INSTRUCTION MANUAL

DIGITAL PROGRAMMABLE POWER SOURCE

MODEL DPS V 50-3

KIKUSUI ELECTRONIC CORPORATION

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1. GENERAL

The DPS V 50-3 Digital Programmable Power Source is a bipolar constant-current constant-voltage power source designed for use in automatic test systems. Its output voltage can be controlled with an external signal.

Voltage setting can be done with two ranges: 0 to ±4.999 V (1 mV resolution) and 0 to ±49.99 V (10 mV resolution). Voltage setting, including polarity setting, can be controlled with a 16-bit signal.

The output voltage is controlled with a TTL level negative logic BCD signal. When the required data is ready, a strobe signal turns on. The data is stored in an internal register and at the same time the output voltage swiftly and accurately shifts to the preset values.

Compliance can be set for a range of approximately ±(100 mA to 3 A) using a manual knob on the front panel. When the set value is reached, the operation changes to the constant-current mode.

The output section is electrically isolated from the input control section. Addresses can be specified as required. A multiple-channel power source system can be easily set-up, making this instrument extremely versatile.

This instrument can be used as a power source for semiconductor testing, IC testing, circuit board testing as well as a regular power source for many electronic devices. When used in conjunction with a Kikusui GP-IB Interface, this instrument is compatible with many types of computers and can be used in automatic measuring systems.

2. SPECIFICATIONS

Instrument name: Digital Programmable Power Source

Model No. : DPS V 50-3

Output section

Type: Bipolar constant-voltage constant-current transfer type

Voltage: 0 to ±49.99 V

Ranges: Two ranges of 5 V and 50 V

Resolutions: 1 mV and 10 mV

Setting accuracy: 0.05% + 0.01% of range (at 25°C (77°F))

Ripple and noise: 300 μV rms or less (at 10 Hz - 1MHz)

Programming noise: ±50 mV peak or less (at rear terminal, 50 V range)

Load regulation: 0.006% of range + 500 μV or less (at rear terminal), for 0 - 100% load change

Line voltage regulation: 0.002% or less, for ±10% line voltage change

Response speed: 500 μsec or faster, for "-" maximum voltage to "+" maximum voltage within the range

Output current: 3 A maximum

Setting: Manual, approx. ±(100 mA to 3 A)

Control section

Input/output signal: TTL level

Control signals

Data	Polarity	1 bit	
	Voltage	15 bits	(BCD)
Strobe		1 bit	(edge)
Address		4 bits	
$\overline{\text{Standby}}$		1 bit	
Range		2 bits	
Set		1 bit	
Direct zero		1 bit	
Direct standby		1 bit	
Data clear			(except polarity)

Output signals

Address coincidence

Data accept (DAC)

Error flag o Data overflow

o Range inconformity

Thermal down

Constant-current transfer (CC)

$\overline{\text{Ready}}$

Ambient temperature:	5°C to 35°C (41°F to 95°F)
Withstanding voltage of input/output circuit:	500 V maximum
Power requirements:	117 V ±10%, 50/60 Hz AC, approx. 360 VA (with full load)
Dimensions:	430W × 160H × 370D mm (16.93W × 6.30H × 14.57D in.)
Maximum dimensions:	440W 175H 420D mm (17.32W × 6.89H × 16.54D in.)
Weight:	Approx. 23 kg (51 lb.)
Accessories:	Instruction manual 1 copy 50P plug 1

3. OPERATION METHOD

3.1 Description of Front Panel (See Figure 3-1.)

① POWER switch:

The power switch (circuit breaker) is a rocker type. The instrument power is turned on as the ON side in an depressed.

② OUTPUT terminals:

The output terminals (binding posts) provide an output of ±(0 to 50 V, 3 A). The white terminal is an L-side terminal. These terminals are connected in parallel with the output terminals on the rear panel.

③ CURRENT:

The current limiting knob has a range of approximately 100 mA to 3 A. When the current has reached the limit value, the operation is transferred into the constant-current mode.

④ DISPLAY lamps:

These LEDs indicate the operating state of the instrument.

3.2 Description of Rear Panel (See Figure 3-2.)

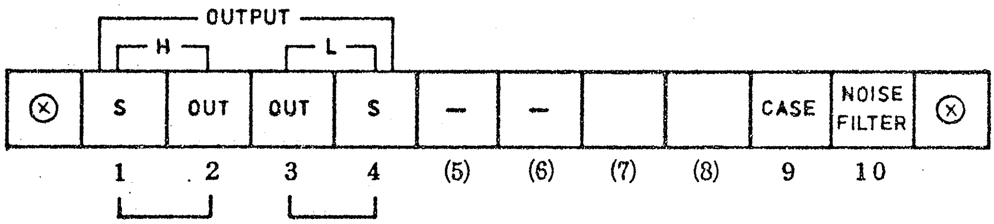
⑤ ADDRESS switch:

These dip switches are for address setting of each individual instrument. 1 is for 2^0, 2 for 2^1, 3 for 2^2 and 4 for 2^3. When flipped to the lower position, these switches become the logical 1 state. Dip switches 5, 6 and 7 are not connected. When this switch is set in the ON state (lower position), the external signal applied via terminals 5 and 6 is added to the data signal. This function may be used to superimpose an AC signal on the DC signal (data signal) or to use the instrument as an amplifier.

⑥ OVP:

This function is to short the output when it has exceeded the preset voltage. Once this circuit has tripped, it can not be reset unless 0 V is written or the power is turned on again. The left-hand side is the "-" side and the function becomes idle when this control is turned to the fully counterclockwise position; the right-hand side is the "+" side and the function becomes idle when this control is turned to the fully clockwise position. A slight voltage of 1 - 2 V may remain even when the circuit is shorted -- this is not an abnormal indication.

⑦ Terminal block



(1) When no sensing is required, short-circuit this sensing terminal (H side) to terminal (2).

(2) Output terminal (H side)

(3) Output terminal (L side)

(4) When no sensing is required, short-circuit this sensing terminal (L side) to terminal (3).

(5) When the address switch (8) is set in the ON state (lower position), the external signal applied viaterminals 5 and 6 is added to the data signal. This function may be used to superimpose an AC signal on the DC signal (data signal) or to use the instrument as an amplifier.

(6) This terminal is the "-" side of the above terminal.

(9) Case ground terminal

(10) Center power line noise filter terminal.
If this terminal is connected to the case ground terminal, a current leak occurs although the filtering effect is improved. Connection of this terminal will vary depending on the usage.

8 Connector

For connection of control input (50-pin connector)

9 Cooling fan

Internal motor-driven fan (cooling air outlet)

10 Fuses

Fuses (4 amperes) in "+" and "-" output lines. To remove bracket, turn it counterclockwise.

11 Fuse

Fuse (5 amperes, 100 V AC) in primary circuit of power transformer.

12 Power cord

To be connected to an AC line (50/60 Hz)

13 Cord holder

To hold power cord in place when this instrument is carried or stored.

