

OPERATION MANUAL
DC HIGH VOLTAGE STANDARD
MODEL 1041

KIKUSUI ELECTRONICS CORPORATION

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1. GENERAL

1.1 Description

KIKUSUI's Model 1041 DC High-voltage Standard is a high voltage, regulated solid-state power source, capable of producing 0 to ± 3122 VDC $\pm 0.05\%$ at 0 to 30 mA in various ranges.

Precise output is accomplished by incorporation of solid-state circuits.

1.2 Features

- o Convenient front panel controls allow selection of three different voltage ranges in either + or - polarity.
- o Vernier control allows adjustments as fine as 0.003% in any range.
- o Current is limited within a range of approximately 5 to 30 mA by built in electronic overload protection circuits.
- o 4-position output voltage trip-off control (100V, 500V, 1000V, 2000V) can be settled
- o Handy BNC connector provided at output terminal

2. SPECIFICATIONS

KIKUSUI MODEL 1041 - DC HIGH VOLTAGE STANDARD

Output voltage:	0 to ± 3122 VDC
Output voltage Ranges:	± 30 , ± 300 , ± 3000 VDC
Output accuracy:	0.05% of setting, or 0.02% of range, whichever is greater
Output Regulation:	0.0005% of range, or less than 100 microvolts, whichever is greater (for no load to maximum rated load)
Line Regulation:	0.0005% of range, or less than 100 microvolts, whichever is greater (for 100V $\pm 10\%$ line voltage)
Voltage Limits:	100V, 500V, 1000V, 2000V, and OFF (approx.)
Voltage Limit accuracy:	Less than $\pm 5\%$
Output Current:	0 to 30 mA
Output Current Limit:	Continuously variable from approx. 5 to 30 mA.
Ripple and Noise:	Less than 300 microvolts RMS, or 0.0001% of range, whichever is greater (5 Hz to 1 MHz)
Overload Protection:	Special circuits place unit in STAND BY mode in case of overload
Specified operating temperature range:	5 to 35°C (41 to 95°F)
Power Requirements:	100 VAC $\pm 10\%$, at 50/60 Hz
Dimensions:	430W x 160H x 370D mm (16.9W x 6.3H x 14.6D in.)
Overall:	431W x 172H x 415D mm (16.9W x 6.8H x 16.4D in.)
Weight:	Approx. 17kg (37.5 lbs.)
Accessories:	(1) Approx. 1.5 m (59 in.) high-voltage output cable with BNC connector at one end (2) Operation manual

3. OPERATION

3.1 Front and Rear Panel Description (Refer to Figures 3-1 and 3-2.)

- (1) POWER: When pushbutton is pressed in, unit is activated, and a red LED illuminates.
- (2) STAND BY: When pushbutton is pressed, or an overvoltage condition occurs or the RANGE or POLARITY switches are changed, the 1041 is automatically switched to STAND BY mode, and a green LED illuminates, while the red OUTPUT switch LED goes out.
- (3) OUTPUT: When momentary-action pushbutton is pressed, the output is activated, and a red LED illuminates and the green STAND BY switch LED goes out.
- (4) RANGE: When selecting one of the three voltage ranges (30, 300 or 3000 V), the reference decimal point on the 4-digit scale is moved one place. Each time the range is changed, the 1041 automatically switches to STAND BY mode. It is necessary to press the OUTPUT switch to reactivate.
- (5) VOLTAGE SETTING DIALS: The desired output voltage is selected by the setting of these dials. The dial effecting the most significant change is the left, which is calibrated in increments of one (0 - 2). The second most significant is the next dial to the right, which is calibrated in increments of one (0 - 10). The other two dials are continuously variable and are calibrated in increments of one (0 - 11) and rank third and fourth in respective significance.
- (6) VERNIER: This knob varies the output settings, through its range of 0 to 10, by one whole number of the least significant scale of the VOLTAGE SETTING dials.

- (7) POLARITY: This 3-position knob switches to either + or - output, at the 1041's output terminal, or to OFF. When switched to (or through) the OFF position, the 1041 is automatically switched to STAND BY mode. Press the OUTPUT pushbutton to reset.

CAUTION

When changing output polarity, or when switching to OFF for any reason, wait at least 10 seconds before selecting the new position.

