bars of the rear panel terminal board are securely connected in the correct positions.

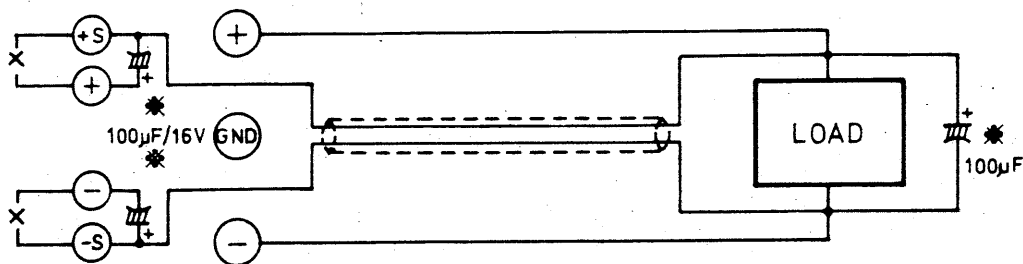
### 3.4 Operation Method of 6 V Power

Constant voltage operation

- (1) Connect the input AC power cord to an AC line receptacle and turn on the input power switch. The power indicator light (LED, green) will turn on.
- (2) Turn the current limiting knob to the extremely clockwise position. Under this state, set the output voltage at the required voltage with the voltage setting knob. (The output voltage increases as the knob is turned clockwise.)
- (3) If the current limiting function is required, short the output terminals and set the limit current at the required value with the current limiting knob. (The output current increases as the knob is turned clockwise.)
- (4) Connect the load to the output terminal.
- (5) When the load is located apart from this instrument, voltage regulation at the load end may be degraded due to voltage drop in the wires between this instrument and load. In such a case, use the sampling terminals.

To use the sampling terminals, disconnect the shorting bars from between +S and + terminals and between -S and - terminals of the rear panel terminal board, and connect the +S and -S terminals to the point where the output

voltage is to be regulated. A voltage drop up to approximately 0.3 V can be compensated for with this provision. (Note that setting of limit current value may vary depending on the resistance of the lead wires.)



Use a 2-core shielded cable or a pair of stranded wires. Connect the shield line to the "+" or "-" terminal as required.

\* Capacitor to suppress oscillation

Figure 3.2

#### Overvoltage protection circuit

- (1) Turn the OVP setting semi-fixed variable resistor of the rear panel to the extremely clockwise position.
- (2) Set the voltage setting knob on the front panel at the required protection voltage.
- (3) Turn gradually counterclockwise the OVP setting semi-fixed resistor on the rear panel to the point where the voltage starts falling.
- (4) Turn counterclockwise the voltage setting knob of the front panel. To reset the overvoltage protection operation, turn the current limiting knob once to the extremely counterclockwise position and then turn it clockwise or turn off the power switch once and turn on it again.

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### 3.5 Operation Method of $\pm 20$ V Powers

- (1) Connect the input AC power cord to an AC line receptacle and turn on the input power switch. The power indicator light (LED, green) will turn on.
- (2) Turn the current limiting knob to the extremely clockwise position. Under this state, set the output voltage at the required voltage with the voltage setting knob. (The output voltage increases as this knob is turned clockwise.) Both positive and negative voltages are set at the same value.
- (3) The negative voltage is variable with the tracking ratio adjustment semi-fixed resistor on the rear panel. (The output voltage decreases as this semi-fixed resistor is turned counterclockwise.) The variable range is 50 - 100% of the positive voltage.
- (4) If the load current limiting function is required, short the output terminals and set the limit current setting knob at the required value with the current limiting knob. (The output current increases as this knob is turned clockwise.) Each of the positive and negative outputs can be set independently.
- (5) When either the positive or negative output is subjected to the current limit operation, the voltage of the other output follows that of the output subjected to the current limit operation. (Patent pending)

#### 4. OPERATING PRINCIPLE

The PWC 0620 consists primarily of rectifier circuits, control circuits and error amplifier circuits the functions of which are as follows:

- (1) Rectifier circuit: Steps down the AC input power with a transformer and rectifies and smoothes out it into a DC power with a rectifying and filter circuit.
- (2) Control circuit: Receives the input DC voltage and controls the output voltage with the signal received from the error amplifier circuit.
- (3) Error amplifier circuit: Detects deviation of output voltage, amplifies the output voltage, and sends the amplified voltage to the control circuit to regulate the output voltage.