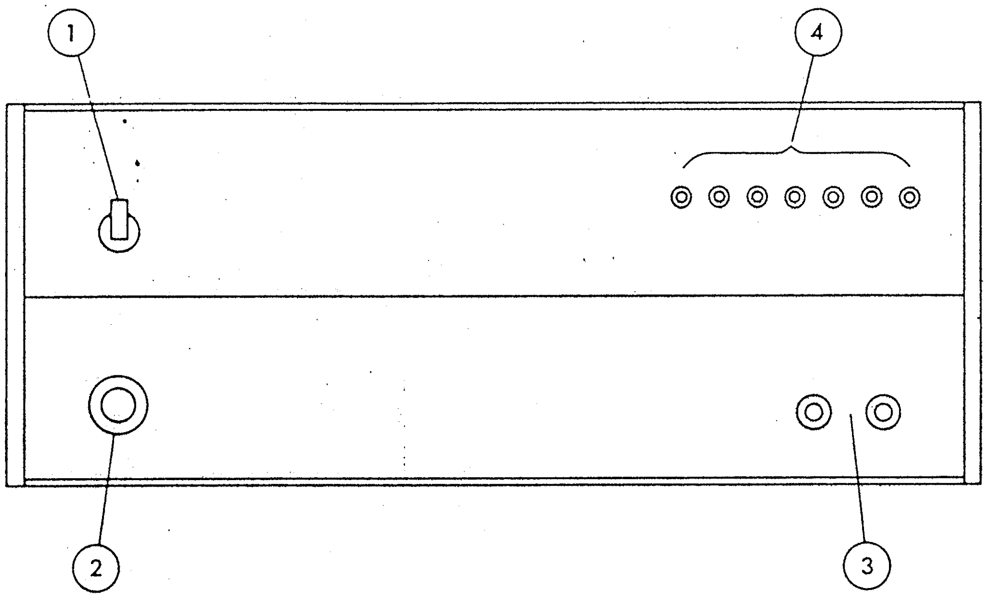


Figure 3-1. Front panel

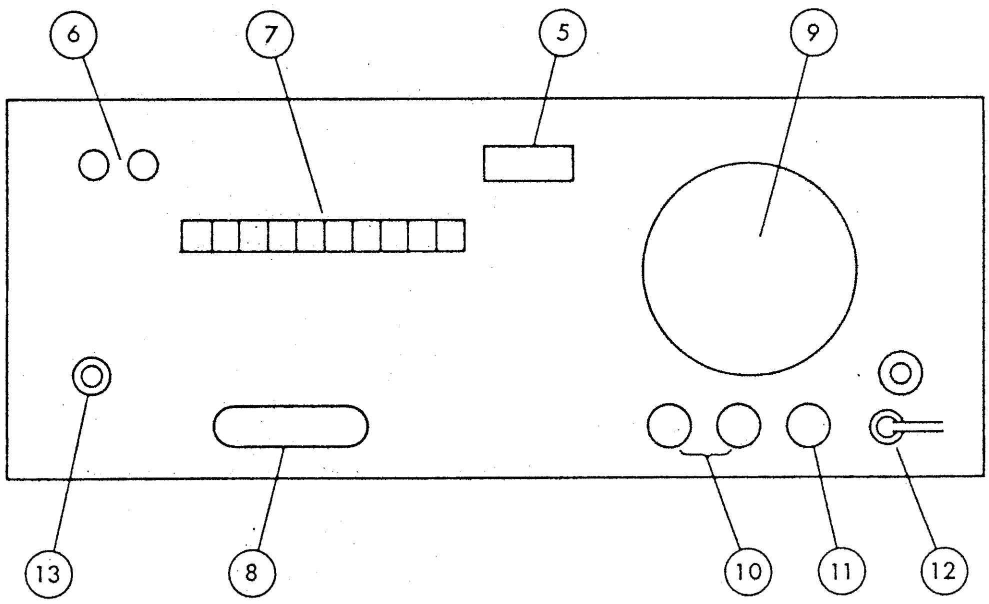


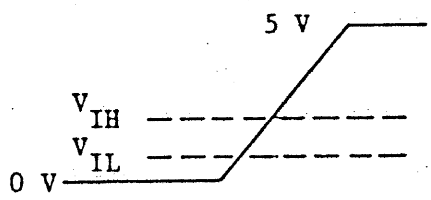
Figure 3-2. Rear panel

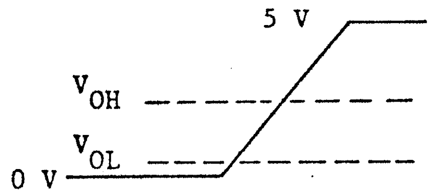
3.3 Pins of Control Input Connector

1	STROBE		26	1	LSD
2			27	2	
3			28	4	
4			29	8	
5			30	1	
6			31	2	
7			32	4	
8	$\overline{\text{STAND BY}}$		33	8	
9			34	1	
10			35	2	
11			36	4	
12			37	8	
13			38	1	
14	DATA CLEAR		39	2	
15	DIRECT STAND BY		40	4	
16	DIRECT ZERO		41		
17	2^0	RANGE	42	THERMAL DOWN	
18	2^1		43	DAC	
19	2^0	ADDRESS	44	2^2	ADDRESS
20	2^1		45	2^3	
21	C C		46	POLARITY	
22	POWER ON SIG		47	ERROR	
23	+5 V OUT		48	$\overline{\text{READY}}$	
24	ADDRESS COINCIDENCE		49	SET	
25	GND		50	GND	

3.4 Input/Output Control Signals

Example: TTL level





V_{IL}: 0.8 V max.

V_{IH}: 2 V min.

I_{IL}: -1.6 mA max. (V_{IL}=0.4 V)

I_{IH}: 40 µA max. (V_{IH}=2.4 V)

V_{OL}: 0.4 V max.

V_{OH}: 2.4 V min.

Output voltage control signal	At L level			Operation (1)
Polarity	At H level			+
	At L level			-
Strobe (data)	H → L → H			Operation (with edge)
Address	Level			Coincidence signal
$\overline{\text{Standby}}$	At H level			Standby ON
	At L level			Standby OFF
Range	Level			* (R: Ranges to be used for respective models)
	2^1	2^0		
	H	H	strobe (data)	R $\leqq$ 1 [V]
	H	L		1 < R $\leqq$ 10 [V]
	L	H		10 < R $\leqq$ 100 [V]
	L	L		100 < R $\leqq$ 1000 [V]
Set	At L level			Standby release
Direct zero	At L level			Output is zero irrespective of address.
Direct standby	At L level			Standby ON irrespective of address.

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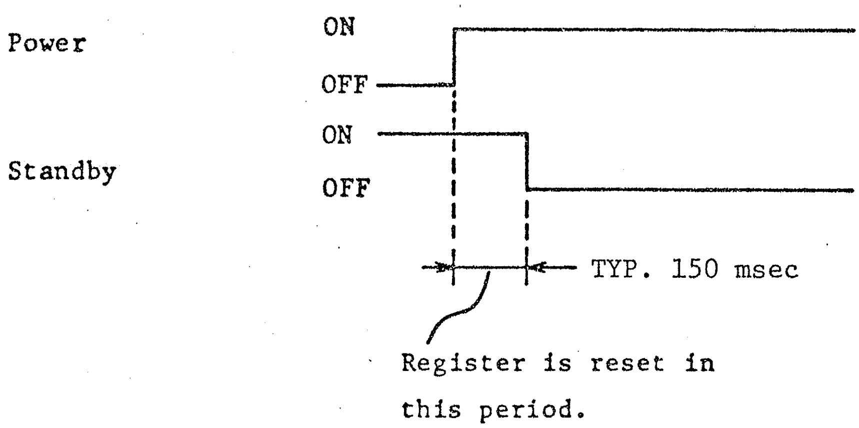
Address coincidence	L level	Coincidence of address code
DAC	(pulse)	Reception of strobe
Error set	L level	Data overflow, invalid range setting
Thermal down	Relay makes contact	Instrument overheating
CC (constant-current transfer)	L level	Constant-current state
$\overline{\text{Ready}}$	H level	
Data clear (10 μsec or over)	L level	Clears resister

* Example: For the model with 5 V range, 2^1 and 2^0 becomes H and L.

