-TR-6141

PROGRAMABLE DC VOLTAGE/CURRENT GENERATOR

INSTRUCTION MANUAL

TAKEDA RIKEN INDUSTRY CO., LTD.

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WARRANTY

All TAKEDA RIKEN INDUSTRY CO., LTD. instruments are guaranteed to be free from defects in workmanship and materials and to perform in full accordance with specifications for a period of 12 months from the date of delivery.
The warranty period for computer peripheral devices, mainly mechanical devices used as system components, is the period specified by the manufacturer of the devices.

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CHAPTER 1 INTRODUCTION

1–1 Description

Unlike conventional voltage generator using resistance division system, the **Model 6141 PROGRAMABLE DC VOLTAGE/CURRENT GENERATOR** incorporates the well known pulse width modulation (PWM) technic in the fields of communication or magnetic recording as the voltage dividing technic based on time division system and generates the DC level as a new and correct DC voltage/current by means of digital technic.
In order that **Model 6141** may also be used in forming a system, it is provided with remote control facility in addition to manual setting.
Moreover, since flip switch is used in manual setting instead of conventional rotary switch, there are no parts susceptible of being worn due to rotation, and increase in reliability and continuous setting function of all digits have been realized.

CHAPTER 2 RATINGS

2–1 Electrical Performance

Output generation range:

Range	Generation range	Resolution
10mV	0 ~ ±11.999mV	1μV
100mV	0 ~ ±119.99mV	10μV
1 V	0 ~ ±1.1999 V	100μV
10 V	0 ~ ±11.999 V	1mV
1mA	0 ~ ±1.1999mA	100nA
10mA	0 ~ ±11.999mA	1μA
100mA	0 ~ ±119.99mA	10μA

Accuracy:

Range \ Error	Setting		Range
10mV	±0.03%	+	± 5μV
100mV	±0.03%	+	± 20μV
1 V	±0.03%	+	±200μV
10 V	±0.03%	+	± 1mV
1mA	±0.035%	+	±300nA
10mA	±0.035%	+	± 3μA
100mA	±0.035%	+	± 30μA

Guaranteed for constant power source and load condition at +23±5°C temperature and less than 70% humidity.
However, the current range is satisfied in positive polarity.

One-day stability:

Range \ Error	Setting		Range
10mV	±0.015%	+	± 3μV
100mV	±0.015%	+	± 15μV
1 V	±0.015%	+	±120μV
10 V	±0.015%	+	±600μV
1mA	±0.02%	+	±200nA
10mA	±0.02%	+	± 2μA
100mA	±0.02%	+	± 20μA

Guaranteed under constant power source and load condition at +23±5°C temperature and less than 70% humidity.
However, the current range is satisfied in positive polarity.

Temperature coefficient /°C :

Range \ Error	Setting		Range
10mV	±0.002%	+	±200nV
100mV	±0.002%	+	± 2μV
1 V	±0.002%	+	± 20μV
10 V	±0.002%	+	±200μV
1mA	±0.002%	+	± 20nA
10mA	±0.002%	+	±200nA
100mA	±0.002%	+	± 2μA

At 0 ~ +18°C, +28 ~ +40°C temperature.

Noise:

Range \ Noise	Below 10Hz	Below 500Hz
10mV	1μV rms	1μV rms
100mV	3μV rms	5μV rms
1 V	20μV rms	50μV rms
10 V	50μV rms	500μV rms
1mA	20nA rms	50nA rms
10mA	200nA rms	500nA rms
100mA	2μA rms	5μA rms

However, the current range is satisfied in positive polarity.

Output impedance and maximum load:

Range	Output impedance	Maximum load
10mV	Approx. 2Ω	20KΩ The load which gives ±0.01% error
100mV	Approx. 2Ω	
1 V	Less than 10mΩ	120mA
10 V	Less than 10mΩ	
1mA	More than 10MΩ	10V output follow up voltage
10mA	More than 100MΩ	
100mA	More than 100MΩ	

2–2 General Specification

Overload protection circuit : An automatic reset type overload protection circuit is built-in.

Load regulation : ±0.005% of setting at each range maximum load.

Response time : Time for attaining 0.1% for 0 to full scale is within 150msec.

Warming up time : Time until the accuracy described in par. 2–1 is satisfied is approximately 10 minutes.

Withstand voltage : DC 500V between the output terminal and chassis.

Output : Floating system

Output voltage/current setting : Manual setting All digit continuous setting by flip switch
Remote setting TTL level negative logic parallel signal

Display : 7 segment light-emitting-diode (hereafter called [LED]) display

Operating temperature : 0°C ~ +40°C

Storage temperature : –55°C ~ +75°C

Power requirement : AC115V ±10%, 50/60Hz

Power consumption : Approx. 25VA

Dimensions : Approx. 300(W) X 85(H) X 255(D) mm

Weight : Approx. 5Kg

CHAPTER 3 OPERATING INSTRUCTIONS

3–1 Inspection

Inspect your **Model 6141** for any damage that may have ocurred during shipment. If the instrument is damaged or does not operate to specifications, contact your nearest Takeda Riken agent.

3–2 Storage

When your **Model 6141** is not being used, cover it with a vinyl cover, etc. and place it into a cardboard box and store it in a dry, dark place. Storage temperature range is −50°C ~ +75°C.

3–3 General Preparations and Precautions Prior to Use

(1) Use a 115V ±10%, 50/60Hz AC power line. Always confirm that the [POWER] switch is set to the [OFF] position before connecting the power cord to the AC line.

(2) Use the instrument within an ambient temperature range of 0°C ~ +40°C and a humidity of under 70%.

(3) Handle the instrument with care so that it is not subjected to excessive mechanical shock.

(4) Allow the instrument to warm-up for a least 10 minutes.

(5) Always connect the frame of the **Model 6141** to an earth ground when the instrument is being used. Since the ground line of the power cord and the [GND] terminal on the rear panel are connected to the frame of the **Model 6141**, either can be connected to an earth ground.

(6) Power cord handling precautions
The power cord employs a 3-pin plug as shown in the following figure. The central round pin is the ground pin. When using the 2-pin adapter for connecting to power socket, connect the lead coming out from the adapter or the ground terminal at the rear panel of the apparatus to external ground.

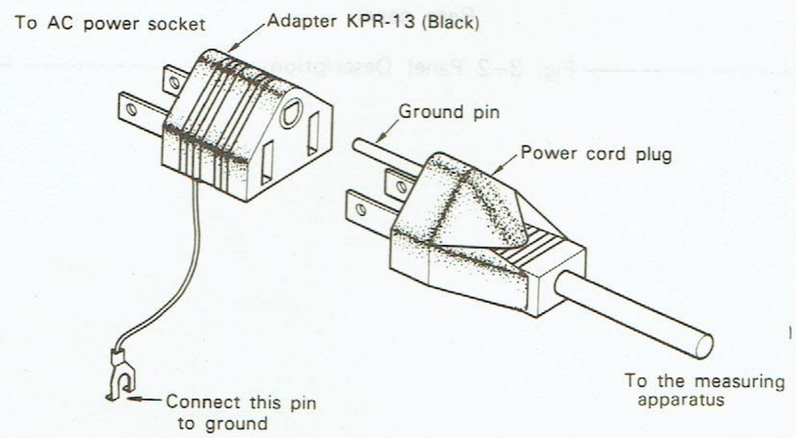
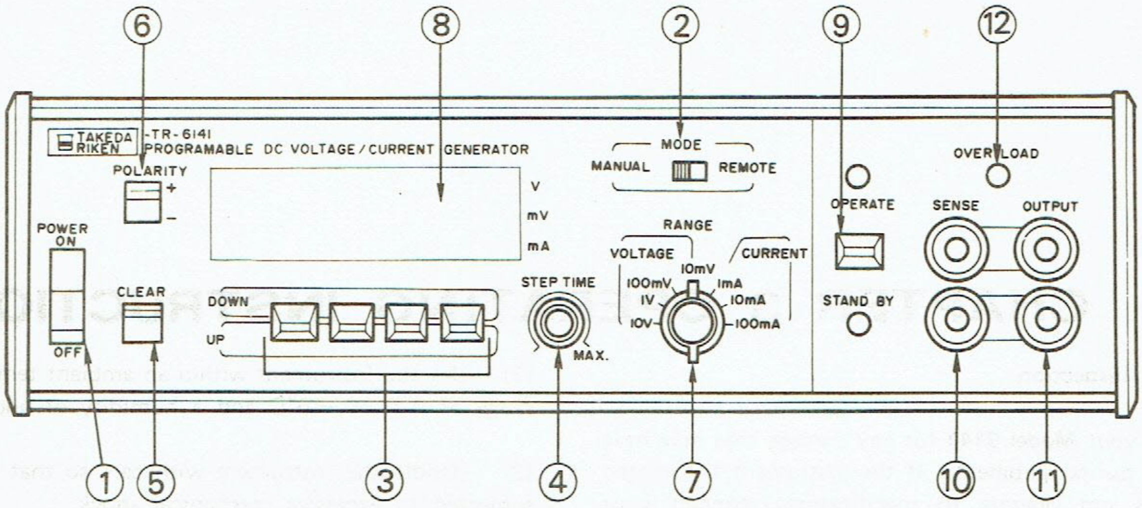
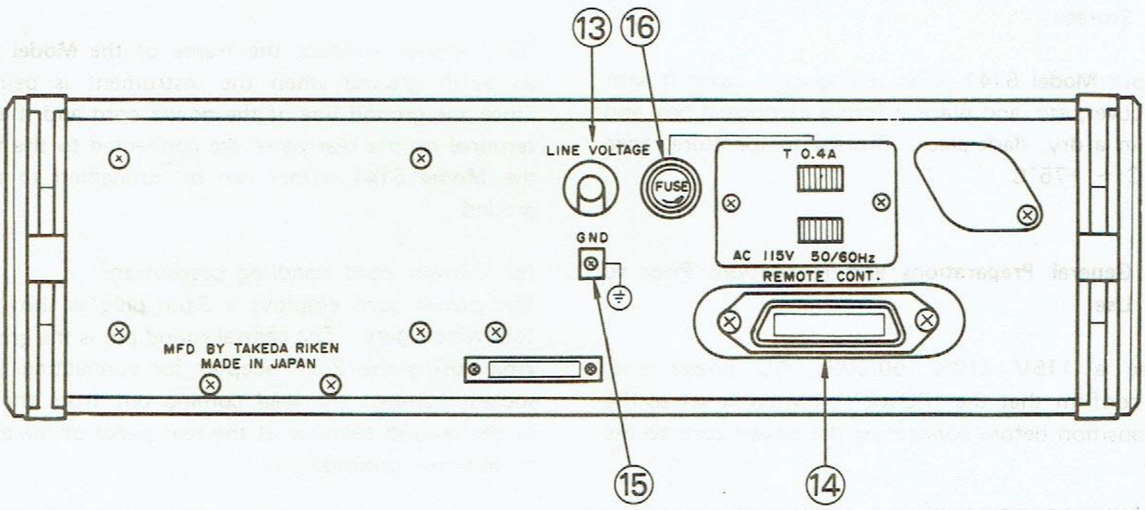


Fig. 3–1 Power cord

3–4 Panel Descriptions



Front panel



Rear panel

Fig. 3–2 Panel Descriptions

Refer to Fig. 3–2.

Front Panel

① **[POWER] switch**
When this switch is set to the [ON] position, power is supplied to all the circuits, the [STAND BY] lamp is lighted and the instrument is placed in the STAND BY state.
When the switch is set to the [OFF] position, the power to all circuits is turned off.

② **[MODE] switch**
This switch selects the control mode for setting the output level.

MANUAL mode . . . . . The output level is set by panel operation when this switch is set to the [MANUAL] position.

REMOTE mode. . . . . The output level is set by control signal input from the [REMOTE CONT.] connector on the rear panel when this switch is set to the [REMOTE] position.

③ **Flip switches**
These switches set the output level.
When a certain switch is set to the [UP] position, the setting value of that digit is increased and when set to the [DOWN] position, the setting value of that digit is decreased.

④ **[STEP TIME] control**
This control sets the step time.
This control adjust the rate of change when the output level is varied continuously with the flip switches ③.
Step time can be varied over the approximate 0.1sec ~ 1sec range. The step time becomes approximately 1 sec when this knob is turned fully clockwise to the [MAX.] position.

⑤ **[CLEAR] switch**
This switch clears all the set output levels to zero.

⑥ **[POLARITY] switch**
This switch sets the polarity of the output level.
When this switch is set to the [+] position, the red terminal becomes positive (+) polarity and when it is set to the [–] position, the red terminal becomes negative (–) polarity.

⑦ **[RANGE] switch**
This switch sets the voltage/current output mode and range.

⑧ **Display**
Displays the setting contents of the output level, polarity, and range. Only negative (–) polarity is displayed. Units display employs 3 units display use LED, mA, mV, and V are indicated.

⑨ **[OPERATE/STAND BY] switch**
This is the output control switch.
When this switch is set to the upper position, the [OPERATE] lamp is lighted and the set output level is output.
When it is set to the lower position, the [STAND BY] lamp is lighted, and the output terminals are opened.

⑩ **[SENSE] terminals**
These are the voltage output terminals.
These terminals are normally shorted to the [OUTPUT] terminals by a shorting bar.
To separate the **Model 6141** and the load, disconnect the shorting bar and use 4 terminal connection.

⑪ **[OUTPUT] terminals**
These are the current output terminals.

⑫ **[OVER LOAD] lamp**
This is the overload indicator lamp.

Rear Panel

⑬ **Power cord**
This cord is connected to the AC power line.
The insertion end of this cord has a 3 pin plug. The center pin of this plug is connected to the frame.
The instrument can be connected to a 2 pin AC power line socket by connecting the AC adapter to this 3 pin plug.
In this case, always connect the green wire of the AC adapter to an earth ground.

⑭ **[REMOTE CONT.] connector**
This is the input connector of the control signal when the instrument is set to the REMOTE mode.

⑮ **[GND] terminal**
This terminal connect the frame of the **Model 6141** to an earth ground.

⑯ **Fuse holder**
This holder contains a 0.4A slow-blow fuse.

3–5 Panel Operation

Refer to Fig. 3–3.

(1) Set the [POWER] switch to the [ON] position and allow the instrument to warm-up for about 10 minutes.

(2) Set the [MODE] switch to the [MANUAL] position.

(3) Connect the output terminals and load with the connection cable. Normally connect the [SENSE] terminal and [OUTPUT] terminal of the same polarity with the shorting bar.

When the connection cable must be long in the case of the voltage output mode, use 4 terminal connection.

(4) Set the output level at the flip switches and [RANGE] switch.

(5) Set the polarity of the output level at the [POLARITY] switch.

(6) Set the [OPERATE/STAND BY] switch to the [OPERATE] position.

(7) The set output level will now be output at the output terminals.