The rectifier circuit of the 6 V power supply employs a center tap system and those of the  $\pm 20$  V powers supply a bridge system. The filter circuits are of a capacitor input type. The control circuits employs power transistors, providing sufficient allowances. The amplifiers are general-purpose operational amplifiers which ensure high operation safety.

The error amplifiers perform a constant-voltage operation that it detects deviation of the output voltage and provides an error signal to balance out the deviation or a constant-current operation that it detects deviation of the output current and balances it out.

#### 4.1 Constant-voltage Circuit

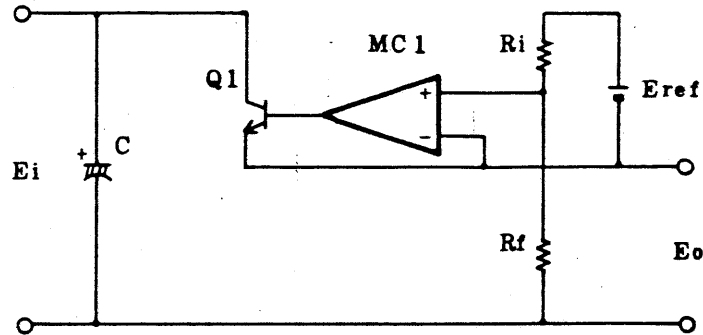


Figure 4.1

The concept of the constant-voltage circuit is shown in Figure 4.1. Assuming MC1 to be an ideal amplifier of infinitive gain, infinitive input resistance and zero output resistance, the following equation can be written.

$$\frac{E_{ref}}{E_o} = \frac{R_i}{R_f}$$

Output voltage  $E_o$  can be written as follows:

$$E_o = \frac{R_f}{R_i} E_{ref}$$

This equation indicates that output voltage  $E_o$  can be maintained constant by maintaining  $R_f$ ,  $R_i$  and  $E_{ref}$  constant. This instrument employs a temperature-compensation zener diode for reference voltage  $E_{ref}$  and aging-durable excellent-temperature-characteristic metal-film or wirewound resistors for input resistor  $R_i$  and feedback resistor  $R_f$ . The output voltage is adjustable by varying feedback resistor  $R_f$ .

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## 4.2 Current-limiting Circuit

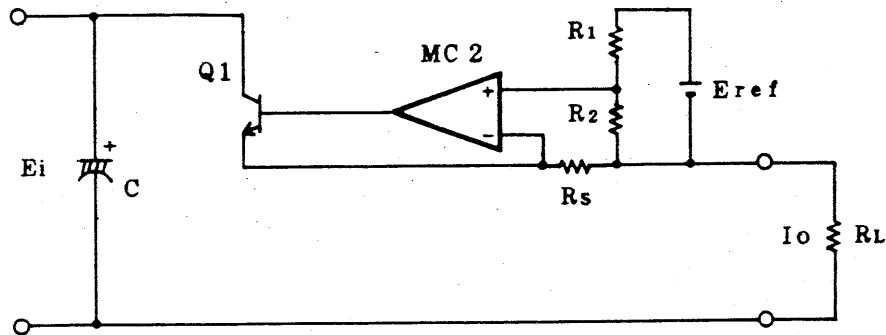


Figure 4.2

The concept of the current limiting circuit is shown in Figure 4.2. When the voltage drop across current detecting resistor  $R_s$  has exceeded the voltage obtained by dividing reference voltage  $E_{ref}$  with dividing resistors  $R_1$  and  $R_2$ , the output voltage of ideal amplifier MC2 falls and the instrument operation enters into the constant-current region. The relationship between  $I_o$  and  $E_{ref}$  is expressed as follows:

$$R_s \cdot I_o = \frac{R_2}{R_1 + R_2} E_{ref}$$

$I_o$  is written as follows:

$$I_o = \frac{R_2}{R_s(R_1 + R_2)} E_{ref}$$

The set current is adjustable by varying the ratio between dividing resistors  $R_1$  and  $R_2$ .