- (8) CURRENT LIMIT: Output current limit may be varied continuously from approximately 5 to 30 mA. If the set limit is surpassed, the 1041 is automatically switched to STAND BY mode. Press the OUTPUT button to reset after conditions are corrected.
- (9) VOLTAGE TRIP: Five points may be selected to allow the various voltage limits to trip shutdown of output (100, 500, 1000, 2000 and Trip Off). The TRIP OFF value is approximately 3280 volts. The 1041 automatically switches to STANDBY mode when the set limit is reached. Press the OUTPUT pushbutton to reset.
- (10) OPERATION: When the OUTPUT switch is pressed to activate the output connector, an LED above the connector indicates that an output is being generated and that a internal capacitor has been charged. When the unit switches to STAND BY mode, the LED remains lit while this capacitor is discharging. The LED goes out when the voltage falls to approximately 100 volts.
- (11) OUTPUT: A convenient BNC connector at the output allows easy connection of special high-voltage cables. Always use cables suitable for high voltages.

CAUTION

Voltages present at the output terminal vary from 0 to 3122 volts DC at up to 30 mA. Do not touch the terminal while instrument is turned on.

(12) OUTPUT GROUND TERMINAL: Used to complete ground circuit to device being powered by the 1041.

(13) CHASSIS GROUND TERMINAL: This is the 1041's chassis ground. It is normally connected to the output ground terminal by a shorting piece. If it is required that the output ground be floating, remove the shorting piece.

CAUTION

With the shorting piece removed, voltage between the output ground and chassis ground is 250 volts DC.

(14) FUSE: This fuse (3 Amp) is for the input power transformer. To remove, twist fuseholder knob counterclockwise; turn clockwise to install.

(15) Power Cord: Connect to 100 V, 50/60 Hz outlet.

(16) Power Cord Storage Clips: Wind cord here when the 1041 is not in use.

(17) Fan Motor: This is the exhaust outlet for the cooling fan.

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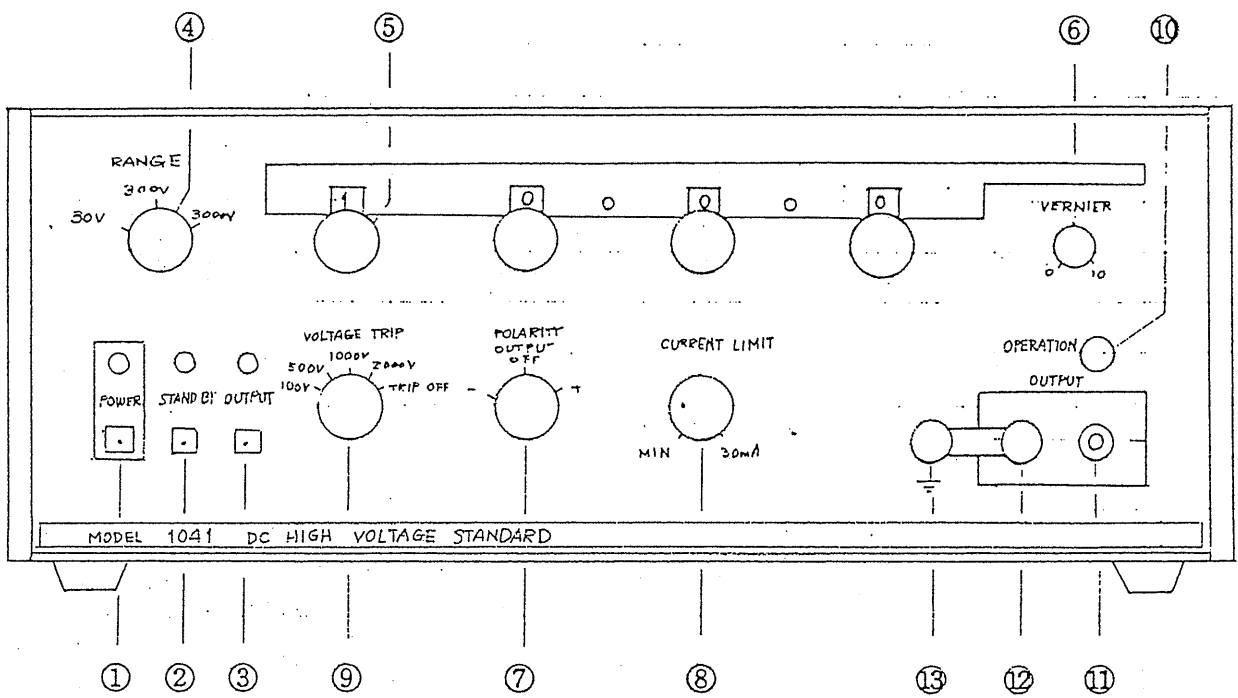