(8) To set the output level to [0000], depress the [CLEAR] switch.

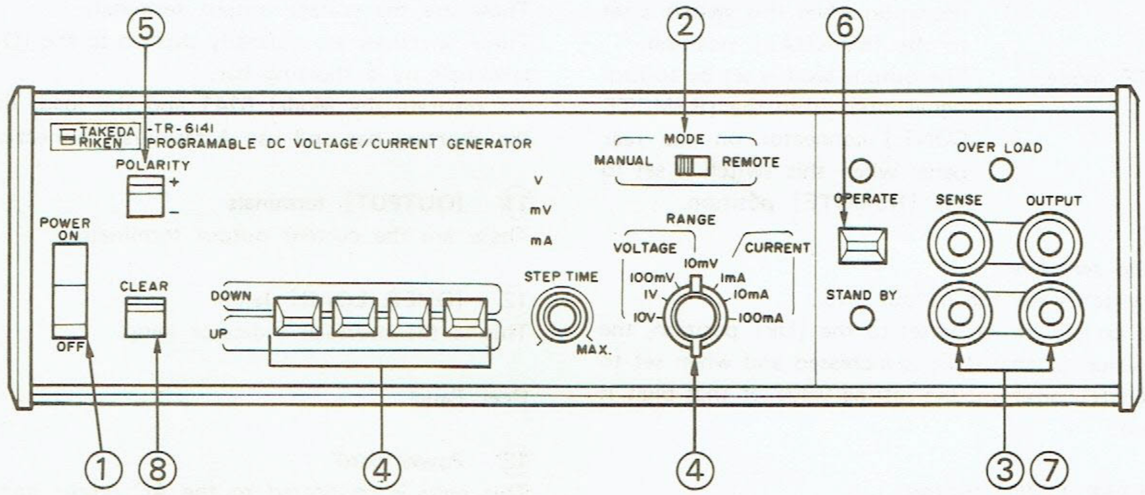


Fig. 3–3 Panel Operation

3–6 Operating the Flip Switches

The output level can be set by operating the flip switches. There are four flip switches consisting of a 10^0 digit, 10^1 digit, 10^2 digit, and 10^3digit switch.

The set value can be increased or decreased one step at a time by setting the switches to the [UP] position or [DOWN] position.

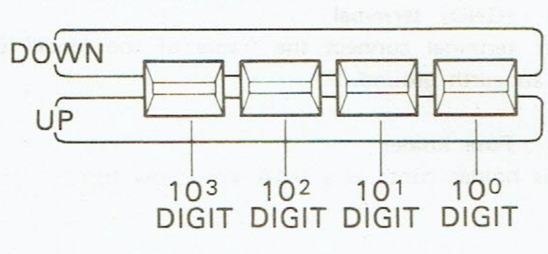


Fig. 3–4 Flip Switches

There are the following 2 setting methods:

(1) One step setting

When the flip switch is depressed and then immediately released (depressed within 270msec), the setting value is increased or decreased one step according to the direction in which the switch has been depressed. When the flip switch of the 10^0 digit (least significant digit) is intermittently depressed to the [UP] position from the set level [0008] one step at a time, setting is performed as follows:

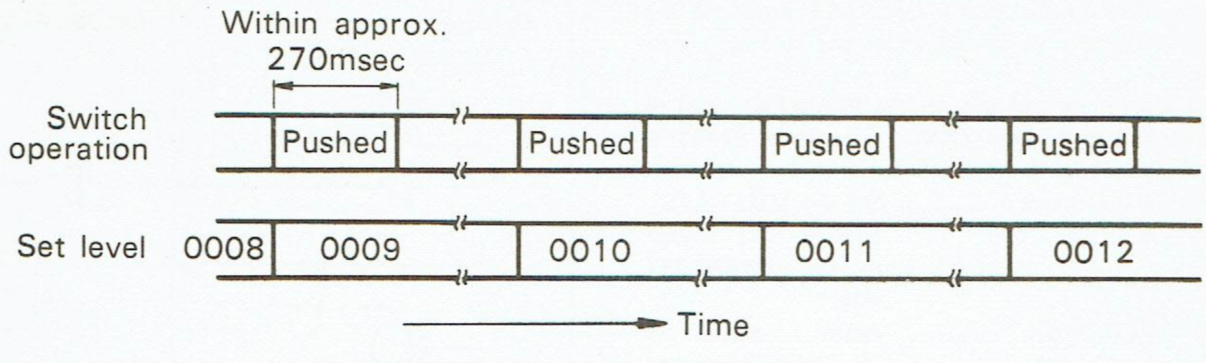


Fig. 3–5 One step Setting

(2) Continuous setting

When the flip switch is continuously depressed to the [UP] or [DOWN] position, the set value is continuously changed at the step time (approx. 0.1sec ~ 1sec) set at the [STEP TIME] control after approximately 270msec (1 step change).

When the flip switch of the 10^3 digit (most significant digit) is continuously depressed to the [DOWN] position from the set level [11999], the set value is changed as follows:

Each flip switch is linked to the next higher digit from the digit of the depressed flip switch.

When depressed to the [UP] position, the value is counted up in the full scale direction and when depressed to the [DOWN] position, the value is counted down in the zero direction.

However, counting up from [11999] and counting down from [0000] are impossible.

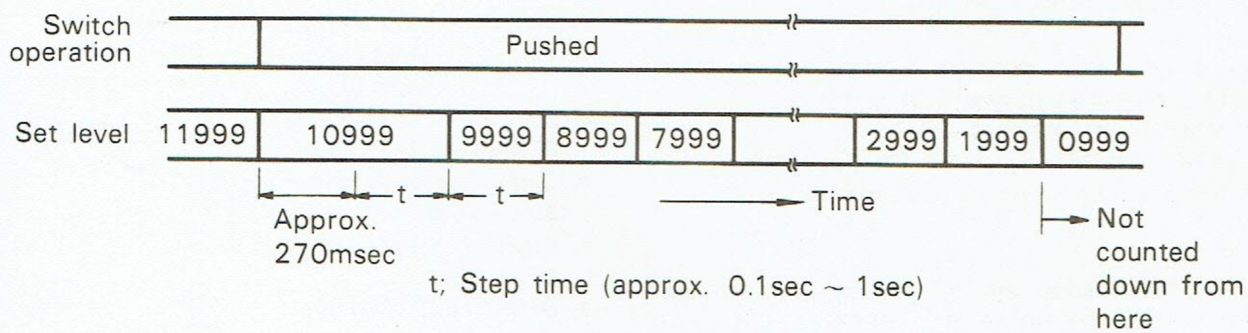


Fig. 3–6 Continuous Setting

3–7 OPERATE/STAND BY FUNCTION

1. STAND BY setting

The output is placed in the STAND BY state and the [STAND BY] lamp is lighted under the following conditions:

(1) When power turned ON

(2) When [MODE] switch is switched

(3) When set to STAND BY in the MANUAL mode or REMOTE mode

a. MANUAL mode .... When the [OPERATE/STAND BY] switch has been set to the [STAND BY] position.

b. REMOTE mode .... When a signal is not applied to pin 29 (OPERATE pin) of the [REMOTE CONT.] connector.

2. OPERATE setting

The output is placed in the OPERATE state and the [OPERATE] lamp is lighted under the following conditions.

The method of switching from the STAND BY state to the OPERATE state in the MANUAL mode and REMOTE mode is described.

(1) MANUAL mode .... Set the [OPERATE/STAND BY] switch to the [OPERATE] side.

(2) REMOTE mode .... Apply a signal to pin 29 (OPERATE pin) of the [REMOTE CONT.] connector.

CAUTION

Note that a voltage of approximately 10V ~ 13V is output at the output terminals when set to the OPERATE state without a load connected to the output terminal in the current output mode. There are also cases when the [OVER LOAD] lamp may be lighted under this state.

3–8 CLEAR FUNCTION

When the following operation is performed, the level setting of each digit is cleared to [0000].

(1) When power is turned ON

(2) When [MODE] switch has been switched

(3) When [CLEAR] switch has been depressed

NOTE

The CLEAR function will not be operated when the [MODE] switch is set to the [REMOTE] position.

3–9 Remote Control

The following four functions can be remotely controlled by applying a control signal to the [REMOTE CONT.] connector on the rear panel.

(1) Level setting of each digit

(2) Output mode and range

(3) Polarity

(4) OPERATE/STAND BY

1. Remote control

The above four functions can be remotely controlled by making each control pin of the [REMOTE CONT.] connector LOW level.

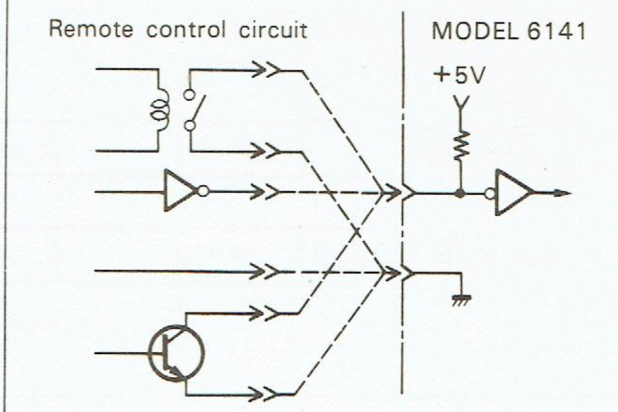


Fig. 3–7 Remote Control Circuit

The input line of the [REMOTE CONT.] connector remains at a HIGH level as long as it is not made LOW level by remote control.

Control the above four functions by means of a contact signal, open collector TTL IC or transistor as illustrated in Fig. 3–7.

2. Control signal

The control signals for the above four functions are given below:

Signal level	Negative logic	TTL level
	Logic [1]	0V ~ +0.4V
	Logic [0]	+2.4V ~ +5.25V

a. Level setting of each digit
   BCD (8–4–2–1) code

b. Output mode and range
   Binary code

c. Polarity
   Binary code

d. OPERATE/STAND BY
   Binary code
   Logic [1] OPERATE state
   Logic [0] STAND BY state

e. LOAD signal
   The control signal (BCD code) of each digits of the four functions can be transferred to the interior of the instrument by making pin 36 (LOAD pin) of the [REMOTE CONT.] connector logic [1].
   The LOAD signal which controls pin 36 (LOAD pin) should be a pulse signal having a width of 50nsec or greater.

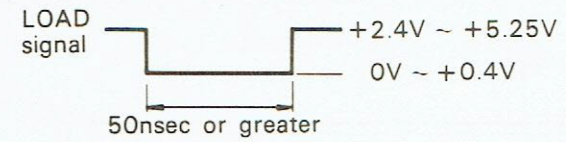
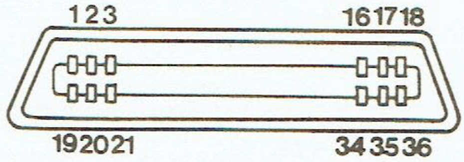


Fig. 3–8 LOAD Signal

Normally, when the **Model 6141** is used in the REMOTE mode, the level can be immediately set by applying the control signal (BCD code) to the control pin of each digit by making the LOAD signal logic [1] beforehand.

3. Description of [REMOTE CONT.] connector pins



[REMOTE CONT.] connector

Connectors used
AMPHENOL 57 – 40360 (**Model 6141** mainframe)
AMPHENOL 57 – 30360 (Connection cable)

Pin No.	Control function	
1	GND	
2	1	
3	2	
4	4	10^0 digit
5	8	
6	1	
7	2	10^1 digit
8	4	
9	8	
10	1	10^2 digit
11	2	
12	4	
13	8	
14	1	
15	2	
16	4	10^3 digit
17	8	
18	1	10^4 digit
19	10V	
20	1V	
21	100mV	
22	10mV	Output mode
23	100mA	
24	10mA	and range
25	1mA	
26	NC	
27	Polarity	
28	NC	
29	OPERATE/STAND BY	
30		
31		
32	NC	
33		
34		
35		
36	LOAD	

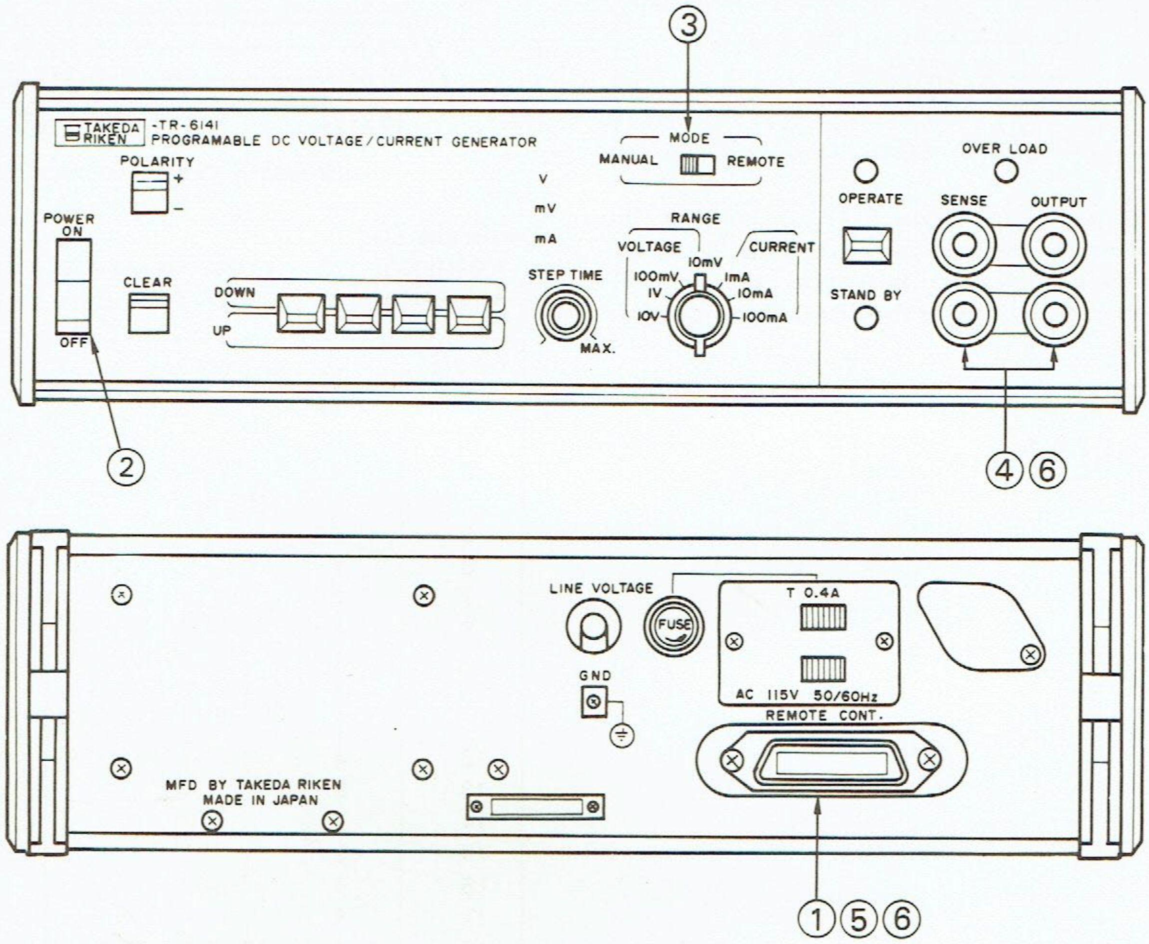


Fig. 3–9 Remote Control Operation

Refer to Fig. 3–9.