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### 4.3 Output Circuit (Dual tracking Outputs)

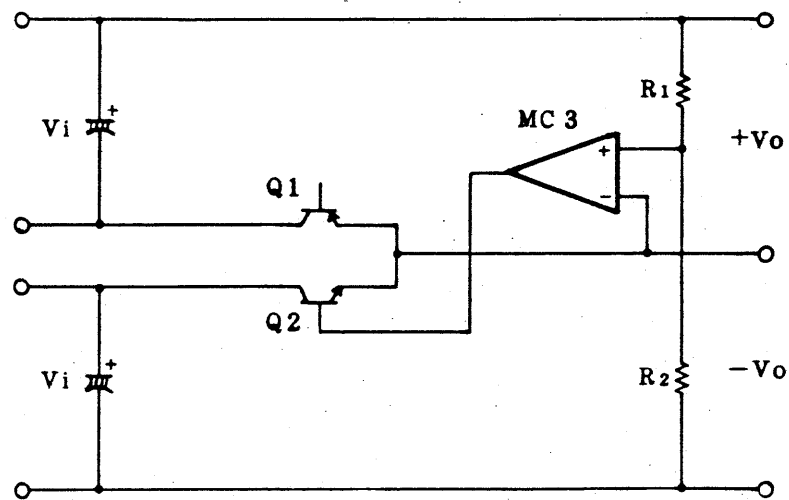


Figure 4.3

The concept of the output circuit is shown in Figure 4.3. Assuming an ideal amplifier for MC3, the relationships of +Vo, -Vo, R<sub>1</sub> and R<sub>2</sub> can be expressed as follows:

$$\frac{+V_o}{-V_o} = \frac{R_1}{R_2}$$

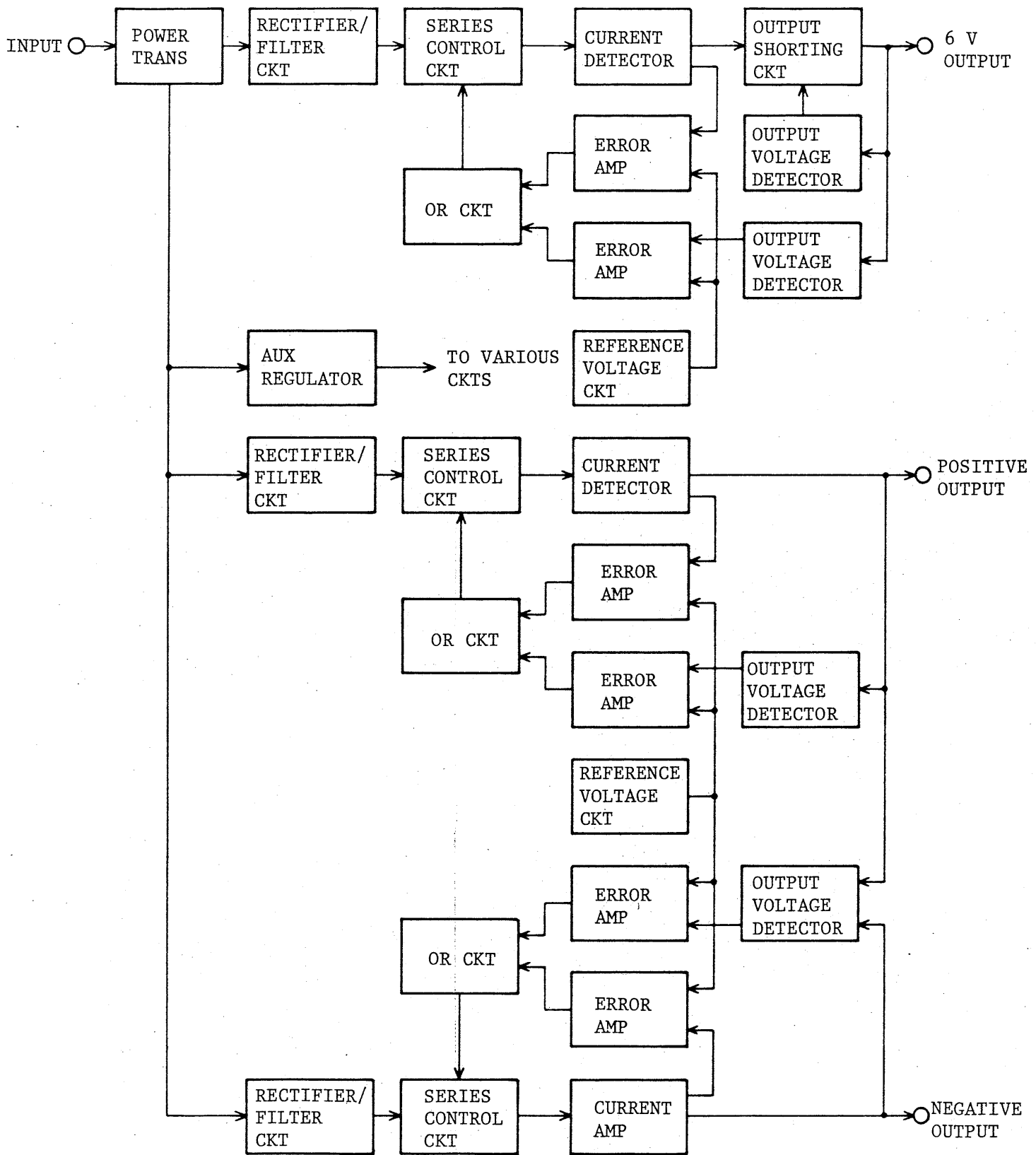
$$-V_o = \frac{R_2}{R_1} \cdot (+V_o)$$

If  $R_2 = R_1$ , the negative voltage (-Vo) follows the positive voltage (+Vo) with the same value but in the reverse polarity.

If  $R_2 = R_1/2$ , the negative voltage follows the positive voltage with a half voltage of the positive voltage.

The follow-up ratio is adjustable for a range of 1 - 1/2 (100% - 50%) by varying R<sub>2</sub>.

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Block diagram

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## 5. INSPECTION AND MAINTENANCE

### 5.1 Adjustment of Maximum Output Voltage

Connect a voltmeter of an accuracy of 0.5% or better to the output terminals. Turn the output voltage setting knob to the extremely clockwise position to obtain the maximum output voltage. So adjust the corresponding variable resistor on PCB A-117 that the required output voltage is obtained. The required output voltages (A) and variable resistors (B) are shown in the following table:

	A	B
6 V, 3 A	6.4 V	R318
+20 V, 1 A	21 V	R417
-20 V, 1 A	21 V	R435

Note: When adjusting the -20 V output, keep the tracking ratio adjustment semi-fixed variable resistor of the rear panel in the extremely clockwise position.  
(See Figure 5.1.)

### 5.2 Adjustment of Maximum Output Current

Connect an ammeter of an accuracy of 0.5% or better to the output terminals. Turn the current limiting knob to the extremely clockwise position to obtain the maximum output current. So adjust the corresponding variable resistor on PCB A-117 that the required output current is obtained. The required output current (C) and variable resistors (D) are shown in the following table:

	C	D
6 V, 3 A	3.2 A	R305
+20 V, 1 A	1.05 A	R406
-20 V, 1 A	1.05 A	R423

(See Figure 5.1.)

### 5.3 Calibration of Meters

Before calibrating the meters, make it sure that they are well set in their mechanical zero position. If not in the zero position, adjust it with the mechanical zero adjustment screw.