Figure 3-1. Front panel

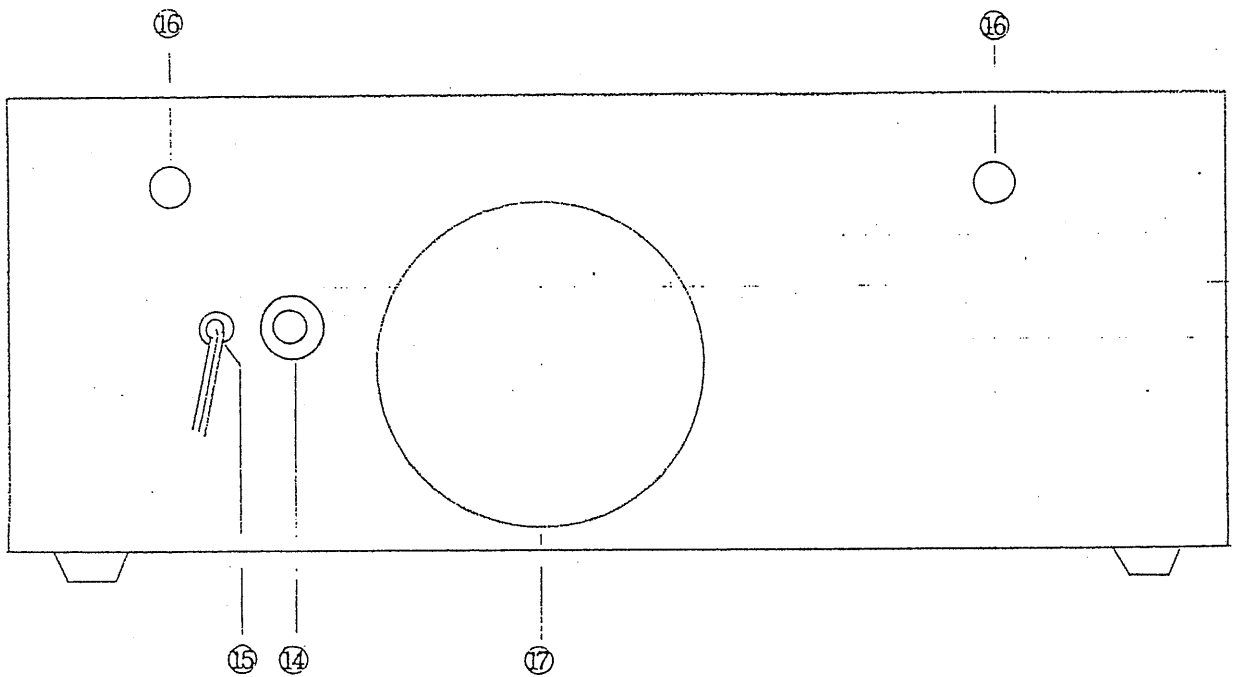


Figure 3-2. Back Panel

3.2 Initial Operation

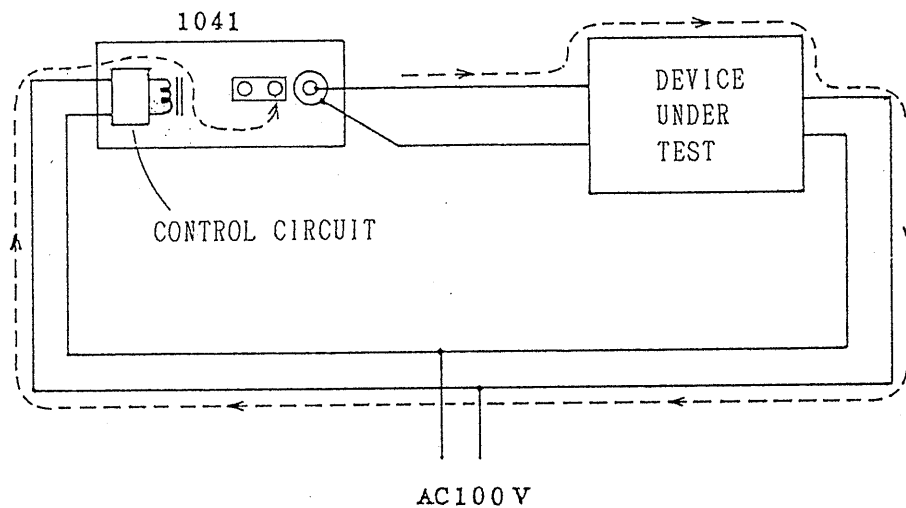
- (1) Make sure that output cable used is of a high tension type, and that it is correctly connected.
- (2) Set all VOLTAGE OUTPUT dials at zero, and the POLARITY switch to OFF.
- (3) Connect AC cord to proper power source.
- (4) Set VOLTAGE TRIP control to the proper setting.
- (5) Set CURRENT LIMIT control to the proper point.
- (6) Press POWER switch in and verify that the red LED above the POWER switch lights, that the green LED above the STAND BY switch lights, and that the red LED's above the OUTPUT switch and the OUTPUT terminal are out.
- (7) Set POLARITY and RANGE switches to the proper positions, and the four VOLTAGE OUTPUT dials to the voltage desired.
- (8) Press the OUTPUT switch. With this action, the green LED above the STAND BY switch goes out and the red LED's above the OUTPUT switch and the OUTPUT terminal illuminate. Output voltage should now be generated.
- (9) After use, press the STAND BY switch, set the VOLTAGE OUTPUT dials to zero, and turn the POLARITY switch to OFF.