(1) Connect the [REMOTE CONT.] connector and remote control device with the connection cable.

Always confirm that the [POWER] switch is set to the [OFF] position before performing this connection.

(2) Set the [POWER] switch to the [ON] position and allow the instrument to warm-up for about 10 minutes.

(3) Set the [MODE] switch to the [MANUAL] position.

(4) Connect the output terminal and load with the connection cable. Normally used by shorting the [SENSE] terminal and [OUTPUT] terminal together with the shorting the bar.

Use a 4 terminal connection when the connection cable must be long in the case of the voltage output mode.

(5) Set the output level by applying a control signal to the [REMOTE CONT.] connector.

Set pin 36 (LOAD pin) to logic [1] and apply a control signal to the level, of each digit output mode and range pins.

(6) The set output level can now be output at the output terminals by setting pin 29 of the [REMOTE CONT.] connector to logic [1].

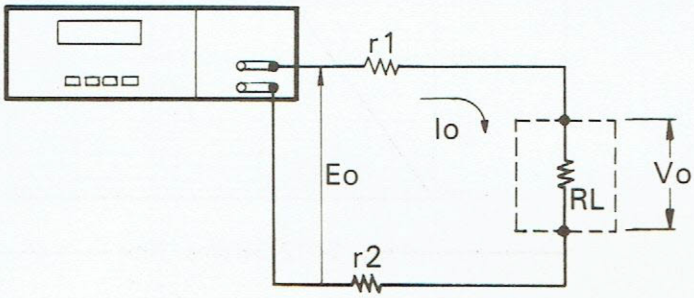
Setting of the level of each digit of the four functions can be remotely controlled even through the [MODE] switch is set to the [MANUAL] side. The control signal (BCD code) of each digit can be transferred to the interior of the instrument and the output level set by applying a LOAD signal having a pulse width of 50nsec or greater to pin 36 (LOAD pin) in the same manner as normal remote control.

Moreover, the output level can be changed with that set value as standard by operating the flip switches at the front panel.

However, since remote control has priority when the LOAD signal becomes logic [1], the function of the flip switches will not be operated.

3–10 4 Terminal Output

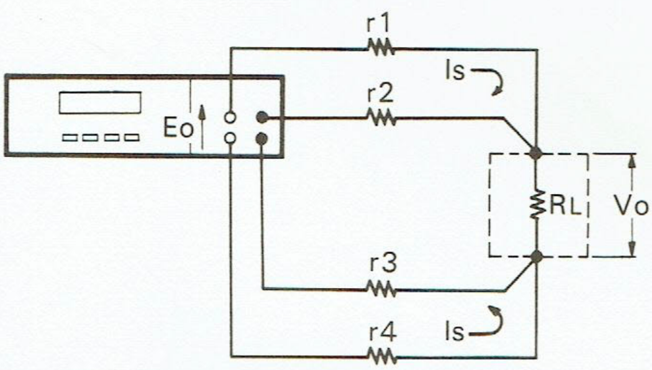
When the load resistance of the device is low and a large current flows in the load in complex measurement in the case of voltage output, the set voltage may not be applied to the device because of the voltage drop caused by the resistance of the cable connected between the **Model 6141** and the device.
The 4 terminal method guarantees the error caused by this voltage drop at the load terminal.
The [OUTPUT] terminal and [SENSE] terminal of the **Model 6141** each has a "+" output terminal and "–" output terminal and a 4 terminal output can be extracted.
Normally, the [OUTPUT] terminal and [SENSE] terminal are connected between the same polarity terminals with a shorting bar.
When the load current is especially large or the connection cable is especially long, disconnect the shorting bar between the output terminals and use as 4 terminal output.
The voltage detection current Is is a maximum 120μA. When the load current Io is larger than Is, the error is smaller for the 4 terminal connection of Fig. 3–11.



r1, r2 : Resistance of connection cable.
Vo : Voltage between load R_L terminals.
R_L : Load
Io : Load current

$$Vo = Eo - \underbrace{(r_1 + r_2) \cdot Io}_{\text{Error}}$$

Fig. 3–10 2 Terminal Connection



r1, r2, r3, r4 : Resistance of connectioncable
Io : Load current
Is : Voltage detection current

$$Vo = Eo - \underbrace{(r_2 + r_4) \cdot Is}_{\text{Error}}$$

Fig. 3–11 4 Terminal Connection

3–11 Settling Time

The time required from the instant a certain voltage (current) is set to the instant the maximum of the set value is reached is called the settling time.
When using at the speed of a high-speed D/A converter, settling time should be given due consideration.
Fig. 3-12 gives the settling times when change is made from 0 to full scale or from a certain point to 1/10 of full scale on all ranges. The horizontal axis represents time and the vertical axis the percentage change.

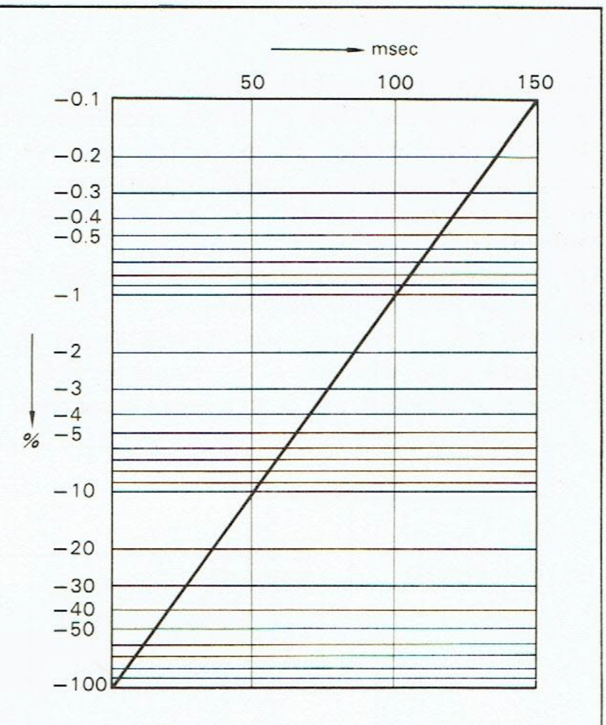


Fig. 3–12 Settling Time

CHAPTER 4 PRINCIPLES OF OPERATION

4–1 Description

Model 6141 is a DC voltage generator incorporating the pulse width modulation (PWM) system used in the communications and magnetic recording fields as its time division voltage division technique. A simple block diagram of the **Model 6141** is shown in Fig. 4–1. **Model 6141** consists of 3 main blocks, namely, setting block, standard voltage generation block, and output amplifier block.

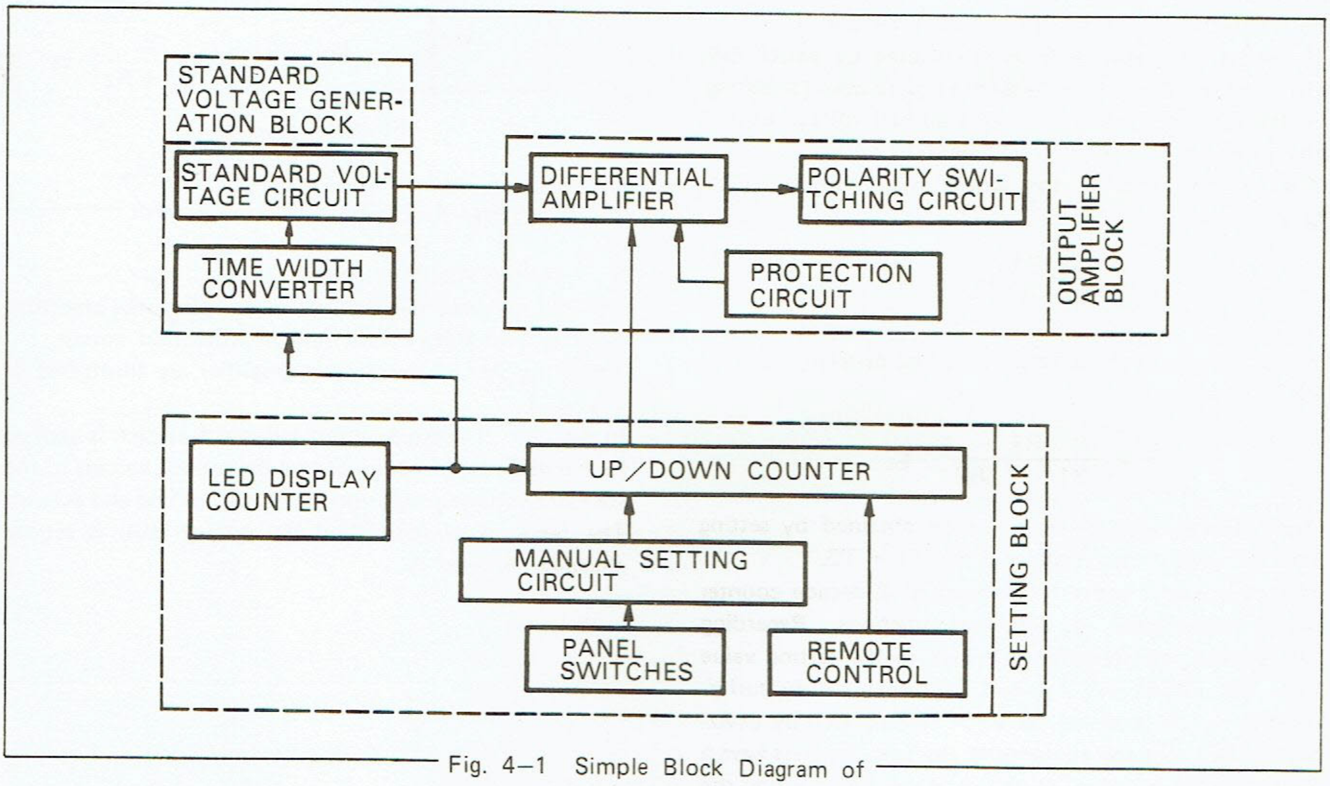


Fig. 4–1 Simple Block Diagram of **Model 6141**

A simple description of each block is given next.

1. Setting Block

The voltage/current output level settling signals from the flip switches and remote control connector are converted to parallel BCD (8–4–2–1) code signals by the UP/DOWN counter and are input to the LED display circuit and standard voltage generation block.

2. Standard Voltage Generation Block

The standard voltage generation block consists of a time width converter circuit and a standard voltage circuit, and performs voltage division by means of a time division system.
Voltage division by the time division system used in the **Model 6141** is shown in Fig. 4–2.
Voltage division by the time division system is performed by converting the input standard voltage Es to a signal interrupted time-wise and averaging this signal by means of an RC low pass filter.
At this time, the ratio of the standard voltage Es and the average output voltage Eo, that is, the division ratio, is determined by the time ratio of the interruption.
If the standard voltage Es is interrupted by switch SW, the interrupted signal will become a square wave consisting of the ratio of time T1 of the standard voltage Es and the time T2 of the zero voltage.
The average value of the square wave shown in Fig. 5–2 (b) is,

$$E = \frac{T1}{T1 + T2} \cdot Es$$

The equation for the general resistance division shown in Fig. 5–2 (c) is,

$$E = \frac{R1}{R1 + R2} \cdot Es$$

Any arbitrary output level can be obtained by setting time T1 relative to constant time T1 + T2.
The time width converter consists of 2 decade counter having independent set and reset functions. Regarding the set side, the counter is preset to the setting value from the outside and a pulse train having a duty corresponding to the external set value is generated by utilizing the fact that the contents of the two counters have a mutual deviation equal to the set value by counting the same clock pulses with the two counters.
The output voltage is obtained by switching the standard voltage from the standard voltage circuit by means of this pulse train and averaging this signal with a low pass filter.

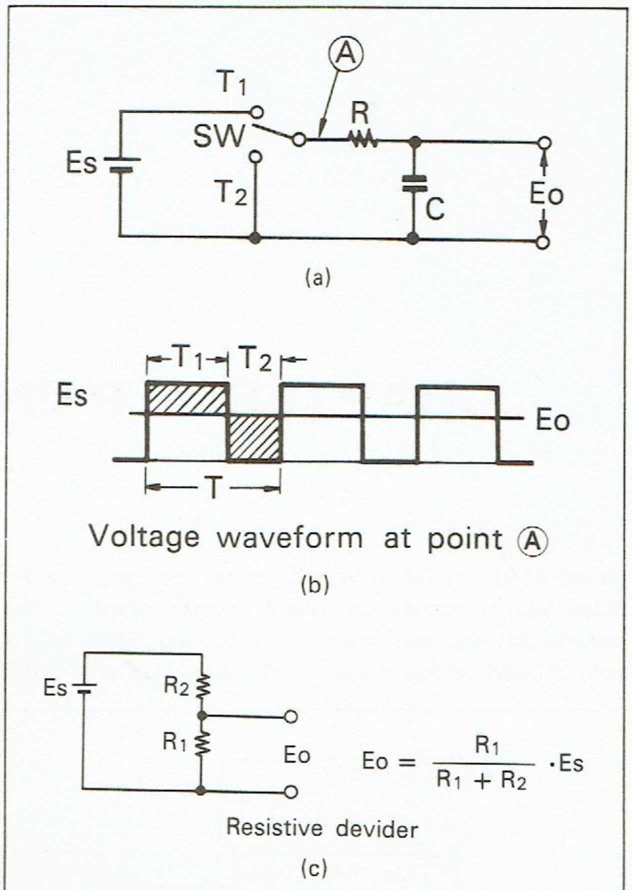
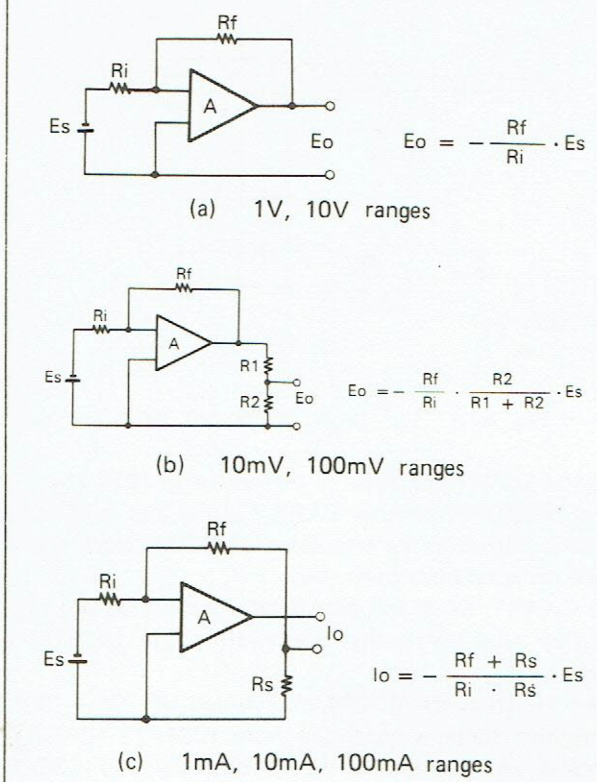


Fig. 4–2 Time Division system

3. Output Amplifier Block

The output amplifier consists of a differential amplifier, polarity switching circuit and a protection circuit.
The principles of the output amplifier are illustrated in Fig. 4–3.
In the case of voltage output, current feedback is applied to the differential amplifier and the output voltage of the standard voltage generation block is amplified and output.
The range is switched and the output level is set by changing Ri and Rf.



$$Eo = -\frac{Rf}{Ri} \cdot Es$$

$$Eo = -\frac{Rf}{Ri} \cdot \frac{R2}{R1 + R2} \cdot Es$$

$$Io = -\frac{Rf + Rs}{Ri \cdot Rs} \cdot Es$$

Fig. 4–3 Output Amplifier Block

4–2 Output Level Setting Circuit (SB239)

The output level setting circuit is centered around an UP/DOWN counter having a preset function.
Both manual setting by means of flip switches and external setting by remote control are possible.