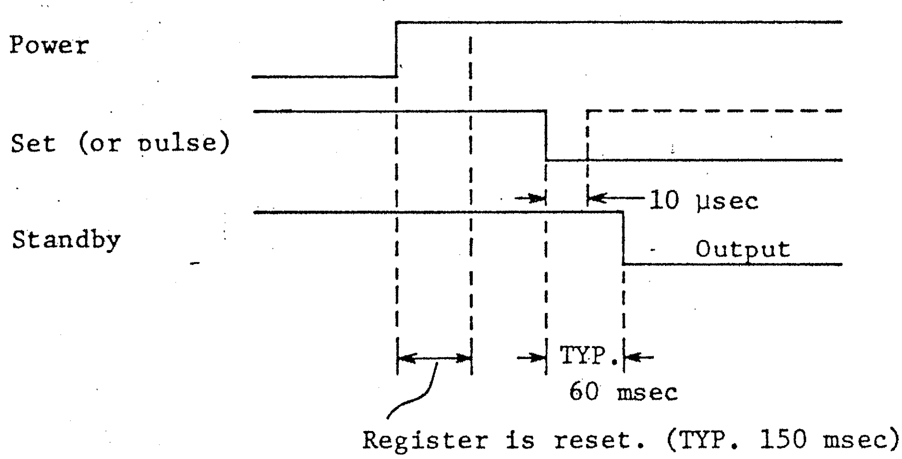
3.5 Timing Charts of Control Signals

(1) When power is ON

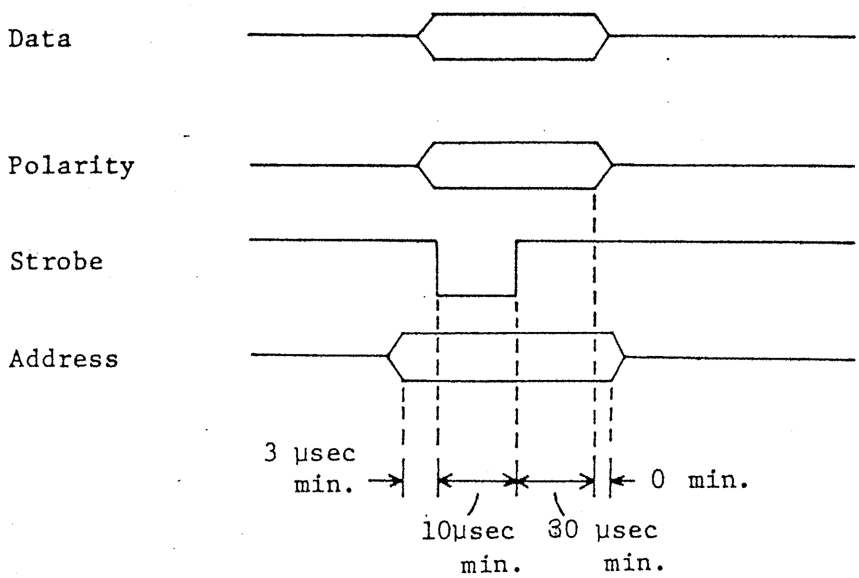
o When the SET signal and STANDBY signal are L



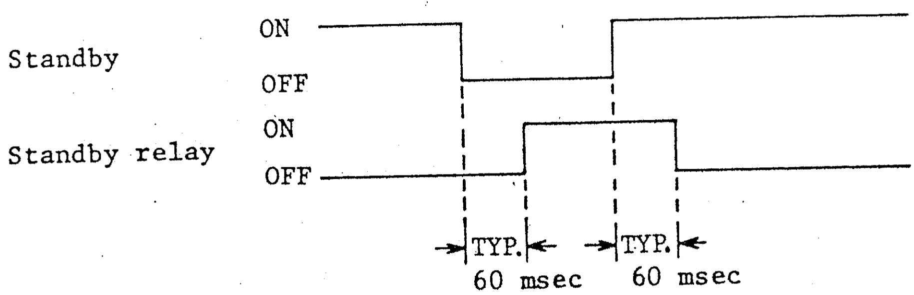
o When the SET signal is H and the STANDBY signal is L



(2) Data, polarity, strobe and address

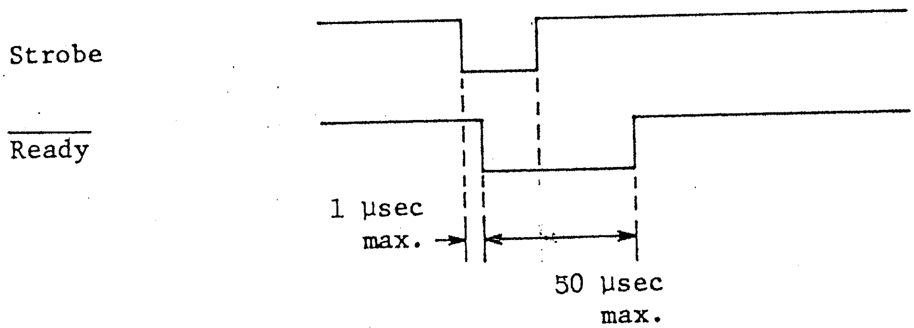


(3) Standby switch

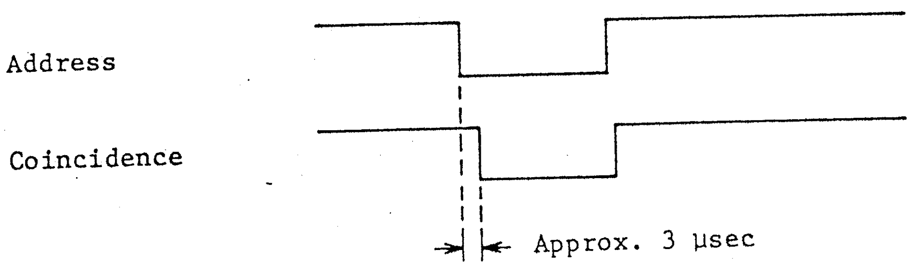


Electromagnetic relay is used for standby switch.