**NOTE!:* After each use, and even if the 1041 is in STAND BY mode, some residual negative voltage (after operating in the positive mode) exists in the internal circuits. This is normal, but make note that there may be a surge of negative current when the output is activated because an internal diode becomes back-biased. To ensure this situation does not occur, it is imperative that this operation (9) be carried out each time before repeating operations (7) and (8).

- (10) When the output RANGE is changed, allow from two to three minutes settling time before use. Also, allow from one to two minutes settling time after turn-on when the RANGE dial is set initially in the 30 or 300 volt ranges.

3.3 Special Notes on Operation

- (1) Use CAUTION when output voltages are present.
- (2) When Output Ground and Chassis Ground are connected:



When there is no load being drawn by the device under test, current will flow as shown. There is a possibility that since the 1041's control circuit is not loaded it may be damaged. Do not operate in this condition.

- (3) Under large capacitive load conditions, even when the OUTPUT switch is pressed, the 1041 may remain in STAND BY and not operate until the load is reduced.
- (4) It is recommended that a suitable bleeder resistor be connected across the output when the 1041 is operated under high capacitive load conditions to prevent retention of high voltages.

- (5) On occasion, even after the 1041's power has been turned off, or the unit has been placed in STAND BY mode, there may be a residual charge on the internal capacitor. Avoid touching the output until the capacitor is fully discharged (about 15 seconds).
- (6) When first turned on, or before reapplying power after shut-off, allow about 10 seconds settling time.
- (7) Do not operate the 1041 with VOLTAGE SETTING dials set between two detents.
- (8) The shorting piece that couples the case ground to the output ground should be in position at all times under normal operating conditions. If it becomes necessary to remove the shorting piece to change output polarity, do not touch either the two terminals simultaneously, or the device under test and the 1041's ground terminals while the power is on.
- (9) In all cases, attach the output cable securely to the device under test. Do not try to short-cut proper safety procedures by switching the output cable to other devices under test while the output is activated. This sort of practice can only lead to possible injury to both the operator and the 1041. Use the pushbutton switch to place the 1041's output in the STAND BY mode before changing any connections.

4. THEORY OF OPERATION

AC is applied to INPUT TRANSFORMER (T002) and DIODE REGULATOR (CRO02). Diode Regulator output is sent through the RELAY (K001) to the HIGH-VOLTAGE TRANSFORMER (T001) where it is stepped up to the appropriate voltage.

AC power from the Transformer (T002) is also used to generate bias voltage for the Series-Pass Element (+90 Volts), and voltages of ± 15 Volts.

The output voltage of the High-Voltage Transformer is rectified and filtered in the RECTIFIER & FILTER (CR401-403) before being regulated by the SERIES-PASS ELEMENT (Q201-211, Q301), which is controlled by the VOLTAGE REGULATOR.

The output of the Rectifier & Filter is also supplied to the input of the PRE-REGULATOR CONTROL CIRCUIT (U106). The output of this circuit is sent back to the PRE-REGULATOR and controls the output amplitude of the High Voltage Transformer, thereby completing a servo loop circuit.

Operation of the momentary -action OUTPUT SWITCH causes the STANDBY CIRCUIT (U101) to turn the output of the 1041 ON through the PRE-REGULATOR CONTROL CIRCUIT.

Any of the following circumstances switch the 1041 to STAND BY mode:

1. Pressing the momentary-action STAND BY switch.
2. 1041 voltage output exceeding the setting of the VOLTAGE TRIP CIRCUIT (U104, 105).
3. Changing the setting of the RANGE SWITCH (S001).
4. 1041 current output exceeding the setting of the CURRENT LIMIT control.