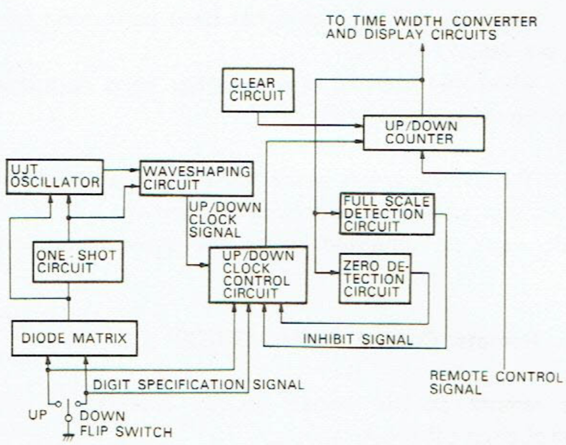


Fig. 4–4 Block Diagram of Output Level Setting Circuit

4–3 UP/DOWN Clock Generator (SB239)

Manual setting can be performed by generating an UP/DOWN clock signal which operates the output level setting use UP/DOWN counter by means of a contact signal from the flip switches.
The block diagram of the UP/DOWN clock generator circuit are given in Fig.4–5.
When any of the flip switches is depressed, its contacts is connected to the one-shot circuit and UJT oscillator through the diode matrix consisting of D81 and D82.
The one-shot circuit outputs the UP/DOWN clock signal at the time of one step setting, and outputs the UP/DOWN signal immediately after a flip switch has been depressed.
The UJT oscillator outputs the UP/DOWN clock signal at the time of continuous setting by continuous depression of the flip switch, and outputs an UP/DOWN clock signal at the step time (approximately 0.1sec ~ 1sec) set at the [STEP TIME] control.
These UP/DOWN clock signals are waveshaped through a NOR gate.

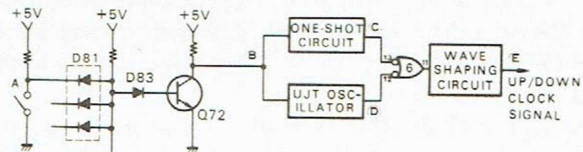


Fig. 4–5 Block Diagram of UP/DOWN Clock Generator Circuit

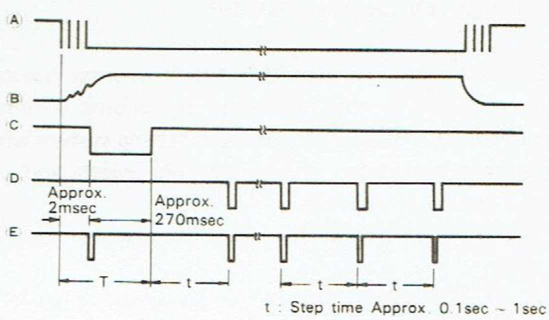


Fig. 4–6 UP/DOWN Clock Generation Timing

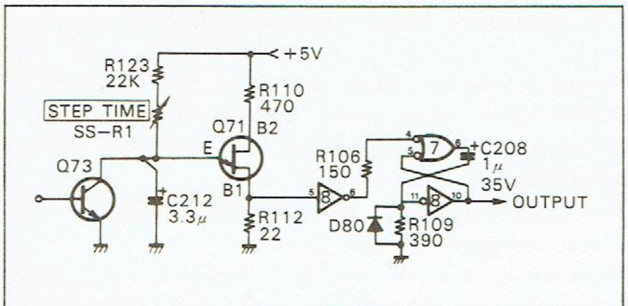


Fig. 4−7 UJT Oscillator

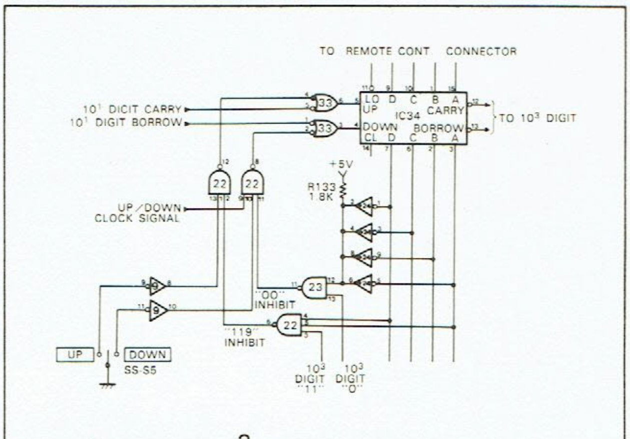


Fig. 4−8 10^2 Digit UP/DOWN Counter

The UJT oscillator is a relaxation oscillator emplying a UJT (unijunction transistor) and consists of Q71, Q73, C212, R123, SS−R1, etc.
When a flip switch is depressed continuously, its contact signal sets Q73 to the OFF state.
At this time, C212 is charged to the ON potential of Q71 through R123 and SS−R1.
This turns Q71 ON and the charge of C212 starts to discharge through R112.
When the state at which the emitter of Q71 is blocked is reached, Q71 is turned OFF.
The period of the oscillating waveform at base B1 of Q71 obtained by means of this operation is determined by the step time (approximately 0.1sec ~ 1sec) set at the [STEP TIME] control, and continuous setting of the flip switch is possible.
The output of the UJT oscillator is waveshaped by the one-shot circuit consisting of IC7, IC8, and C208 through an inverter.
D80 is a clamping diode which prevents the input side of IC8 from becoming minus when the one-shot circuit is inverted.

4−4 UP/DOWN Counter (SB239)

Model 6141 uses a 4 digit UP/DOWN counter having a preset function so that operation by adding a remote control setting system to the manual setting system which permits both one step setting by flip switch and continuous setting is possible.
The UP/DOWN counter for the 10^2 digit is shown in Fig. 4−8.
When the flip switch (SS−S5) is depressed to the [UP] side in the MANUAL mode, the UP/DOWN clock signal and IC32 (10^1 digit) CARRY signal are connected to the UP terminal (pin 5) of the 10^2 digit UP/DOWN counter (IC34) through the NOR gate (IC33) and the UP operation is performed at IC34.
When the flip switch (SS−S5) is depressed to the [DOWN] side, the UP/DOWN clock signal and IC32 (10^1 digit) BORROW signal are connected to the DOWN terminal (pin 4) of IC34 through the NOR gate (IC33) and the DOWN operation is performed at IC34.
Each UP/DOWN counter CARRY signal and BORROW signal is output as the respective UP/DOWN clock signal under the conditions given next.
The CARRY signal and BORROW signal are output as a negative pulse having the same width as the UP/DOWN clock signal.
When the contents of IC34 are counted UP "9"→ "0", a negative pulse is generated from IC34−12 (CARRY terminal) and is output as the UP clock signal to IC36−5 (UP terminal).
When the contents of IC34 are counted down "0"→"9", a negative pulse is generated from IC34−13 (BORROW terminal) and is output as the DOWN clock signal to IC36−4 (DOWN terminal.)
Considering the UP operation and DOWN operation at the 10^2 digit, the UP/DOWN signal input to the UP/DOWN terminal of IC34 is inhibited under the following conditions.

1. When the UP operation has been performed from the set value [119XX]
2. When the DOWN operation has been performed from the set value [00XX]

The UP/DOWN counter block has a full scale detection circuit and a zero detection circuit and the UP/DOWN clock signal is inhibited under the above conditions.

4−5 Remote Control Buffer (SB239)

The remote control signals are all supplied to each control circuit through buffers.
The remote control signals are classified into level setting signal and range setting signal.
The level setting signal is connected to the preset input of the UP/DOWN counter through the buffer

consisting of IC55 ~ IC58.
Moreover, +5V is supplied to Vcc of IC57 and IC58, which form the range setting signal buffer at REMOTE, and the range setting signal is controlled by setting the [MODE] switch to the [REMOTE] position.

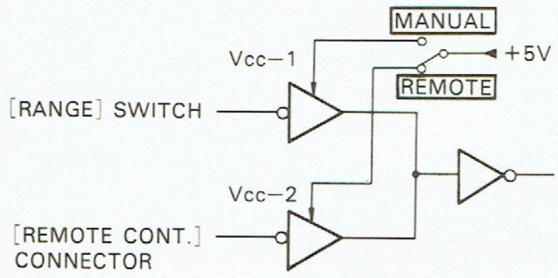


Fig. 4–9 Control of Range Setting Signal

When the [MODE] switch is set to the [MANUAL] side, +5V is supplied to Vcc of IC16 and IC17, which form the buffer in the MANUAL mode, and range setting is performed from the [RANGE] switch.
In the MANUAL mode, mixed level setting by means of flip switch and remote control is possible.
The LOAD signal when remote control setting is performed is 50nsec or greater pulse signal.

4–6 Time Width Converter (SB239)

The time width converter consists of a 5MHz oscillator, free running counter, and preset counter, and generates a pulse train having a duty corresponding to the output level setting value.
The block diagram of the time width converter is shown in Fig. 4–10.

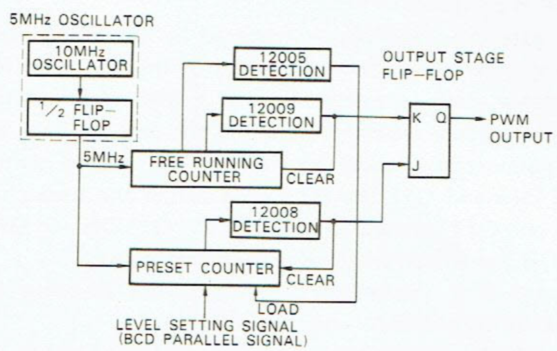


Fig. 4–10 Block Diagram of Time Width Converter

The free running counter counts the 5MHz signal from the 5MHz oscillator circuit. When the contents of this counter reach "12005", the 12005 detection signal is generated from the 12005 detection circuit.
This 12005 detection signal becomes the LOAD signal of the preset counter and the level setting signal applied to the input of the preset counter is transfered to the inside of the counter and the counter is set to the initial value.
When the contents of the free running counter reach "12009", the 12009 detection circuit generates the 12009 detection signal which clears the contents of the counter and is applied to the "K" input of the output stage flip-flop as the free running counter CLEAR signal.
When the contents of the preset counter reach "12008", the 12008 detection circuit generates the 12008 detection signal which clears the contents of the counter and is applied to the "J" input of the output stage flip-flop as the preset counter CLEAR signal.
The phases of the 2 counters are shifted only the number of pulses of the 5MHz clock signal corresponding to the set level by presetting the level setting signal at the preset counter by means of the 12009 detection signal (LOAD) signal having a fixed repetition period from the free running counter.
A pulse train (PWM signal) having a duty ratio corresponding to the set level is obtained by operating the output stage flip-flop by using this phase deviation.
The operation timing of the above is described by using a simple example.
If the fixed repetition signal of the free running counter is assumed to be "10" and the set level of the preset counter is assumed to be "4", the following is obtained.

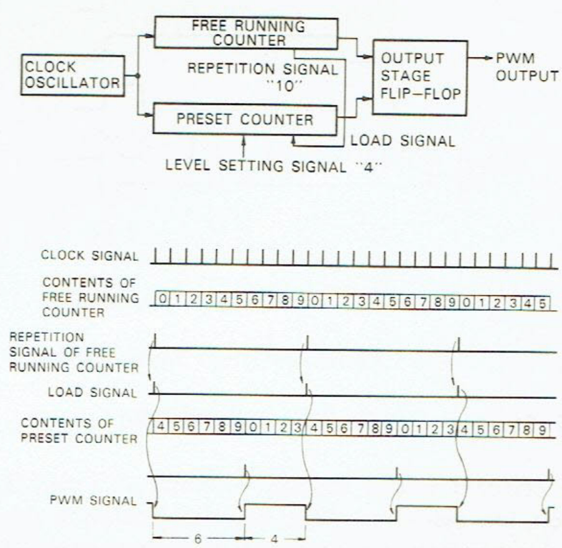


Fig. 4–11 PWM Signal Timing Chart

4–7 12009 Detection Circuit (SB239)

Three detection circuits are included in the time width detection circuit, but the generation timing of the 12009 detection signal is described here.
The BCD code signal of IC44 (10^0 digit) and IC49 (10^3 digit) are passed through the NAND gate of IC52 and the 12009 contents of the free running counter are detected.
This 12009 signal is synchronized with the 5MHz clock signal by the J–K flip-flop of IC46-a and a 12009 repetitive pulse is output at the Q output. The 12009 detection signal clears the contents of the free running counter each time the 12009 repetitive signal is generated. The 12009 detection signal timing chart is given in Fig. 4–13.
Each detection signal is extracted as a signal synchronized with the 5MHz clock signal by the J–K flip-flop relative to the delay of the counter and gate.