(4) $\overline{\text{Ready}}$

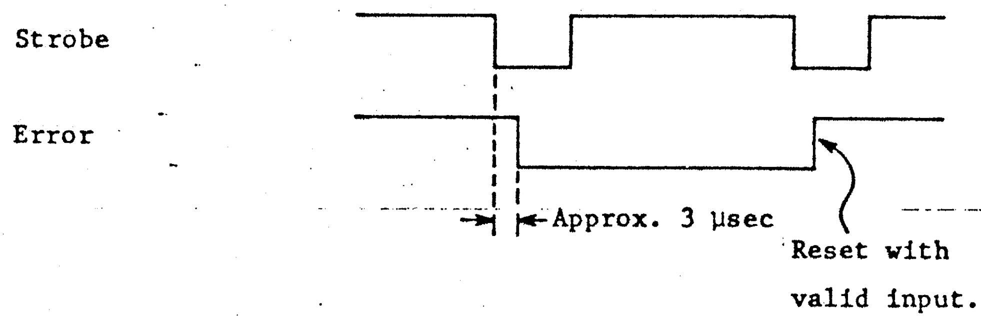


(5) Address coincidence

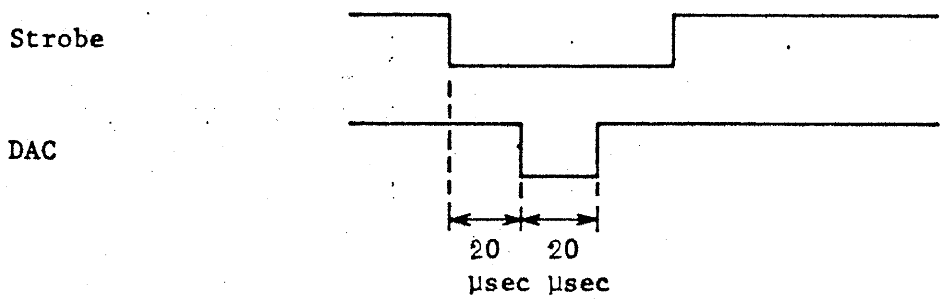


(6) Error o Invalid range setting

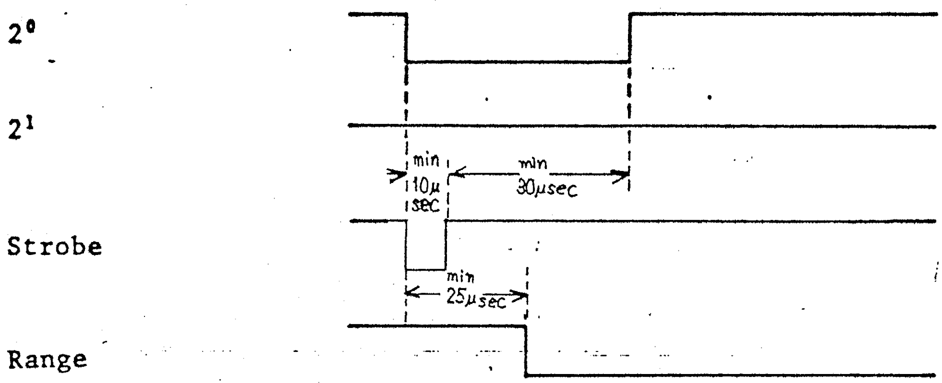
o Data overflow



(7) DAC (data accept)



(8) Range



3.6 Preparations for Operation

(1) Connect the power cord to an AC line outlet of the correct voltage and frequency.

(2) Turn on the power switch.

(3) The instrument is ready for operation several minutes after turning on the power. When high accuracy is required, allow a stabilization period of 30 minutes or more.

(4) Enter data and set the initial values.

(5) Adjust the current limit knob to the required value.

(6) Apply the Set signal.

(7) Release the standby state. Note that relay chattering and overshoots may occur when the standby state is released.

- The Set signal needs only to be applied once each time the power is turned on.

- The direct standby and zero signals can be controlled independently of address specification. The direct zero signal is electrically switches the output signal to zero volts. The standby signal mechanically disconnects output signal. When the direct zero or standby signal is removed, the original state is automatically restored.

- If the controller's address setting is HHHH (0000) or if the address input is open, all attached power supplies will be controlled regardless of their individual addresses.

Note: No overshoots or undershoots are caused when the voltage varies in the same polarity. However, slight overshoots or undershoots may be caused if the voltage is small and both polarity and data are changed at the same time.

3.7 Example of Control

- o Although various input/output signals are available, output voltage alone can be controlled only with data and strobe signals.

(1) For multi-channel operation, address setting on each instrument's rear panel must be set. The control code is a 4-bit binary negative logic signal (pin numbers 19, 20, 44 and 45).

(2) For a model which has different ranges, a range specification is required (pin numbers 17 and 18). The range specification is done with a 2-bit structure. If a fixed-range is required, this can be done by means of electrical connections.

The ranges are written with a strobe signal in the instrument. If the range setting is invalid, the data cannot be written. Be sure to check the code before setting the ranges. The range codes are as follows:

When the maximum value is	2^1	2^0
0.1 to less than 1	0	0
1 to less than 10	0	1
10 to less than 100	1	0
100 to less than 1000	1	1

Of the 2-bit negative logic code, "1" is the L level. The V series is in the [V] unit and the C series is in the [mA] unit.

Examples:

		2^1	2^0
V 20-1	2 V range	0	1
	20 V range	1	0
C 20-1	100 mA range	1	0
	1 A range	1	1

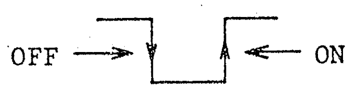
(3) When setting is not required for a model which has the Set signal feature, make electrical connections so that the bit signal is for "1" (L level). When the power is turned on, an output signal of 0 V DC will be produced. To operate this model, set it in the "1" state after initial set up. Alternately, a negative-going pulse signal (⊔) may be applied (pin number 49).

(4) Set data with a negative logic BCD signal and apply a strobe signal.

Although control at the TTL level is most recommendable, control may be done with relays, transisters, switches, etc. (pin number 1 (strobe), pin numbers 26 - 41 (data)).

(5) For standby control (isolation with output relay)

The standby state is reset as the level is changed from H to L. It is set as the level is changed from L to H. (Edge operation) (Pin number 8)



The standby state is controlled in the addressed state.

(6) Direct standby (If not required, set OPEN or H) (Pin number 15)

This standby state is controlled irrespective of address. This standby state is reset by the H level and set by the L level. (Level operation)

(7) Direct zero (If not required, set OPEN or H) (Pin number 16)

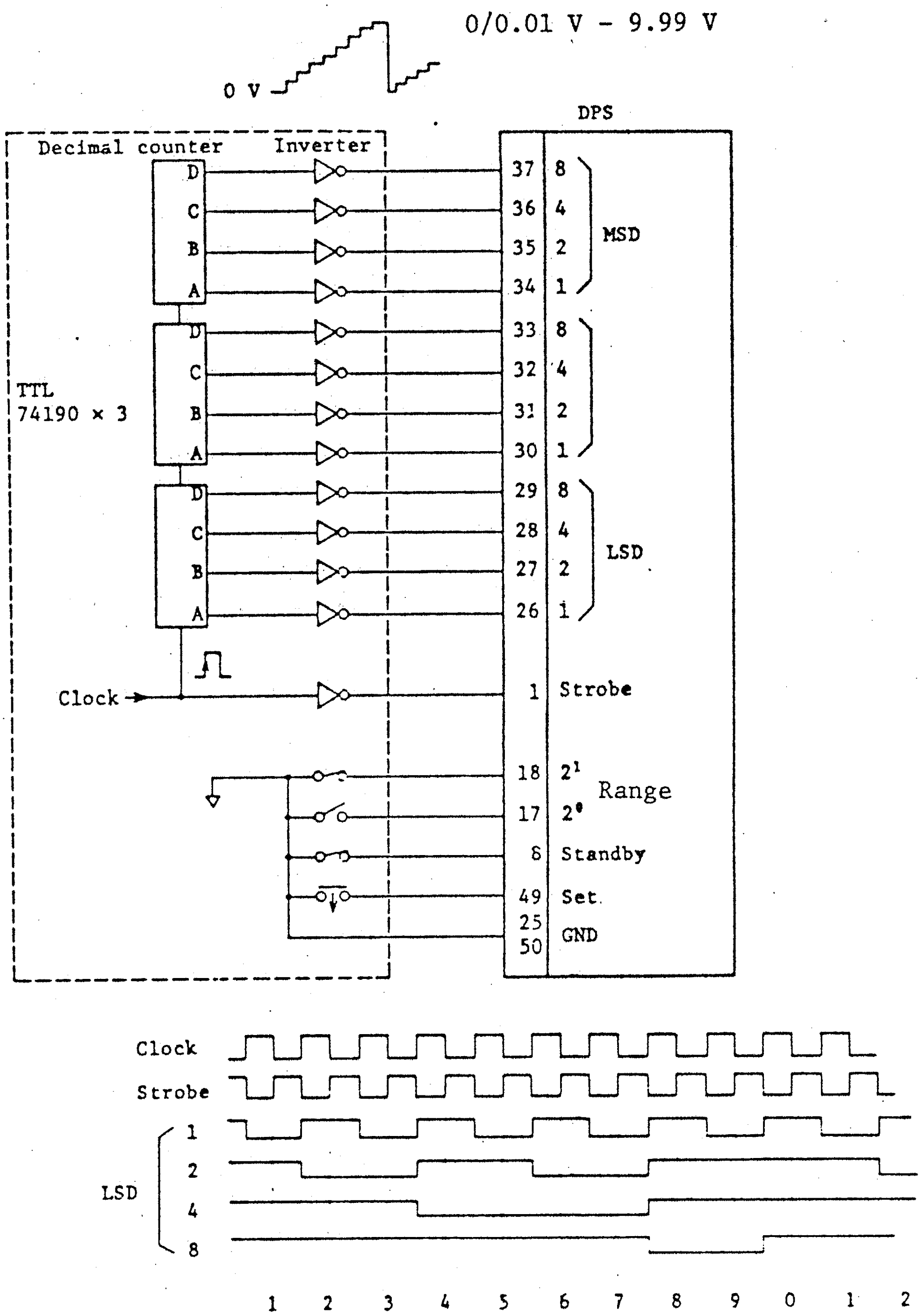
This signal is for DC ON/OFF control of the output voltage. When this signal is at the L level, the output voltage becomes zero. This signal does not clear the contents of the register and, therefore, the previous set voltage is restored when this signal is returned to the H level.