The output of the 1041 is fed to the setting of the VOLTAGE SETTING SWITCHES (S002-005) where it is used to control the input of the VOLTAGE REGULATOR which is also controlled by the setting of the RANGE SWITCH. The output of the Voltage Regulator controls the SERIES-PASS ELEMENT.

CURRENT REGULATOR (U103) is also driven by the output current of the unit. The output of the Current Regulator is summed with the output of the Voltage Regulator and controls the STANDBY CIRCUIT.

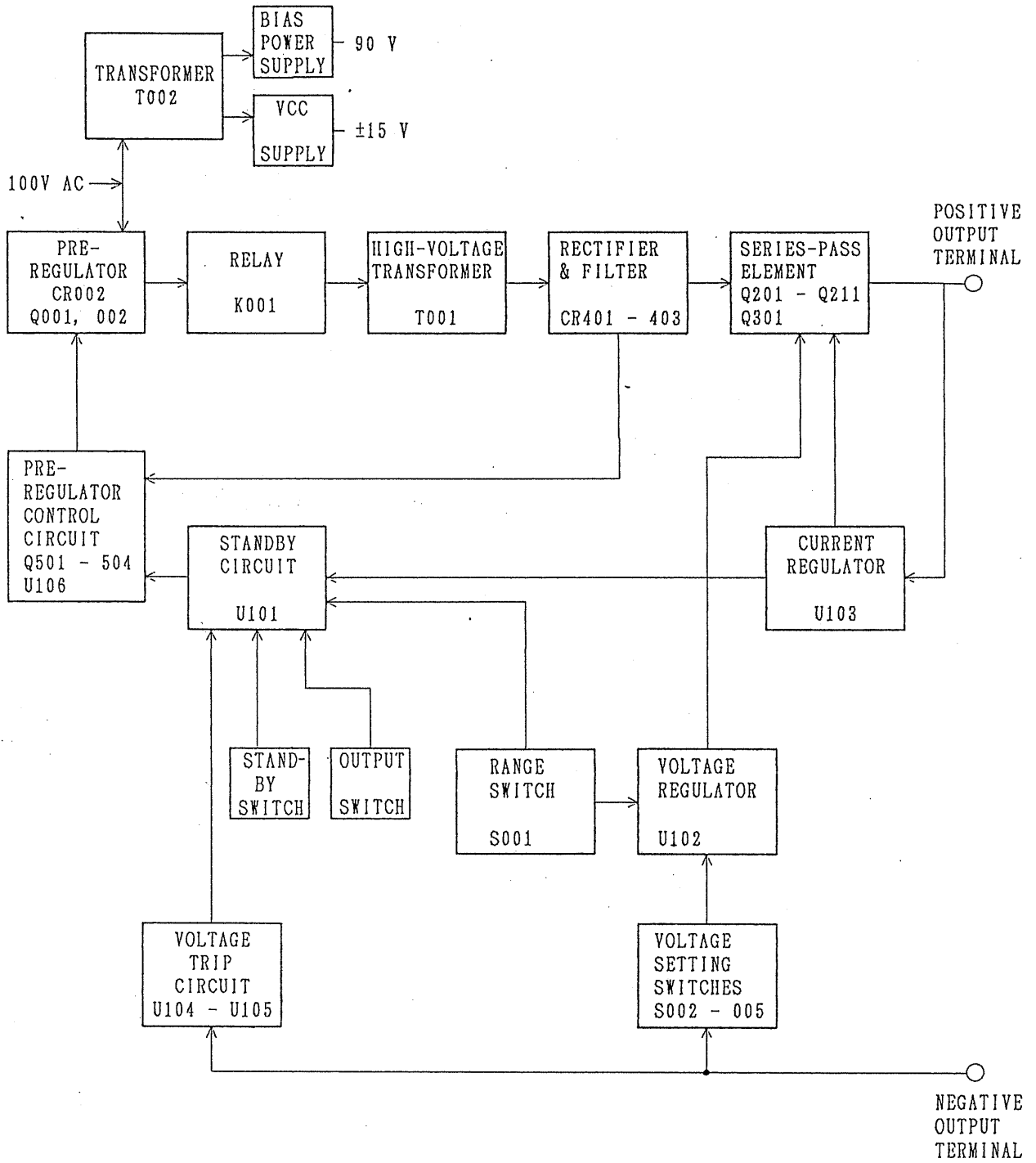


Figure 4-1. Block Diagram

5. MAINTENANCE

5.1 Removing the Outer Case

- (1) Unplug the 1041 and wait 2 to 3 minutes for discharge of all transient voltages which may be present in the circuits.
- (2) Remove the eight screws holding the outer case to the chassis.
- (3) Remove the outer case by carefully and gently pulling upward.