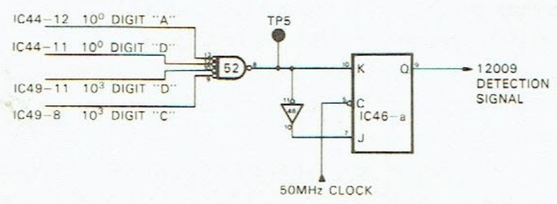


Fig. 4–12 12009 Detection Circuit

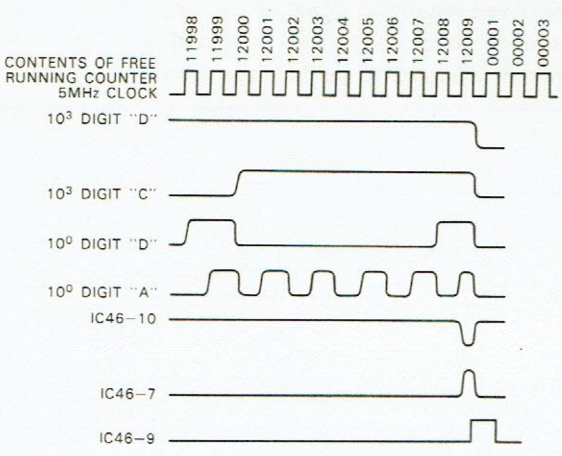


Fig. 4–13 12009 Detection Signal Timing

4–8 Standard Voltage Generator (SH166)

The standard voltage generator consists of a switching circuit, low pass filter and an impedance converter and is the block which performs time division of the stable zener voltage by means of the PWM signal from the time width converter.

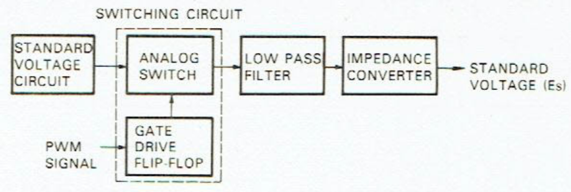


Fig. 4–14 Block Diagram of Standard Voltage Generator

4–9 Switching Circuit (SH166)

The switching circuit consists of a gate drive flip-flop and an analog circuit, and is the output section which extracts a DC voltage proportional to the set level by switching the approximately 6.3V zener voltage produced by a zener diode (D31) by means of the PWM signal passed through a pulse transformer (SB239-TP245) and passing it through a low pass filter. The switching circuit is shown in Fig. 4–15.

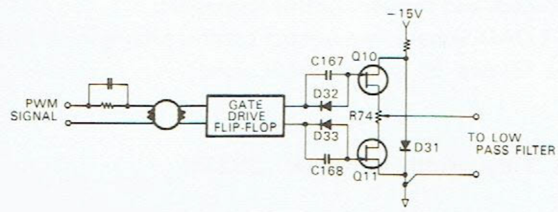


Fig. 4–15 Switching Circuit

Since the pulse transformer (SB239-TP245) isolates the logic section (SB239) and analog section (SH166) to DC, when the PWM signal is passed through the pulse transformer, a timing pulse taking the edge of the PWM signal is produced.
The gate drive flip-flop is triggered by this PWM signal timing pulse to produce the signal to the analog switch. A stable static characteristic and a high speed switching characteristic which determines the time accuracy can be obtained by using an FET at the analog switch. FET Q10 and Q11 are the analog switch and transistors Q12 and Q13 are used to turn Q10 and Q11 ON and OFF. One of the analog switches is described here.
When Q12 is turned ON, coupling diode D32 connected in series with Q10 is reverse biased.
When D32 is reverse biased, the gate potential and source potential become the same and Q11 is turned ON. Next, when Q12 is turned OFF, the collector potential of Q12 becomes a negative potential, D32 is forward

biased and Q11 is turned OFF.

Capacitors C167 and C168 connected in parallel with coupling diodes D32 and D33 are speed-up capacitors and are used to reduces the turn on time of the analog switch.

Variable resistor R74 improves the linearity by compensating the difference of the time constant caused by the ON resistance and OFF resistance of Q10 and Q11.

4–10 Low Pass Filter (SH166)

The time divided signal of the zener voltage, (standard voltage) produced by this switching operation is connected to a 5-stage RC ladder type filter consisting of R67 ~ R72 and C162 ~ C166.

The filter is a low pass filter which passes all frequencies from DC to the cutoff frequency and attenuates frequencies above this.

The frequency components of the PWM signal consists of the fundamental frequency and a large number of harmonic components, and the ripple included in the time division output waveform is determined by which harmonic components are attenuated relative to the fundamental frequency.

When attempting to reduce the ripple, the time constant of the low pass filter becomes large and the settling time until the set level is reached becomes long.

Ripple attenuation rate and settling time are opposites quantities, and the settling time until –0.1% of the set level is reached has been made 150msec with the **Model 6141**.

4–11 Impedance Converter (SH166)

The low pass filter consists of RC passive elements, and its output impedance is fairly large.

Consequently, an impedance converter must be added at the output of the low pass filter to convert the output impedance of the filter.

The impedance converter consists of a composite type amplifier comprising a twin FET differential amplifier and an operational amplifier.

A high input impedance is obtained by making the input section an FET. The impedance converter is shown in Fig. 4–16.

The impedance converter is a high input impedance, low output impedance unity gain buffer amplifier.

Moreover, in order to improve the CMR (Common Mode Rejection Ratio) of the twin FET differential amplifier, a constant current circuit consisting of Q9, D30, R65, R66 is connected at the center tap of variable resistor R150 connected at the source of Q8.

This constant current circuit is a constant current circuit which utilizes the fact that the collector current of Q9 is not changed by the collector voltage.

Variable resistor R150 is an amplifier offset adjustment use resistor.

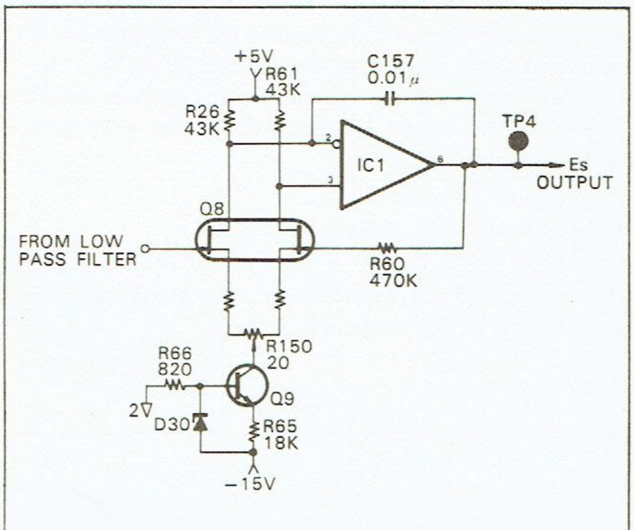


Fig. 4–16 Impedance Converter

4–12 Output Amplifier (SH166)

The output amplifier consists of an FET input differential amplifier, range switching feedback resistor and relay, and a protection circuit which protects the circuits against damage by overvoltage and overcurrent.

The output amplifier is shown in Fig. 4–17.

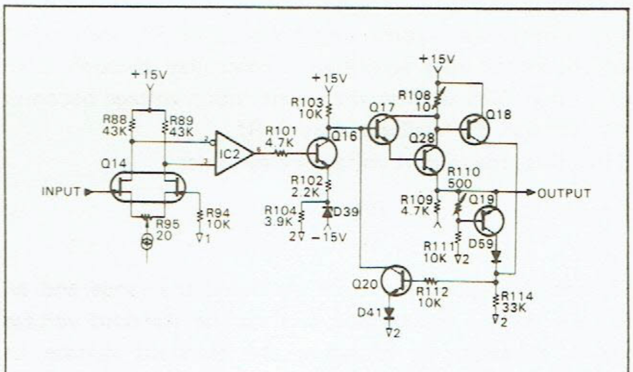


Fig. 4–17 Output Amplifier

The differential amplifier is a drift compensation type DC amplifier having a high input impedance because of its FET input.

The source current is made a constant current by the constant current consisting of Q15, D38, R92, and R93.

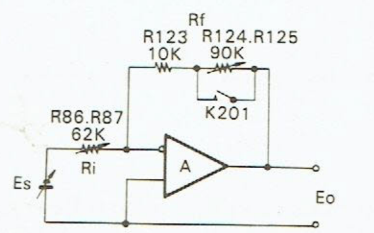
The output amplifier performs main amplification by means of a differential amplifier consisting of Q14 and IC2 and performs output stage amplification by means of Q16, Q17, and Q18.

When the impedance of the load connected to the output terminals is extremely small in the case of voltage output, Q18 is driven and overcurrent is detected by the current is detected by the current flowing through R108.
Moreover, in the case of current output, an overvoltage is detected by means of the current flowing through R110 and negative feedback is applied to the base of Q17 through Q20 at both Q18 and Q19.
At this time, Q21 is simultaneously driven and the [OVER LOAD] lamp is lighted to indicate that there is an overload.

4–13 Attenuator Circuit (SH166)

The composition of the feedback resistor of each range by switching of the range is as follows :

1. 1V, 10V ranges



Relay / Range	K201
1V	ON
10V	OFF

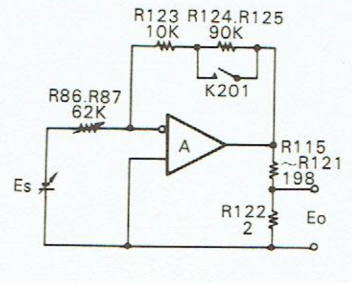
Fig. 4–18 1V, 10V Ranges

When the standard voltage Es output from the standard voltage generator is connected to the invert input of the differential through input resistance Ri, the output of the differential amplifier is controlled through Q16, Q17, and Q28 so that the invert input voltage becomes 0V through the feedback resistor Rf.
Therefore, the output voltage Eo becomes,

$$Eo = -\frac{Rf}{Ri} \cdot Es$$

Ri and Rf become constant by fixing the range and an output voltage Eo proportional to the standard voltage Es is obtained by changing the standard voltage Es approximately −6.3V ~ 0V.
Since the output impedance of the differential amplifier becomes extremely small depending on the amount of negative feedback, this voltage can be used as the standard voltage supply.

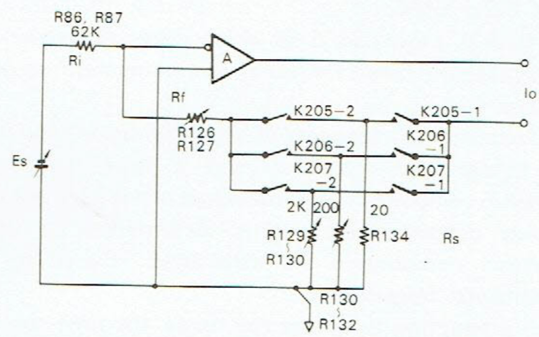
2. 10mV, 100mV ranges
The output of the 1V, 10V ranges is divided to 1/10 by resistors R115 ~ R122 and output for this range.



Relay / Range	K201
10mV	ON
100mV	OFF

Fig. 4–19 10mV, 100mV Ranges

3. 1mA, 10mA, 100mA Ranges



Relay / Range	K205	K206	K207
1mA	OFF	ON	ON
10mA	ON	OFF	ON
100mA	OFF	OFF	ON

Fig. 4–20 1mA, 10mA, 100mA Ranges

The load current produced by connecting the load to the output terminals is divided by Rf and Rs and the load current flowing through Rf produces a feedback voltage across the terminals of Rf.
When the standard voltage output Es output from the standard voltage generator and this feedback voltage are applied to the invert input of the differential amplifier, the difference between these voltages is amplified and appears at the output of the differential amplifier and and Q17 and Q28 are controlled by feeding back the load current so that the invert input voltage of the differential amplifier becomes 0V through current amplification Q16.
Therefore, the output current Io becomes,

$$Io = -\frac{Rf + Rs}{Ri \cdot Rs} \cdot Es$$

Ri and Rf are fixed by fixing the range and a load current proportional to the standard voltage Es is obtained by changing the standard voltage Es.
In this way a standard current is generated.
Since the load current is constant, the output impedance can be extremely high.

CHAPTER 5 TROUBLE SHOOTING

When the **Model 6141** is not operating normally or calibration is impossible, refer to the following troubleshooting information given below.
The method of locating the faulty point when the instrument is abnormal is described in this chapter.

5–1 Preliminary Inspection Before Repair

(1) First determine if the trouble is in the **Model 6141** itself or due to another cause. Causes other than the **Model 6141** can be the AC line voltage, noise, induction, connected devices, etc.

(2) Check if the power fuse is blown or the power cord is open.

(3) Before checking the interior of the **Model 6141** mainframe, determine which circuit block is faulty by operating in accordance with Chapter 3 OPERATING INSTRUCTIONS.

(4) Remove the top and bottom covers and disconnect the wiring and check for burned parts, abnormal printed circuit boards, etc.

5–2 Parts Replacement

After the preliminary checks of par. 5–1 Preliminary Inspection Before Repair are complete search for the faulty point with a multimeter, oscilloscope, or other measuring instrument while referring to par.5–4 Classification of Troubles According to Operating Instruction and the circuit diagram.

1. Replacement parts
After the fault part has been located, replace it with a new part.
The replacement parts must satisfy the ratings required by the circuit functions.
Consequently, the replacement parts must be the same as the original part. However, when procurement of the identical part is difficult, another part having the same ratings can be used, except for semiconductor parts.