(8) Data clear (If not required, set OPEN or H) (Pin number 14)

This is the clear bit signal of the data register. When this signal is set at the L level, the contents of the resister are cleared and the output becomes zero. (A negative-going pulse may be used instead.)

3.8 Actual Example of Control

To obtain an output which varies stepwise



4. OPERATING PRINCIPLE

4.1 Circuit Structure

The circuit structure of this instrument is shown with a block diagram in Figure 4-1.

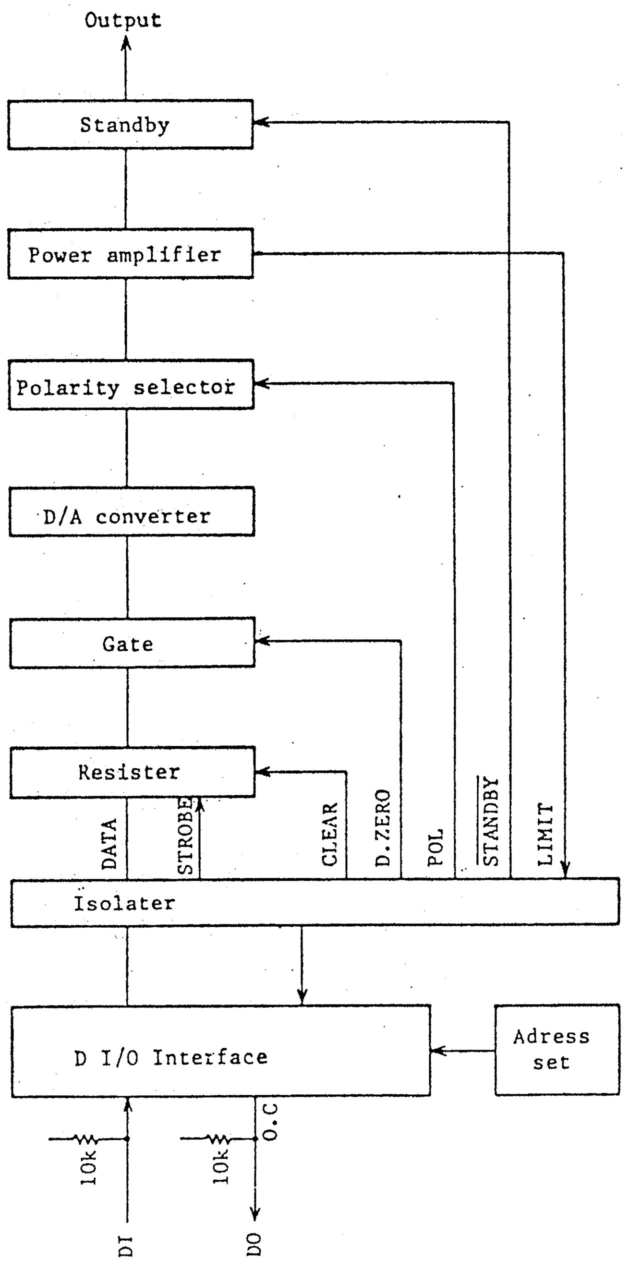


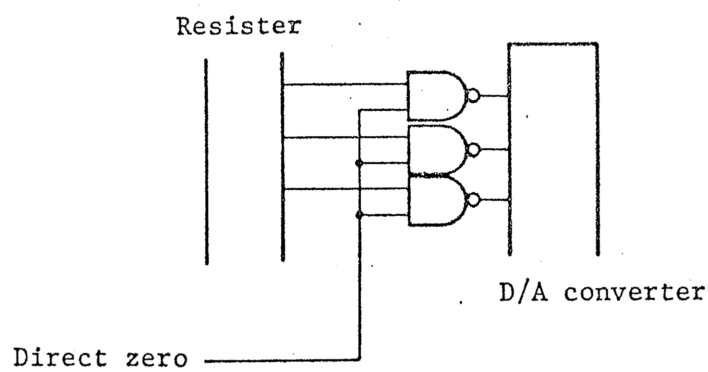
Figure 4-1

4.2 Operation Description

The input/output Logic Level signal is pulled up by a resister (10 kΩ). Data entered at the TTL level is subjected to a buffer effect at the D I/O interface section, it is isolated with a photocoupler, and then it is stored in the register.

The Strobe signal is passed on when address "0" is specified (or when open) or when the address set at the instrument (main unit) conforms with the specified address. The Strobe signal then is fed via the isolator to the register to let the data stored in the register. The stored data is maintained, until the next Strobe signal is applied, even when the input is varied.

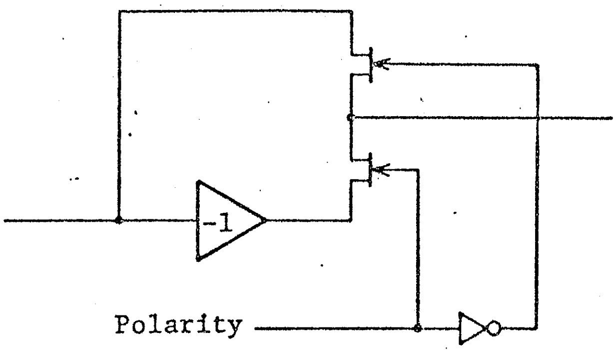
The Data Clear signal clears the register, making all bits "0". The stored data is fed via a gate to the D/A converter. The gate is for the direct zero signal, and is capable of making all bits "0" temporarily without clearing the register.



For the gate, a NAND gate is used as the D/A converter input is a complimentary type. When the gate is closed, its output becomes the H level.

The digital signal is converted into an analog signal by the D/A converter, the polarity of the analog signal is selected by the Polarity signal, and the resultant signal is fed to the output amplifier.

The Polarity Selector, being controlled with the Polarity signal and an FET switching circuit, selects between polarity inversion and non-inversion.