**NOTE!:* As the case is removed, an interlock switch opens to ensure that the AC power is interrupted.

CAUTION

Because of the way the output circuit of the 1041 is designed, when the shorting piece is installed, the inner sealed case becomes to + output terminal. In this condition, there is a potential between the inner sealed case and the outer case. Use extreme care when the unit is switched on.

5.2 Component Layout

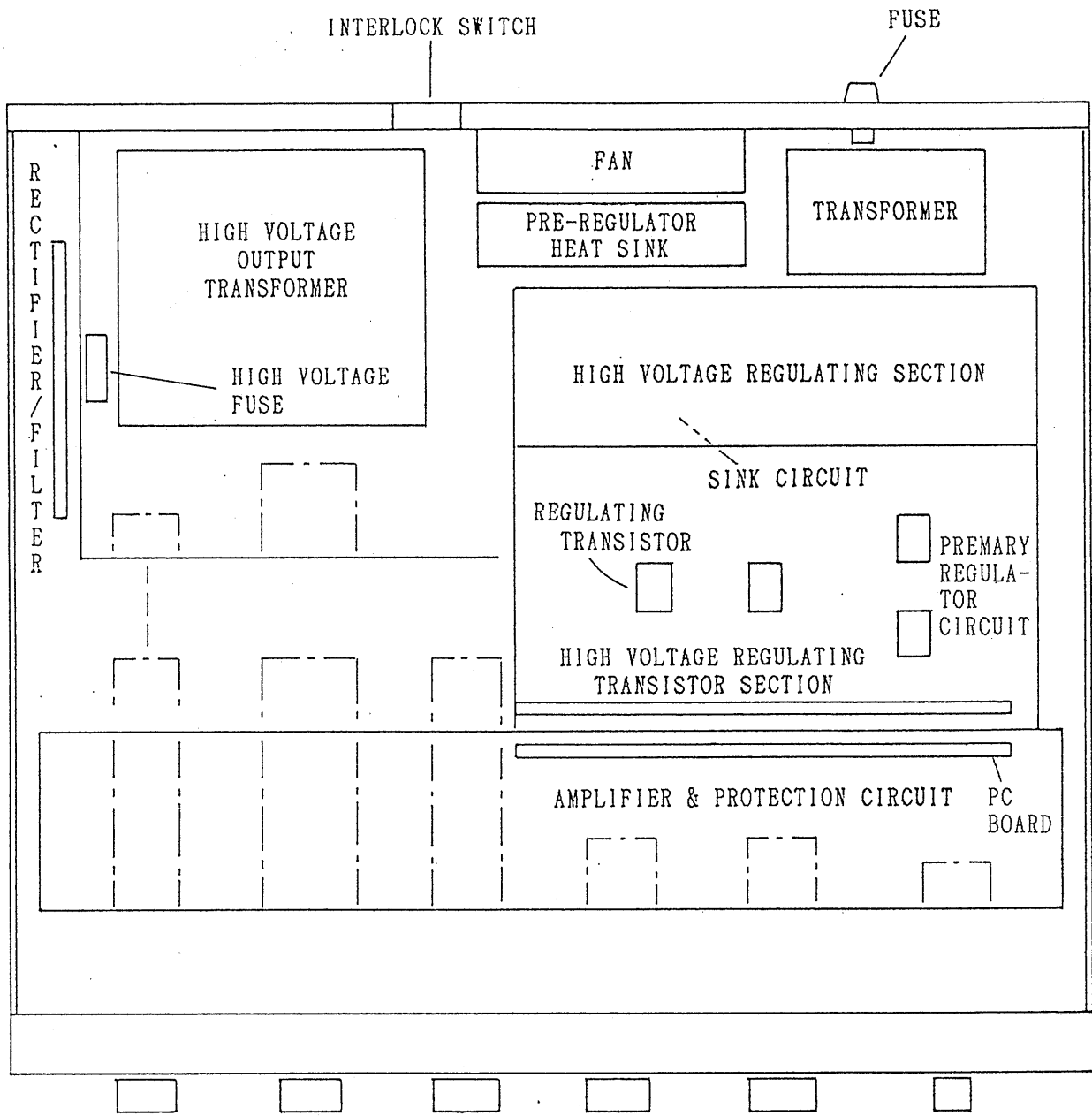


Figure 5-2. Component Location

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5.3 Adjustments and Calibration

**NOTE!:* When making adjustment, calibration or repair, the chassis and various components which is charged up high voltage potential are exposed, posing possible hazards. Make sure the precautions outlined below are taken.