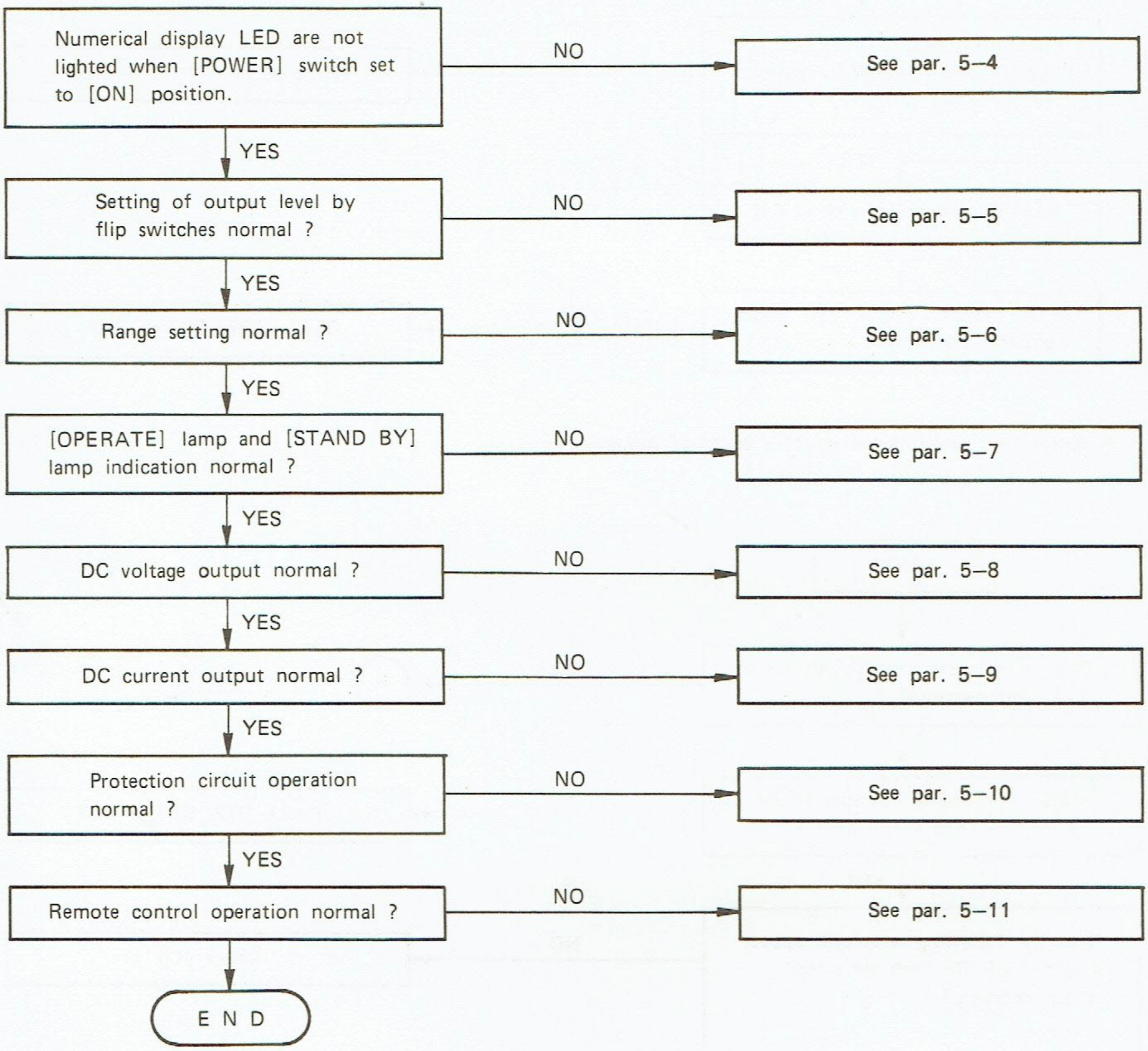
2. Replacement of semiconductor parts
Since semiconductor parts are weak against heat, when replacing a semiconductor thought to be faulty, the leads at the semiconductor side must be grasped with tweezers having good thermal conductivity and the part must be replaced quickly using a soldering iron (30W or less). This work must be performed carefully since the copper foil of the printed circuit board will peel off and the part itself will be burned if the soldering iron is placed against the printed circuit board for a long period of time.

3. Replacing resistors, capacitors, etc.
Replace resistors, capacitors, and other passive components with a good component having the same ratings as the original component.

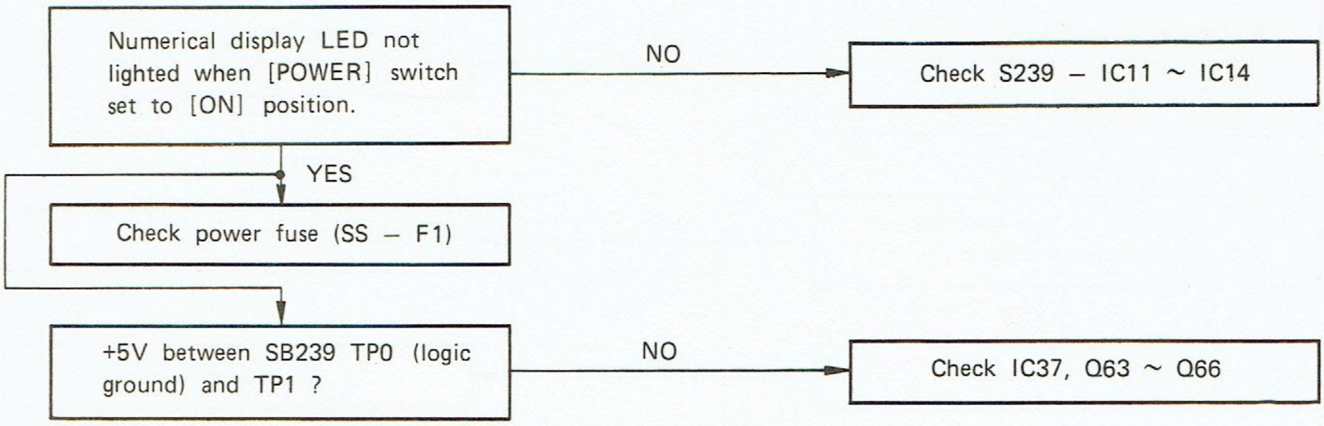
4. Wiring lead wires
Since the lead wires are effected by induction, especially the signal lines and AC power line, wiring must be performed with care.
When soldering the lead wires, wrap the wire around the connection part 1 ~ 2 turns and solder quickly so that the covering of the lead wire is not damaged.

5. Removing printed circuit boards
Disconnect the connector connected to the printed circuit board and remove the board by removing the mounting screws.

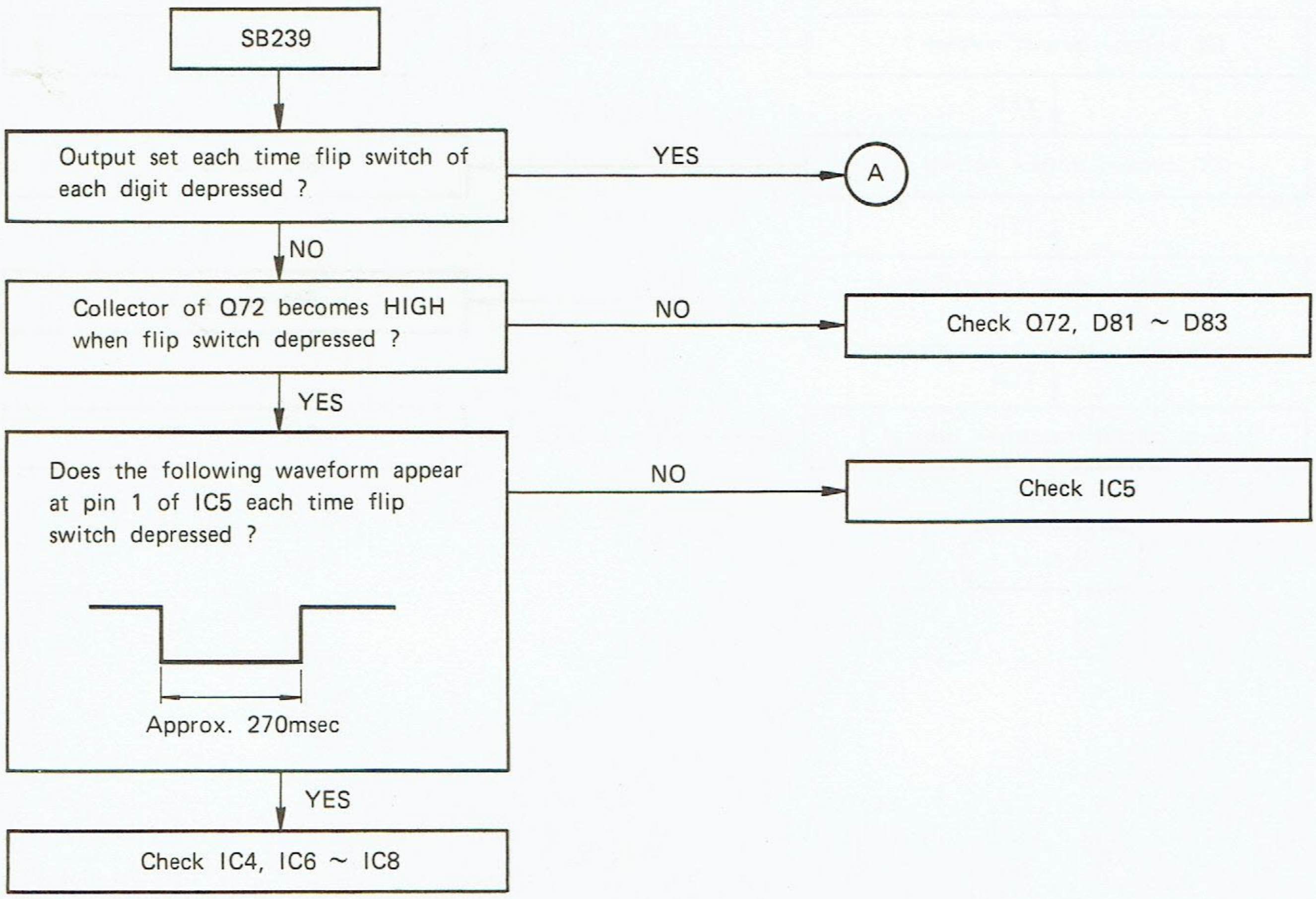
5–3 Classification of Troubles According to Operating Instruction