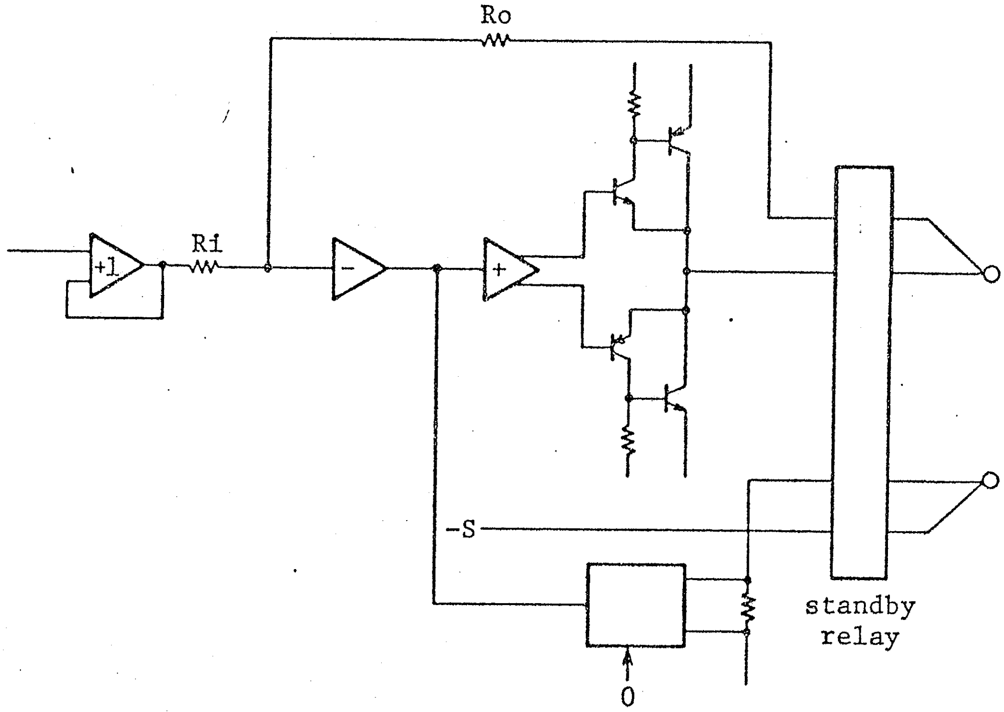
To reduce the effects of the ON resistance of the FET switch circuit, the voltage is received with a voltage follower and its output is fed to the output amplifier.

The power amplifier consists of an IC (initial stage), transistor circuits, and control transistors. It is a high speed, high stability, high accuracy operational amplifier.

The output current limiter monitors the voltage developed across the resistor inserted in series with the load circuit. When the monitored voltage has exceeded the preset voltage, the limiter circuit makes up a closed loop with the final stage of the constant-voltage amplifier. The instrument operation switches to the constant-current mode and remains in this mode. This mode is indicated on the front panel. When in this mode, the output is delivered through the isolator.

This instrument has a motor-driven fan to cool the control transistors of the output section.

In order to guard against instrument overheating, a thermal sensor has been installed on the heat sink of the control transistors. The thermal sensor trips at 70°C (158°F) and the instrument is released into the standby state.



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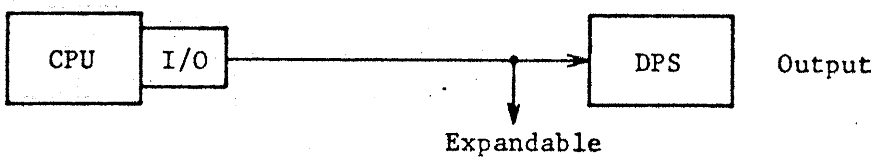
5. APPLICATION

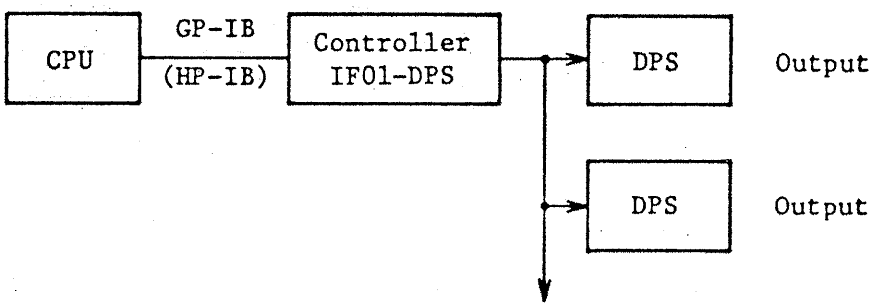
5.1 Examples of Controls of DPS Series

(1) Direct control with CPU

CPU: Various controllers (computers, digital equipment, etc.)

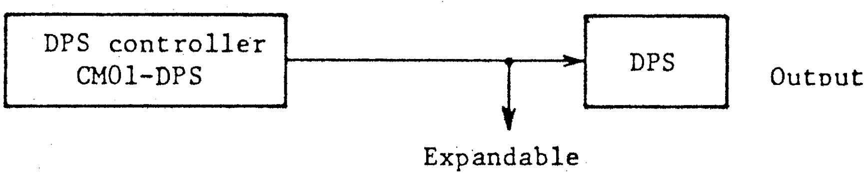


(2) Control with standard interface



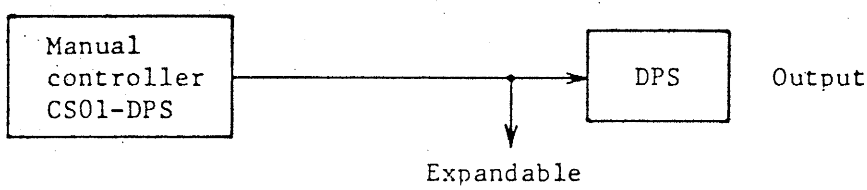
Up to 15 units can be controlled.

(3) Function generation with KIKUSUI MODEL CM01-DPS



Non-volatile memory of 64 steps available

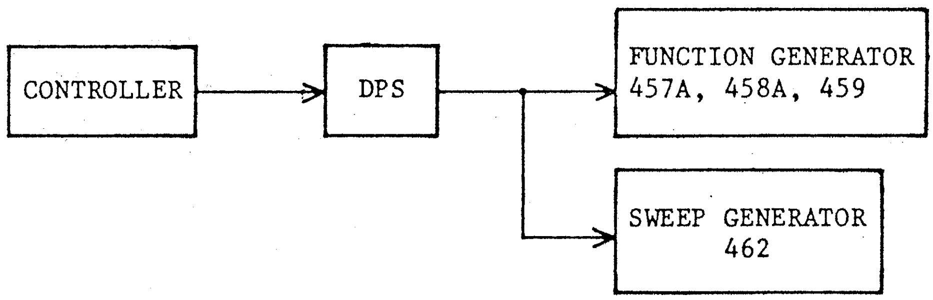
(4) Remote control



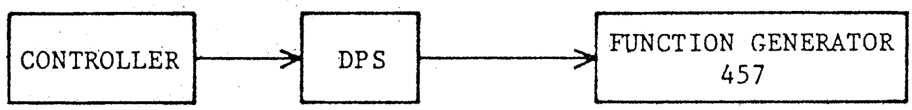
5.2 Examples of Use of DPS Series

(1) For programmable control of generator

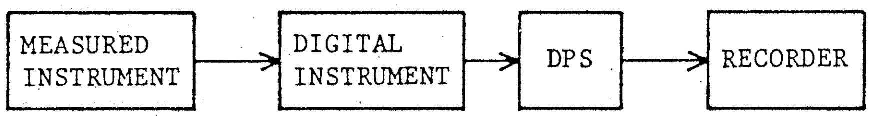
Oscillating frequencies of a frequency generator can be program-controlled. For example, apply the DPS output to the VCG (voltage-controlled generator) terminal of a function generator.



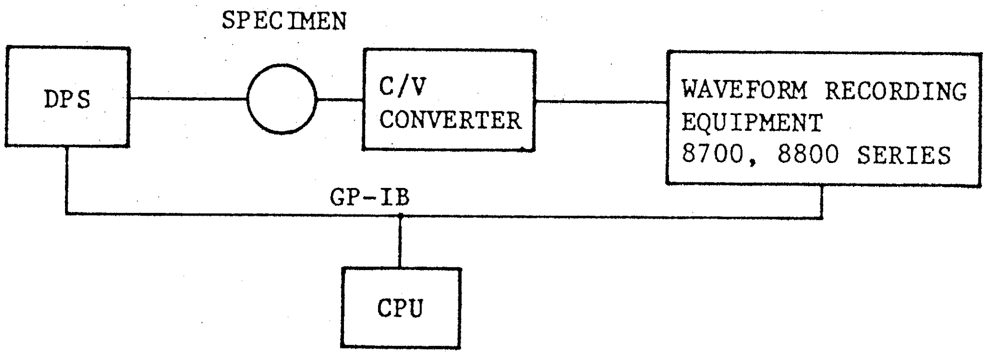
Output amplitude control also is programmable. For example, apply the DPS output to the VCA (voltage-controlled amplitude) terminal of a function generator.