- *Wear rubber gloves and boots.*
- *Operat or touch the unit with the right hand, do not come in contact with work bench, chassis or components with the with the other hand.*
- *Always use a suitable non-conducting tool. Never use a metallic object to perform any adjustments.*

In order to maintain the 1041's accuracy over long periods, it is necessary that calibration be done on a regular basis. At least once every 6 to 12 months is recommended. All adjustments to the 1041 should be carried out in a temperature-regulated environment.

Optimum temperature is 77 degrees F (25 degrees C). Always allow a warm-up period of at least one hour before attempting any adjustments.

(1) Output Voltage Calibration:

Set the RANGE switch to 30 V.

Set the VOLTAGE SETTING dials and the VERNIER knob to zero.

Set POLARITY switch to "+".

Connect a Digital Voltmeter (resolution: 10 microvolt) or a 1.5 mV (full scale) Voltmeter across the output.

Adjust RV104 to read zero volts on the meter.

(2) 300 V RANGE Calibration:

Set the RANGE switch to 300 V.

Set the VOLTAGE SETTING dials thusly: [0] [10] [0] [0].

Set the VERNIER knob to zero.

Connect suitable DVM or other voltmeter to output terminal.

Adjust RV102 to read 100 volts $\pm 0.01\%$ on the meter.

Set the VOLTAGE SETTING dials thusly: [1] [0] [0] [0].

Adjust RV002 to read 100 volts $\pm 0.01\%$ on the meter.

Set the VOLTAGE SETTING dials thusly: [2] [0] [0] [0].

Adjust RV003 to read 200 volts $\pm 0.01\%$ on the meter.

Set the VOLTAGE SETTING dials thusly: [2] [10] [0] [0].

Adjust RV102 to read 300 volts $\pm 0.01\%$ on the meter.

(3) 30 V RANGE Calibration:

Set the RANGE switch to 30 V.

Set the VOLTAGE SETTING dials thusly: [2] [10] [0] [0].

Set the VERNIER knob to zero.

Adjust RV103 to read 30 volts $\pm 0.01\%$ on the meter.

(4) 3000 V RANGE Calibration:

**NOTE!:* Following adjustments involve very high voltages.
Follow all prescribed safety precautions.

**NOTE!:* Never touch the inner sealed case.

Set the RANGE switch to 3000 V.

Set the VOLTAGE SETTING dials thusly: [2] [10] [0] [0].

Adjust RV101 for 3000 volts $\pm 0.01\%$ on the meter.

(5) CURRENT LIMIT Circuit Calibration:

Set the RANGE switch to 300 V.

Adjust the VOLTAGE SETTING dials to produce 100 V output.

Turn the CURRENT LIMIT dial fully clockwise.

Connect an adjustable resistor in series with a suitable milliammeter to the output.

Adjust the load (resistor) until the 1041 output reaches 32 mA current.

Adjust RV105 until the instrument switches to STAND BY mode.

(6) Adjusting the VOLTAGE LIMITING Circuit (VOLTAGE TRIP):

Reconnect the DVM or voltmeter.

Set the VOLTAGE TRIP knob to 500V.

Set the RANGE switch to 3000 V.

Adjust the VOLTAGE SETTING dials to produce about 490 V.

Increase output by 1-volt increments.

Adjust the RV106 so that the unit switches to STAND BY mode as 500 volts is reached.

Set the VOLTAGE TRIP knob to 100 V.

Adjust the VOLTAGE SETTING dials to produce about 95 V.

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Increase output by 1-volt increments.

Adjust RV107 (if needed) so that unit switches to STAND BY mode as approximately 102 volts is reached.

(7) Adjusting the OPERATION LED:

With suitable DVM or voltmeter connected to the output:

Set the RANGE switch to 3000 V.

Adjust the VOLTAGE SETTING dials to produce 1000 V output.

Press the STAND BY switch.

Adjust RV108 so that the LED goes out when the output reaches approximately 100 V.

**NOTE!:* The last operation may take repeated cycles to accomplish. Follow all operating procedures in Section 3.2 of this manual.