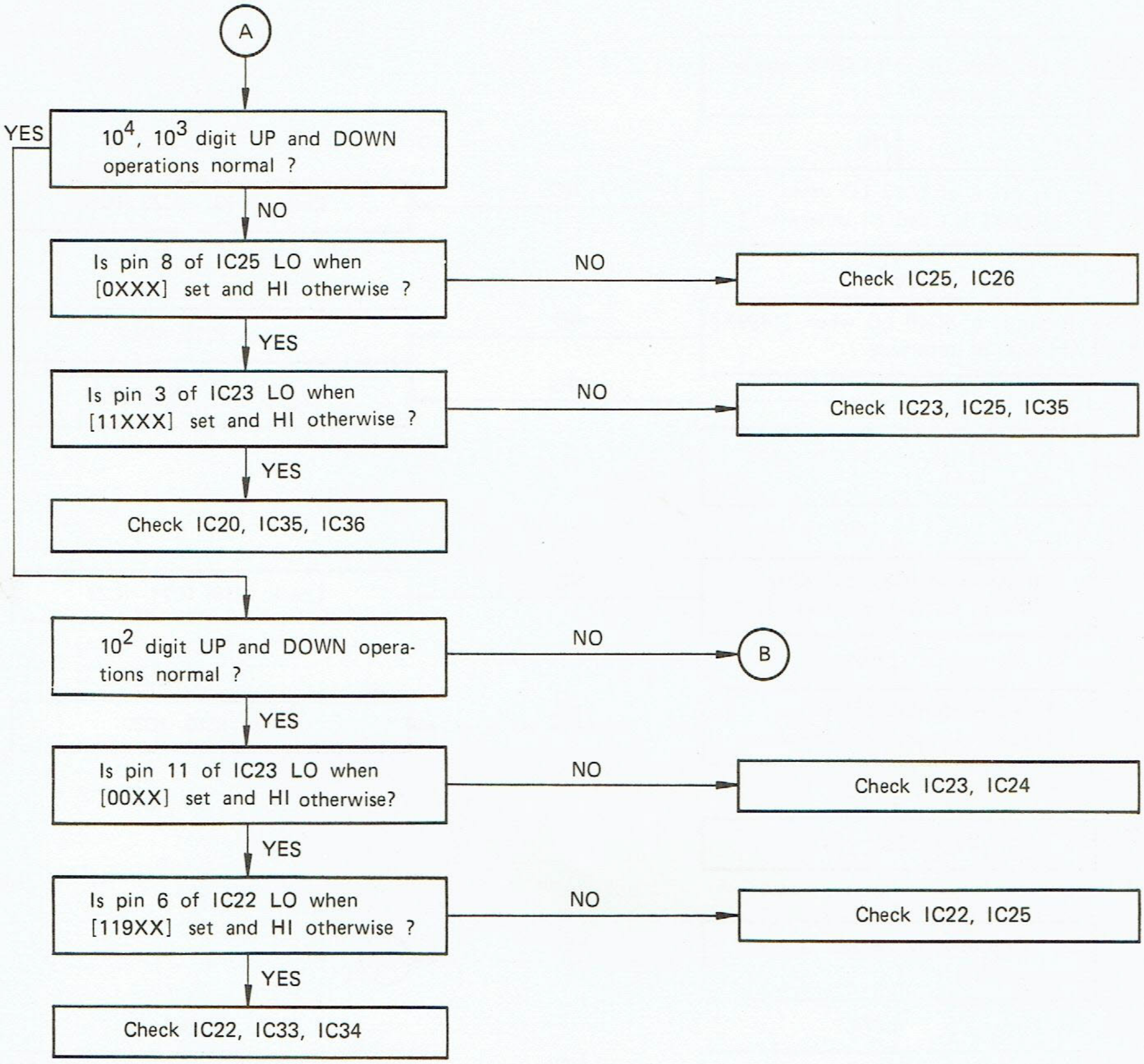


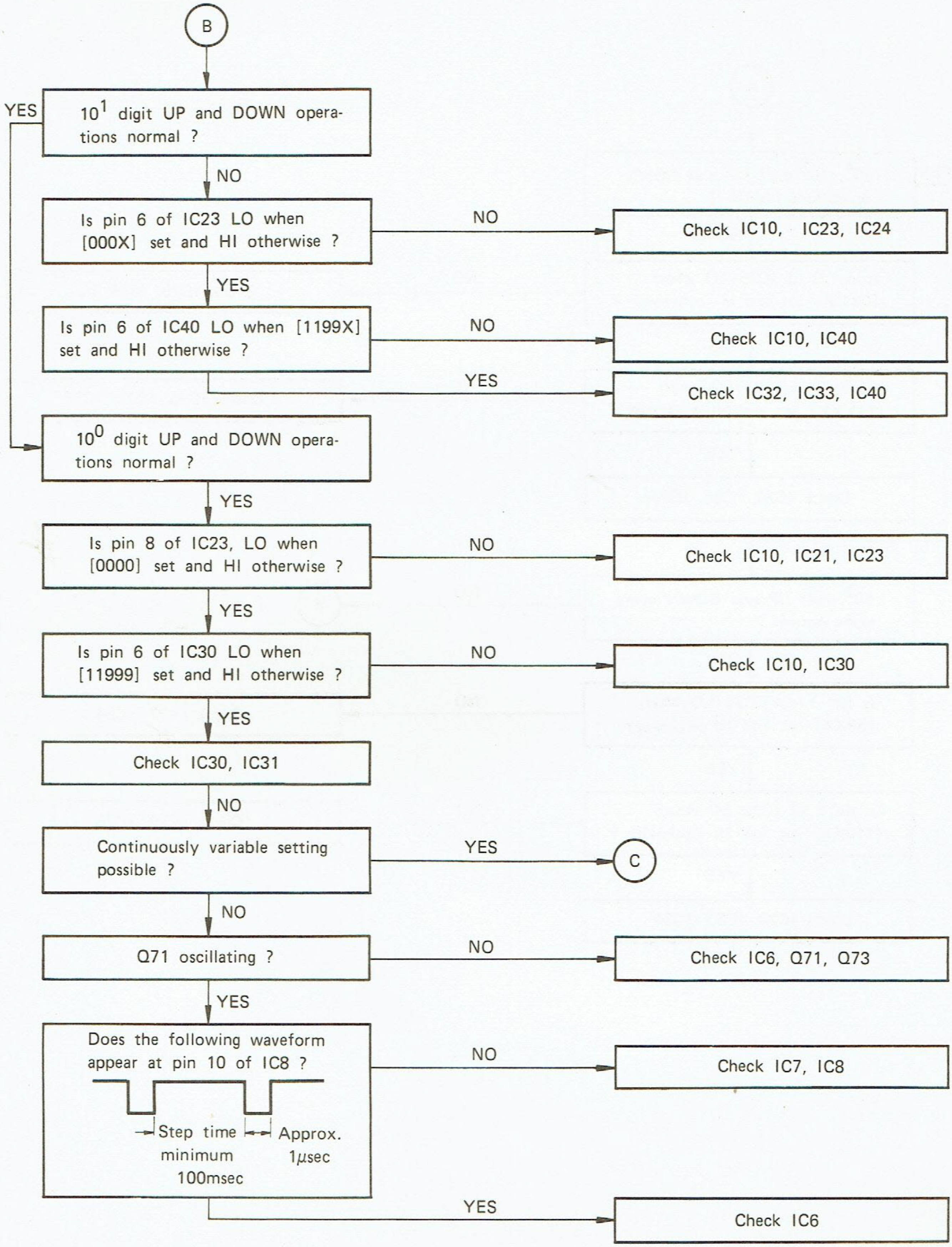
5–4 Numerical Display LED Not Lighted

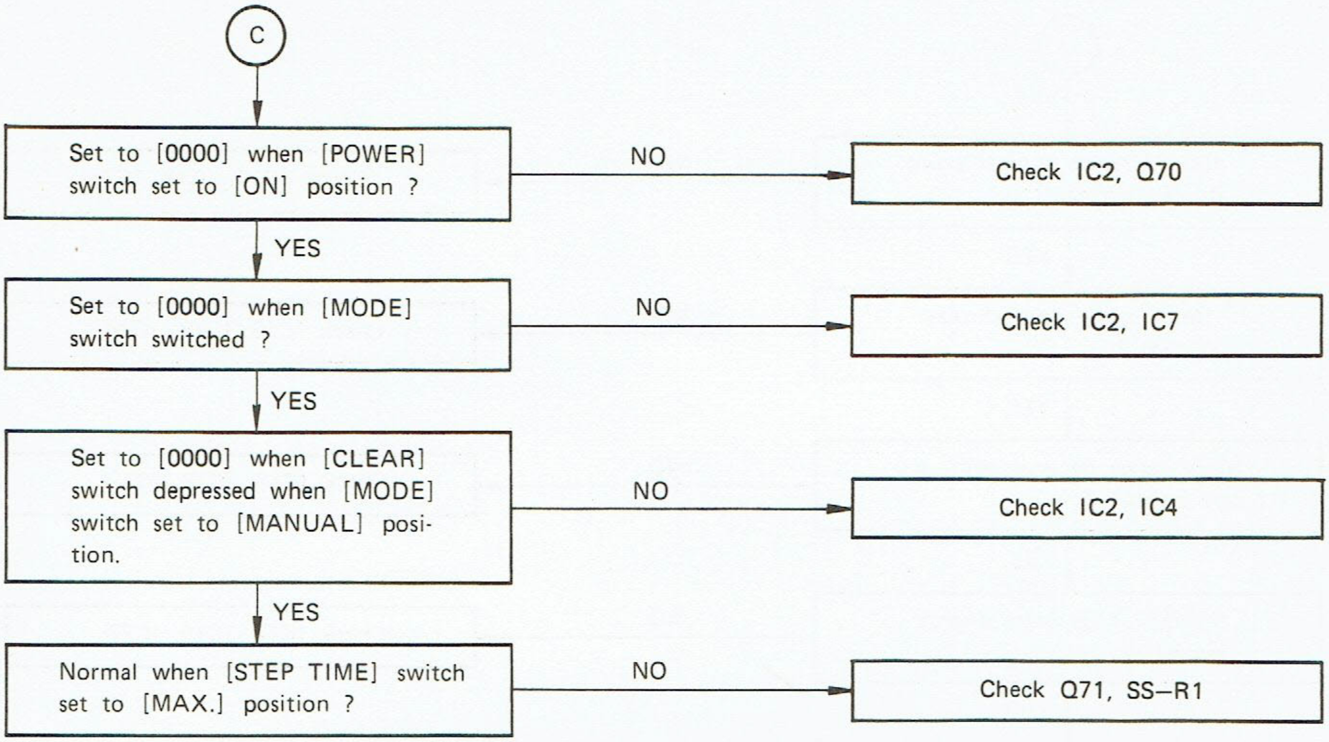


5–5 Setting of Output Level by Flip Switches Abnormal

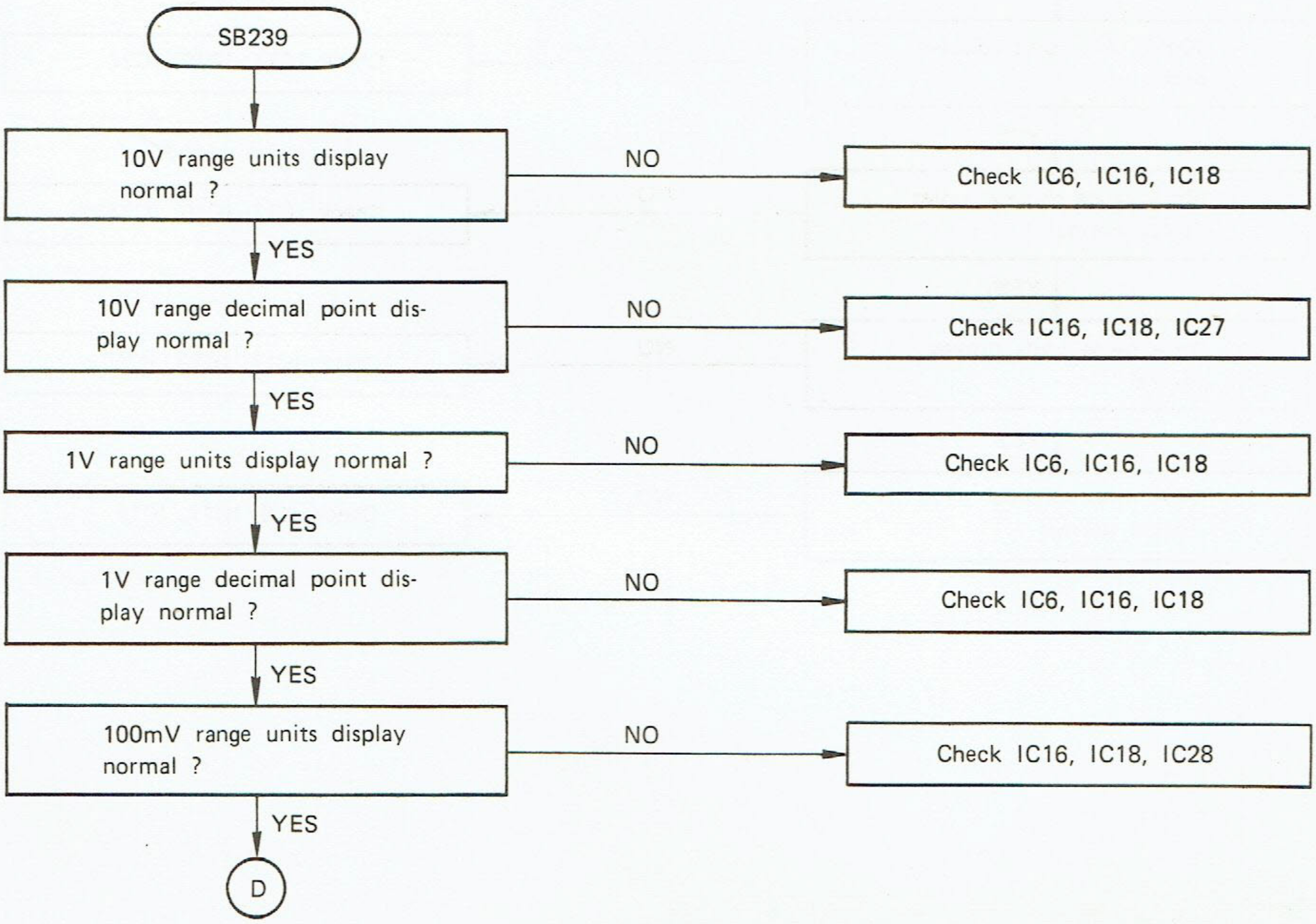


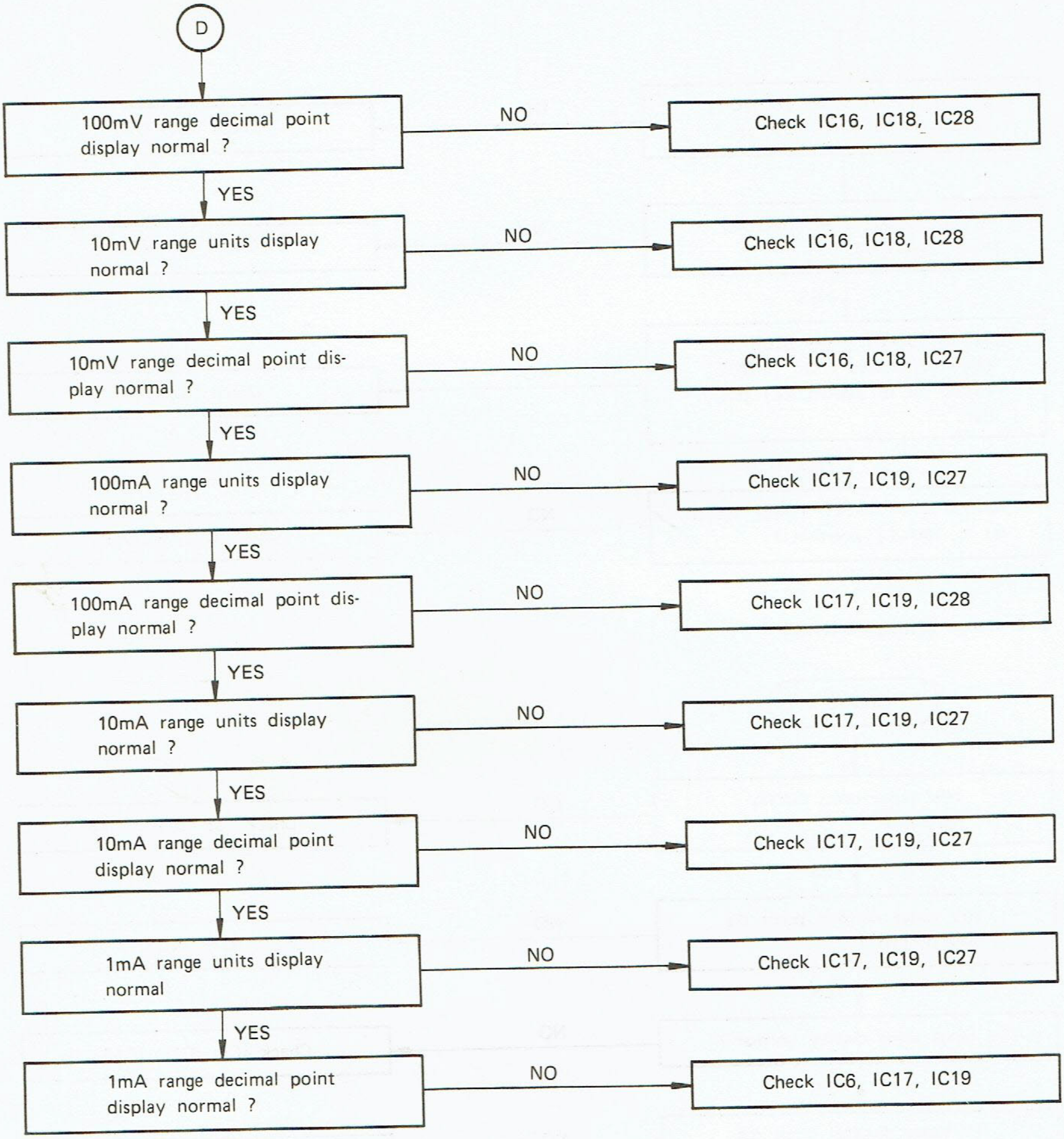

A
10⁴, 10³ digit UP and DOWN operations normal ?
YES
NO
Is pin 8 of IC25 LO when [0XXX] set and HI otherwise ?
NO
Check IC25, IC26
YES
Is pin 3 of IC23 LO when [11XXX] set and HI otherwise ?
NO
Check IC23, IC25, IC35
YES
Check IC20, IC35, IC36
10² digit UP and DOWN operations normal ?
NO
B
YES
Is pin 11 of IC23 LO when [00XX] set and HI otherwise?
NO
Check IC23, IC24
YES
Is pin 6 of IC22 LO when [119XX] set and HI otherwise ?
NO
Check IC22, IC25
YES
Check IC22, IC33, IC34


B
10^1 digit UP and DOWN operations normal ?
YES
NO
Is pin 6 of IC23 LO when [000X] set and HI otherwise ?
NO
Check IC10, IC23, IC24
YES
Is pin 6 of IC40 LO when [1199X] set and HI otherwise ?
NO
Check IC10, IC40
YES
Check IC32, IC33, IC40
10^0 digit UP and DOWN operations normal ?
YES
Is pin 8 of IC23, LO when [0000] set and HI otherwise ?
NO
Check IC10, IC21, IC23
YES
Is pin 6 of IC30 LO when [11999] set and HI otherwise ?
NO
Check IC10, IC30
YES
Check IC30, IC31
NO
Continuously variable setting possible ?
YES
C
NO
Q71 oscillating ?
NO
Check IC6, Q71, Q73
YES
Does the following waveform appear at pin 10 of IC8 ?
Step time minimum 100msec
Approx. 1μsec
NO
Check IC7, IC8
YES
Check IC6