(2) To use as a simple D/A converter

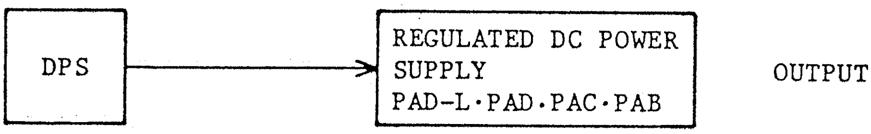


(3) To use as a signal source (an example for impurity density measurement of semiconductors)



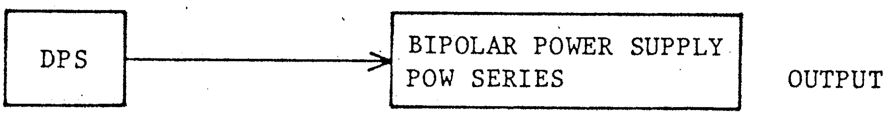
(4) For digital control of outputs of large ratings

For DC voltage/current:

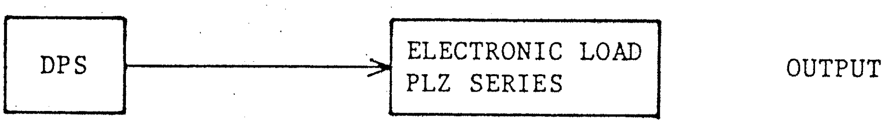


(Minor modification is required.)

For bipolar power:



For constant-current load device:



6. MAINTENANCE

6.1 Layout of Components

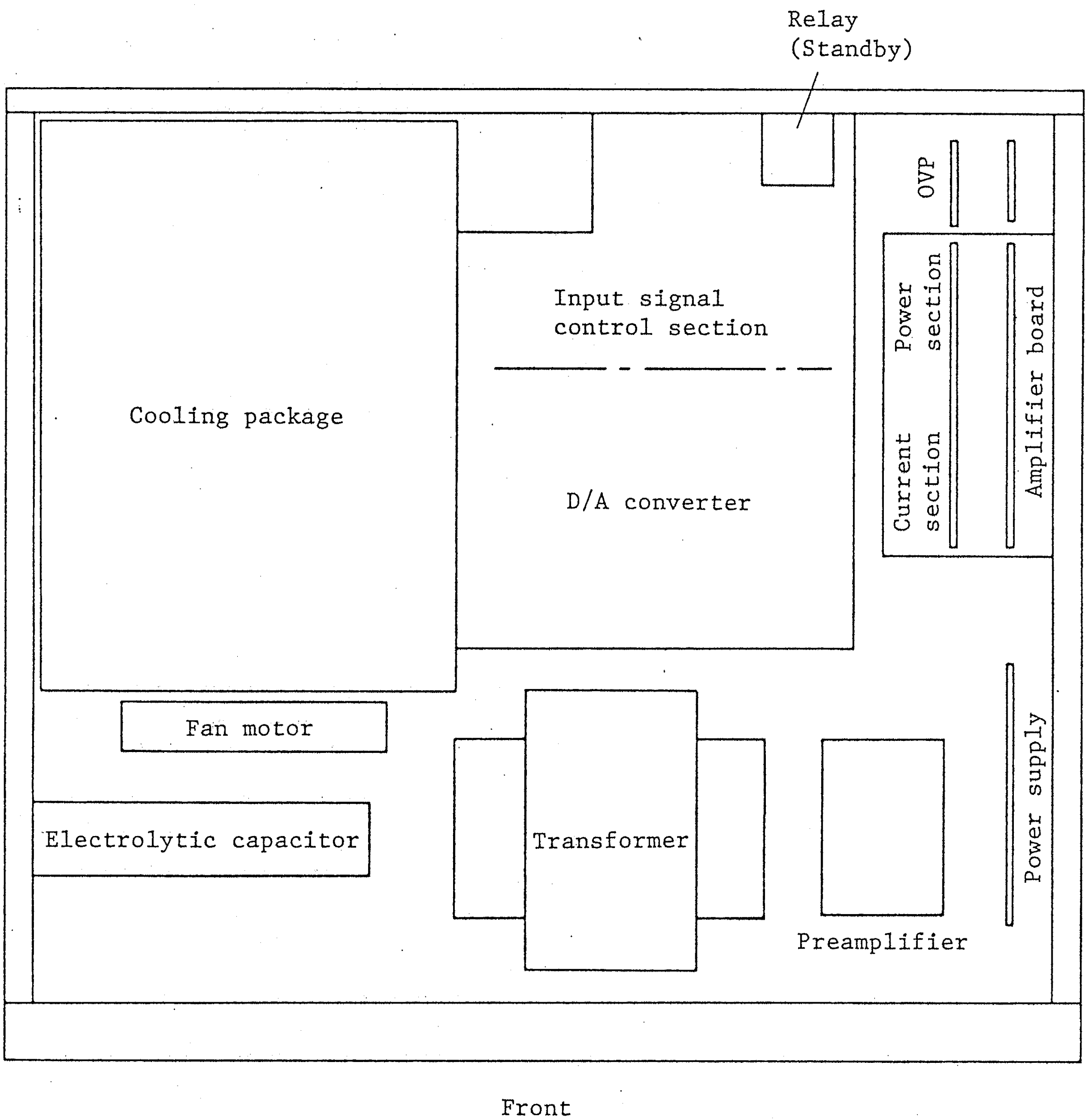


Figure 6-1 (Top view)