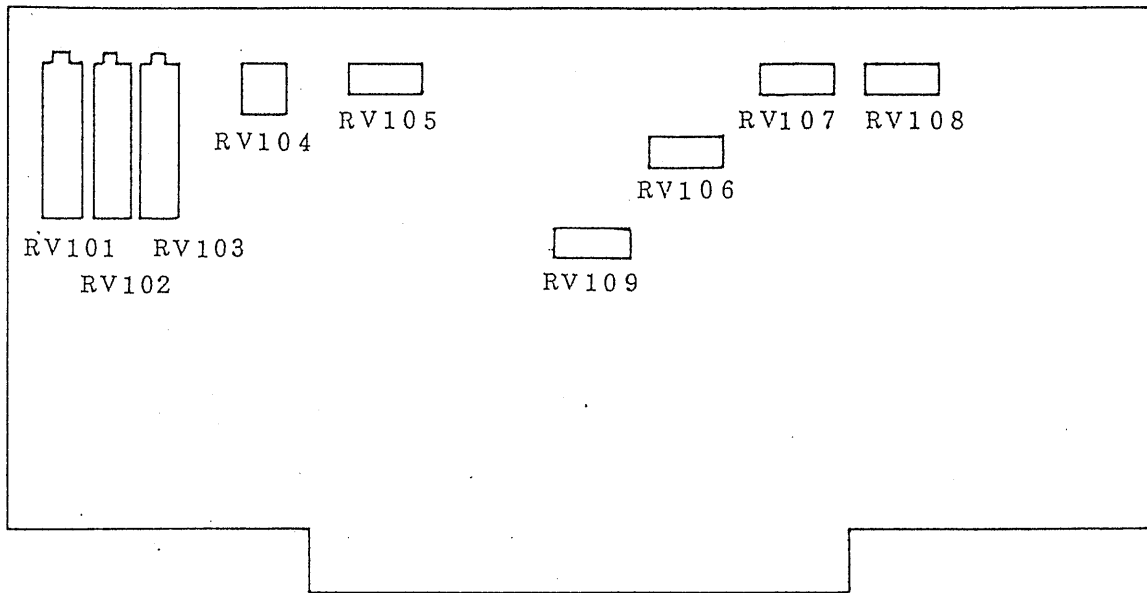


Figure 5-2 OUTPUT REGULATOR PC BOARD LAYOUT

- | | |
|--------------------------|---------------------------------|
| RV101: 3000 V RANGE ADJ. | RV105: 30 mA CURRENT LIMIT ADJ. |
| RV102: 300 V RANGE ADJ. | RV106: 500 V VOLTAGE TRIP ADJ. |
| RV103: 30 V RANGE ADJ. | RV107: 100 V VOLTAGE TRIP ADJ. |
| RV104: OFFSET ADJ. | RV108: OPERATION LED ADJ. |
| | RV109: SERIES PASS BIAS ADJ. |

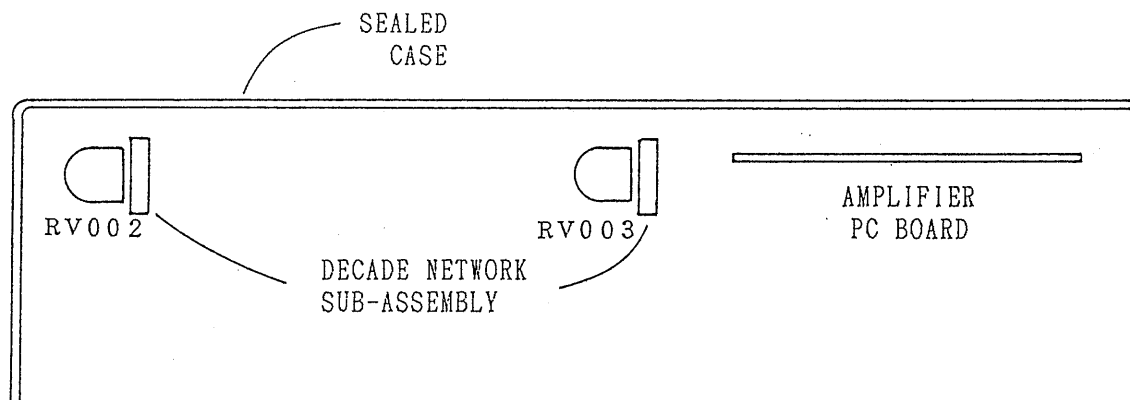


Figure 5-4 OUTPUT REGULATOR COMPONENTS INSIDE SEALED CASE

- | | |
|-------------------|-------------------|
| RV002: 100 V ADJ. | RV003: 200 V ADJ. |
|-------------------|-------------------|