#### Voltmeter:

Set the meter selector switch (E) in the required position. Connects a voltmeter of an accuracy of 0.5% or better to the output terminals. Adjust the output voltage at the required voltage (F) with the output voltage setting knob. So adjust the corresponding variable resistor (G) on PCB A-117 that the instrument voltmeter indicates the set voltage.

	E	F	G
6V, 3 A	6 V, 3 A	6 V	R331
±20 V, 1 A	+20 V, 1 A	20 V	R439

Note: When calibrating the ±20 V outputs, keep the tracking ratio adjustment semi-fixed variable resistor on the rear panel in the fully clockwise position and check that the voltage remains unchanged when the meter selector switch is changed between +20 V, 1 A and -20 V, 1 A. If the voltage changes, adjust the -20 V output as explained in Sub-section 5.1. (See Figure 5.1.)

Ammeter:

Set the meter selector switch in the required position (H). Connect an ammeter of an accuracy of 0.5% or better to the output terminals. Set the output current at the required value (I) with the current limiting knob and so adjust the corresponding variable resistor (J) on PCB A-117 that the instrument ammeter indicates the set value. The required currents (I) and the corresponding variable resistors (J) are shown in the following table:

	H	I	J
6 V,	6 V, 3 A	3 A	R329
+20 V, 1 A	+20 V, 1 A	1 A	R437
-20 V, 1 A	-20 V, 1 A	1 A	R442

(See Figure 5.1.)

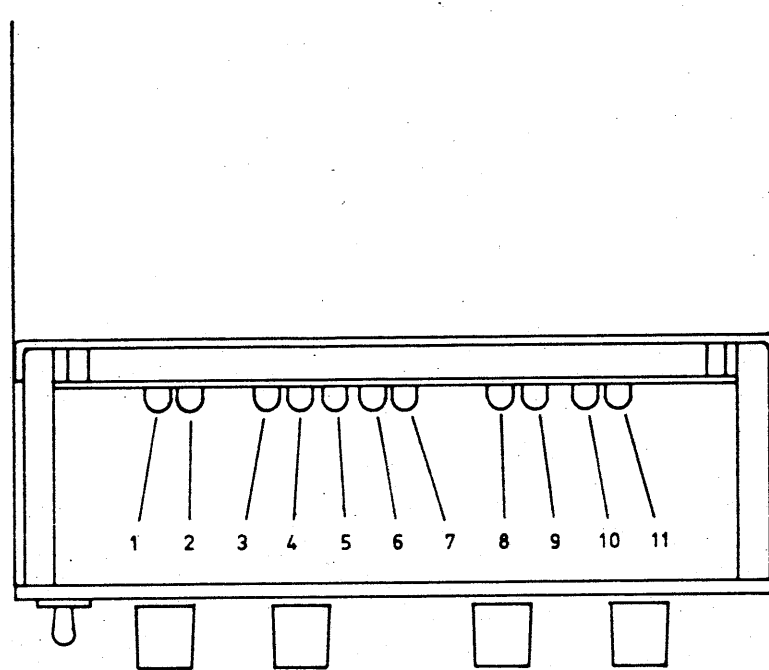


Figure 5.1

- |     |                     |  |
|-----|---------------------|--|
| 1.  | 6 V output:         | Maximum current limiting range adjustment (R305) |
| 2.  | 6 V output:         | Maximum constant-voltage range adjustment (R318) |
| 3.  | 6 V output:         | Ammeter calibration (R329)                       |
| 4.  | 6 V output:         | Voltage calibration (R331)                       |
| 5.  | -20 V output:       | Ammeter calibration (R442)                       |
| 6.  | +20 V output:       | Ammeter calibration (R437)                       |
| 7.  | $\pm$ 20 V outputs: | Voltmeter calibration (R439)                     |
| 8.  | -20 V output:       | Maximum current limiting range adjustment (R406) |
| 9.  | -20 V output:       | Maximum constant-voltage range adjustment (R435) |
| 10. | +20 V output:       | Maximum current limiting range adjustment (R406) |
| 11. | +20 V output:       | Maximum constant-voltage range adjustment (R417) |