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Layout of potentiometers

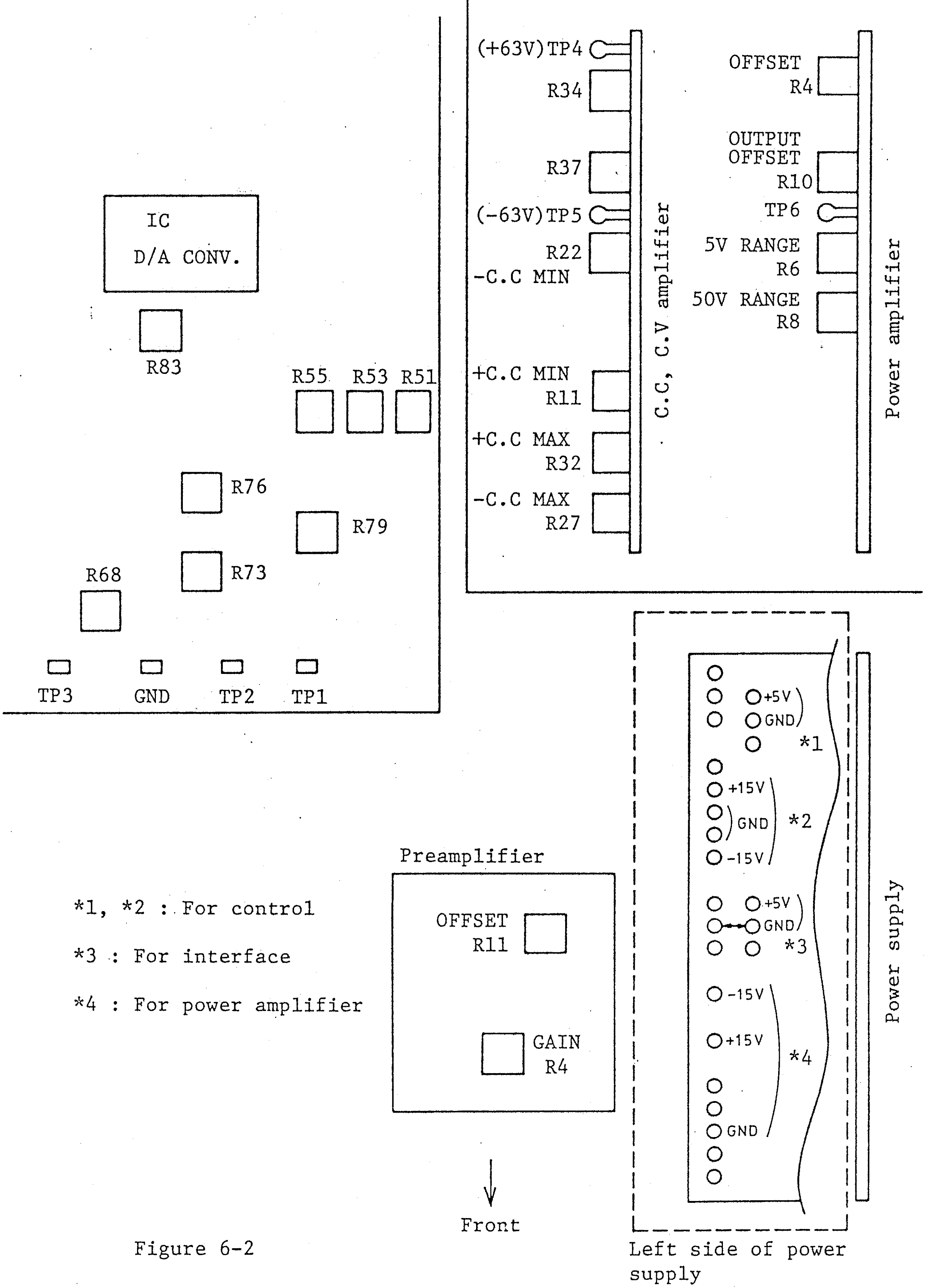

Figure 6-2

6.2 Adjusting Procedures (See Figure 6-2.)

(1) Check and Adjustment of Supply Voltages

1-1 Check of +15 V and -15 V supplies of control circuit

Each of these supplies employs a 3-terminal fixed-output IC. Connect a voltmeter between control GND terminal and +15 V terminal, and check that the voltage is within 14.2 V to 15.8 V. Connect a voltmeter between control GND terminal and -15 V terminal, and check that the voltage is within -14.2 V to -15.8 V.

1-2 Check of +5 V supply of control circuit

This supply employs a 3-terminal fixed-output IC. Connect a voltmeter between control GND terminal and +5 V terminal, and check that the voltage is within 4.75 V to 5.25 V.

1-3 Check of +15 V and -15 V supplies of power amplifier

Each of these supplies employs a 3-terminal fixed-output IC. Connect a voltmeter between power GND terminal and +15 V terminal, and check that the voltage is within 14.2 V to 15.8 V. Connect a voltmeter between power GND terminal and -15 V terminal, and check that the voltage is within -14.2 V to -15.8 V.

1-4 Check of 5 V supply of interface circuit

This supply employs a 3-terminal fixed-output IC. Connect a voltmeter between interface GND terminal and +5 V terminal, and check that the voltage is within 4.75 V to 5.25 V.

1-5 Adjustment of ±63 V supplies of power amplifier (CC, CV amplifier board)

Connect a voltmeter between power GND pin No. 4 (L side) and TP4. So adjust potentiometer R34 that the voltmeter reads within 62.5 V to 63.5 V. Connect a voltmeter to TP5 and adjust the potentiometer R37 so that the voltmeter reads within -62.5 V to -63.5 V.

(2) Offset adjustment of IC

o Enter data [+0000].

2-1 Connect a digital voltmeter between pin 6 (TP1) of MC16 of D/A converter and GND terminal, and adjust the potentiometer R79 so that the digital voltmeter reads within ±20 μV.

2-2 Connect a digital voltmeter between pin 6 (TP2) of MC15 of inverter and GND terminal, and so adjust potentiometer R73 that the digital voltmeter reads within ±20 μV.

2-3 Connect a digital voltmeter between pin 6 (TP6) of MC1 of power amplifier and GND terminal, and adjust the potentiometer R4 so that the voltmeter reads within ±20 μV.

(3) Gain adjustment of D/A converter

Set the range at 5 V (0, 1) or 50 V (1, 0).
Set the potentiometer R76 at a midposition of its control range.
Enter data [-0999].

3-1 Connect a digital voltmeter between TP6 and GND.
Adjust the potentiometer R84 so that the voltage becomes +1.998 V ±100 μV.

(4) Power amplifier offset and gain adjustment

- o Set the range at 50 V (1, 0) and enter data [-0000].

4-1 Connect a digital voltmeter to the output terminal and adjust the potentiometer R10 so that the voltmeter reads a value within ±50 µV.

- o Change data to [-0999].

4-2 Adjust the potentiometer R8 so that the output voltage becomes -9.99 V ±500 µV.

- o Change data to [-1000].

4-3 Adjust the potentiometer R55 of the D/A converter section so that the output voltage becomes -10.00 V ±500 µV.

- o Change data [-2000].

4-4 Adjust the potentiometer R53 so that the output voltage becomes -20.00 V ±1 mV.

- o Change data to [-3000].

4-5 Adjust the potentiometer R51 so that the output voltage becomes -30.00 V ±1.5 mV.

- o Change data to [+4999].

4-6 Adjust the potentiometer R68 of the inverter section so that the output voltage becomes +49.99 V ±2.5 mV.

4-7 Very each input data and measure the output voltage checking to insure that it is within the tolerance. If it is not within the tolerance, adjust it with corresponding potentiometer.

o Set the range at 5 V (0, 1) and enter data [-4999].

4-8 Adjust the potentiometer R6 so that the output voltage becomes -4.999 V $\pm$250 μV.

4-9 Vary each input data and measure the output voltage checking to insure that it is within the tolerance. If it is not within the tolerance, adjust it with corresponding potentiometer again.

(5) Adjustment of output current

Set the output voltage at zero. Connect a slide-wire rheostat and a DC ammeter in series to the output terminals. (Select a slide-wire rheostat of a resistance which will allow a current of 3 A or more to flow then the output voltage is applied.)

5-1 Turn the current limit knob on the front panel to the extreme counterclockwise position. Enter "-" data to produce the output voltage. Varying the resistance of the rheostat, adjust the potentiometer R22 of the current amplifier so that the operation is transferred into the constant-current mode when the output current is approximately -20 mA.

5-2 Turn the current limit knob to the extreme clockwise position. Reduce the resistance of the rheostat and adjust the potentiometer R27 of the current amplifier so that the operation is transferred into the constant-current mode when the output current is approximately -3.15 A.

5-3 Repeat alternately the procedures of 5-1 and 5-2 so that the best conditions are obtained for both requirements.

5-4 Turn the current limit knob on the front panel to the extreme counterclockwise position. Enter "+" data to produce the output voltage. Varying the resistance of the rheostat, adjust the potentiometer R11 of the current amplifier so that the operation mode will switch to the constant-current mode when the output current is approximately +20 mA.

5-5 Turn the current limit knob to the extreme clockwise position. Reduce the resistance of the rheostat and adjust the potentiometer R32 of the current amplifier so that the operation switches to the constant-current mode when the output current is approximately +3.15 A.

5-6 Repeat alternately the procedures of 5-4 and 5-5 so that the best conditions are obtained for both requirements.

(6) Offset and gain adjustment of preamplifier P/C board

o Set the range at 50 V (1, 0) and enter data [-0000].

6-1 Connect a digital voltmeter to the output terminal and apply 0 V to the EXT IN terminal. Asjust the potentiometer R11 so that the output voltage becomes within ±100 μV.

6-2 Apply a voltage of 5 V to the EXT IN terminal and adjust the potentiometer R4 so that the output voltage becomes 50 V ±5 mV.