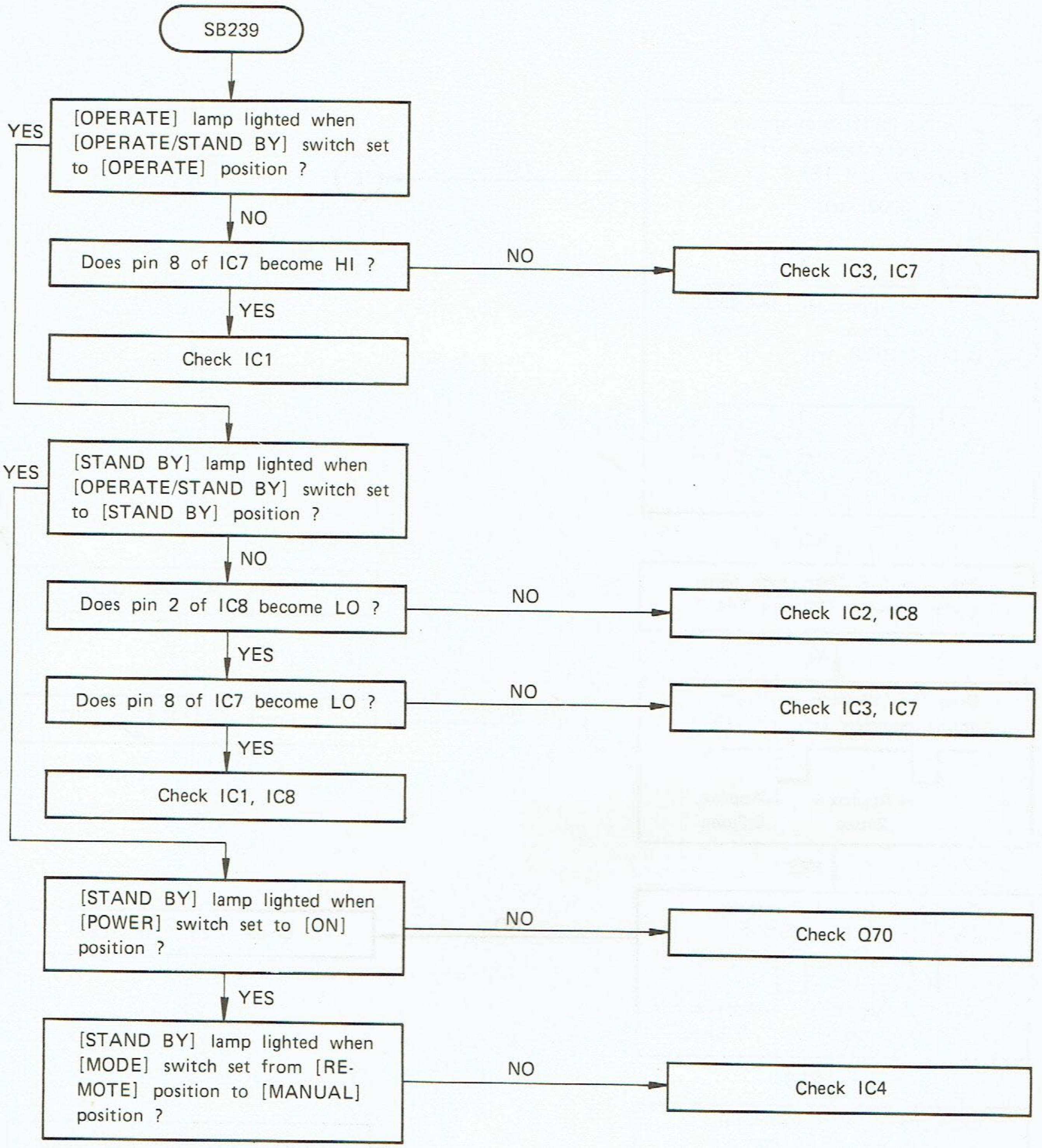


5–6 Range Setting Abnormal

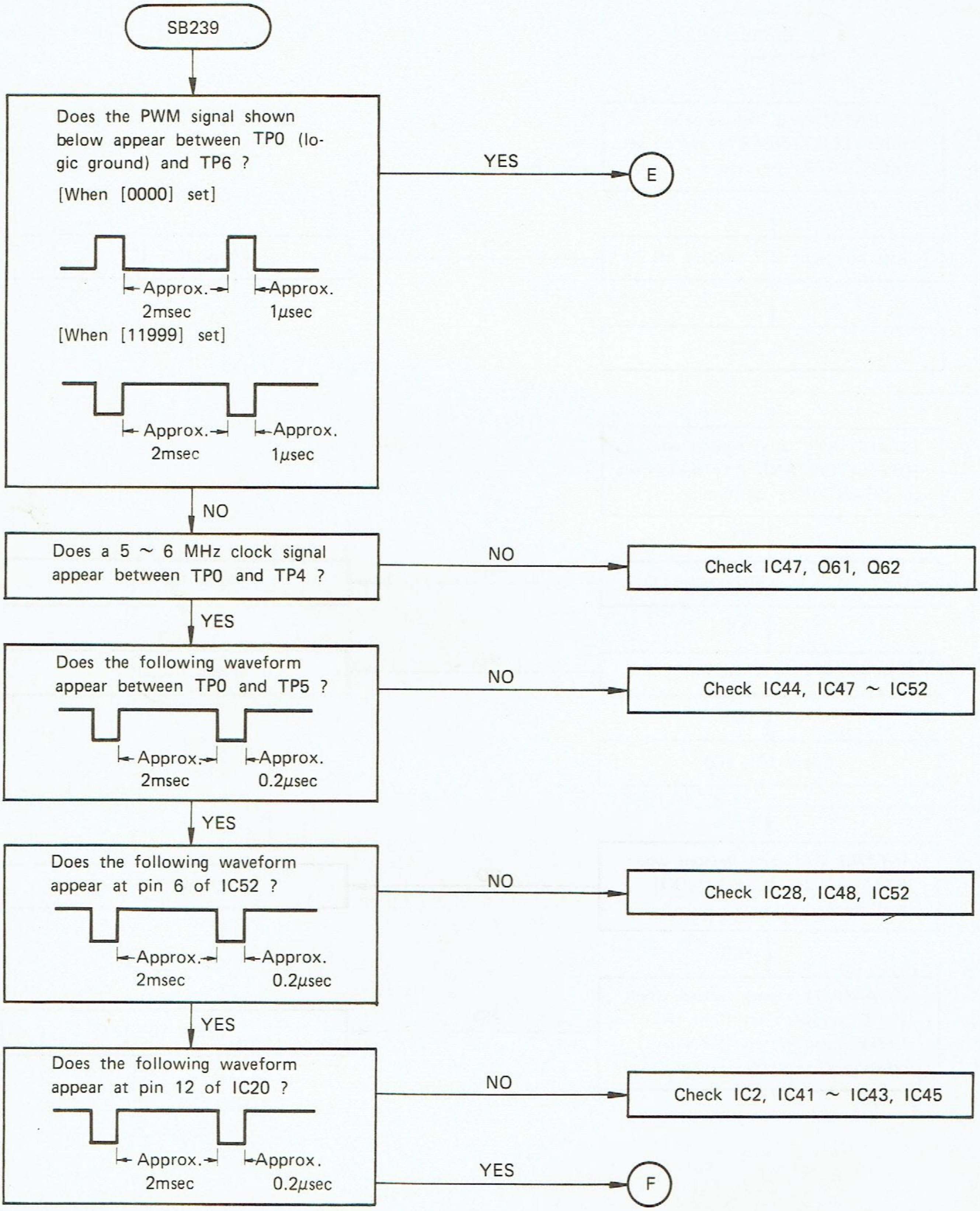



D
100mV range decimal point display normal ?
NO
Check IC16, IC18, IC28
YES
10mV range units display normal ?
NO
Check IC16, IC18, IC28
YES
10mV range decimal point display normal ?
NO
Check IC16, IC18, IC27
YES
100mA range units display normal ?
NO
Check IC17, IC19, IC27
YES
100mA range decimal point display normal ?
NO
Check IC17, IC19, IC28
YES
10mA range units display normal ?
NO
Check IC17, IC19, IC27
YES
10mA range decimal point display normal ?
NO
Check IC17, IC19, IC27
YES
1mA range units display normal
NO
Check IC17, IC19, IC27
YES
1mA range decimal point display normal ?
NO
Check IC6, IC17, IC19

5–7 [OPERATE] Lamp and [STAND BY] Lamp Indication Abnormal



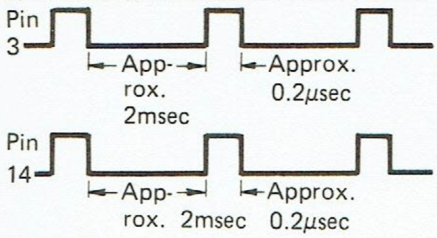
5–8 DC Voltage Output Abnormal



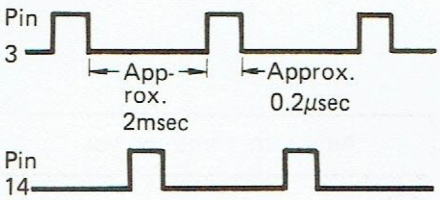
F

Does the waveform of pin 3 and pin 14 of IC46 change as follows in accordance with each set level when a dual trace oscilloscope is externally triggered by the signal of TP5 ?

[When [0000] set]



[When [6000] set]



NO → Check IC41 ~ IC43, IC45

YES → Check IC46

E

SH166

Does +15.5V appear between TP0 (power line ground) and TP1 ?

YES → G

NO ↓

Can the voltage of TP1 be adjusted to +15.5V with R144 ?

YES → Adjust to +15.5V

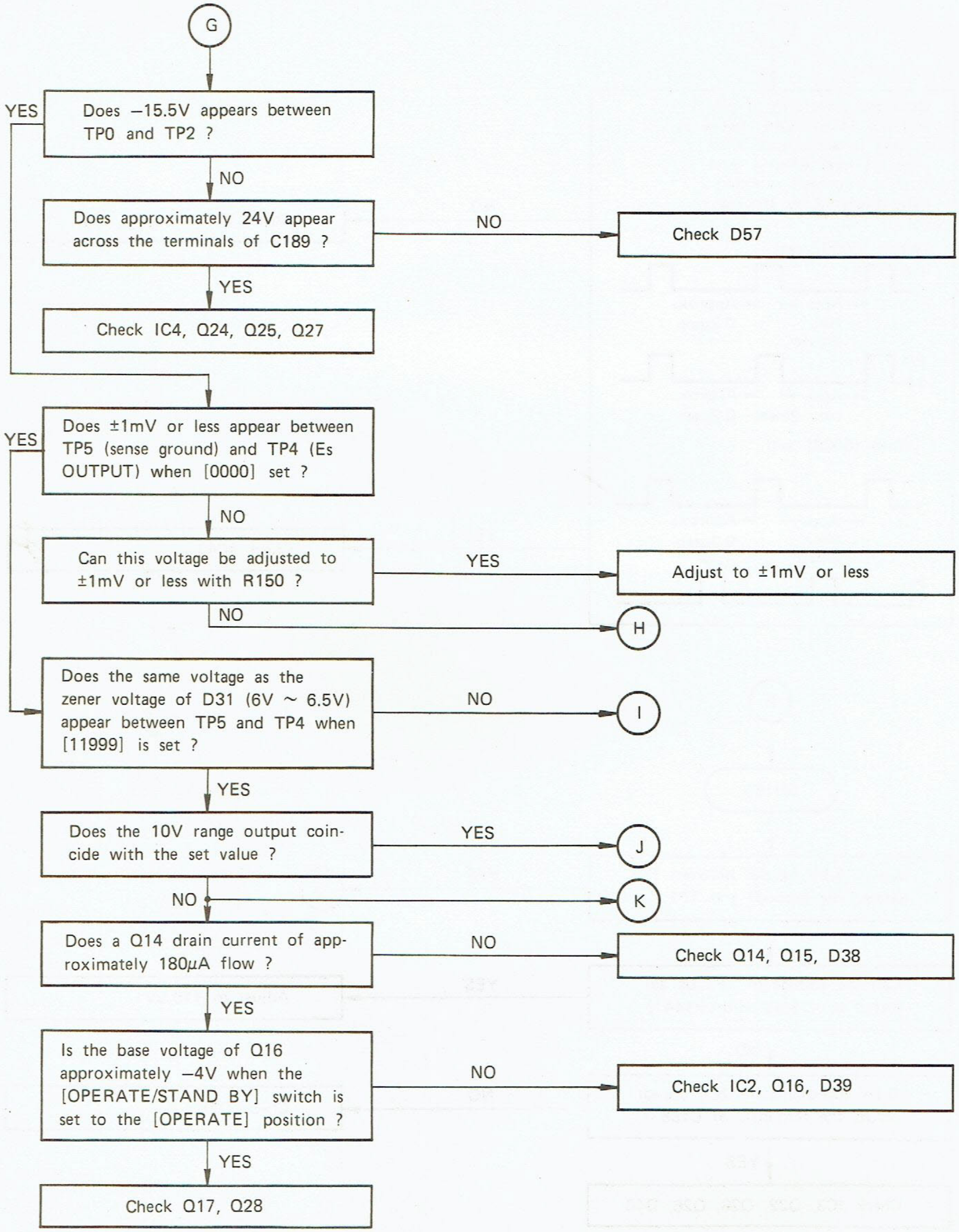
NO ↓

Does approximately 26V appear across the terminals of C185 ?

NO → Check D56

YES ↓

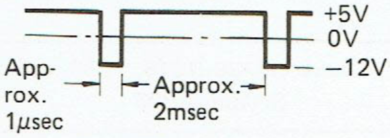
Check IC3, Q22, Q23, Q26, D46


G
Does −15.5V appears between TP0 and TP2 ?
YES
NO
Does approximately 24V appear across the terminals of C189 ?
NO
Check D57
YES
Check IC4, Q24, Q25, Q27
Does ±1mV or less appear between TP5 (sense ground) and TP4 (Es OUTPUT) when [0000] set ?
YES
NO
Can this voltage be adjusted to ±1mV or less with R150 ?
YES
Adjust to ±1mV or less
NO
H
Does the same voltage as the zener voltage of D31 (6V ~ 6.5V) appear between TP5 and TP4 when [11999] is set ?
NO
I
YES
Does the 10V range output coincide with the set value ?
YES
J
NO
K
Does a Q14 drain current of approximately 180μA flow ?
NO
Check Q14, Q15, D38
YES
Is the base voltage of Q16 approximately −4V when the [OPERATE/STAND BY] switch is set to the [OPERATE] position ?
NO
Check IC2, Q16, D39
YES
Check Q17, Q28

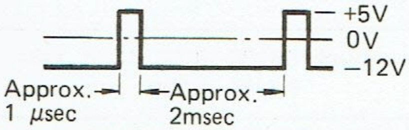
(H)

Does the following waveform appear between TP0 and TP3 ?

[When [0000] set]



[When [11999] set]



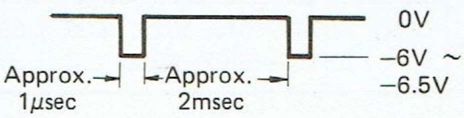
NO → Check Q12, Q13

(I) →

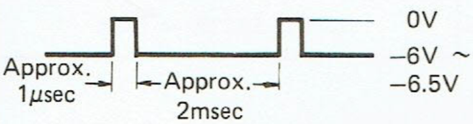
YES ↓

Does the following waveform appear at the drain of Q11 ?

[When [0000] set]



[When [11999] set]



NO → Check Q10, Q11, D32, D33

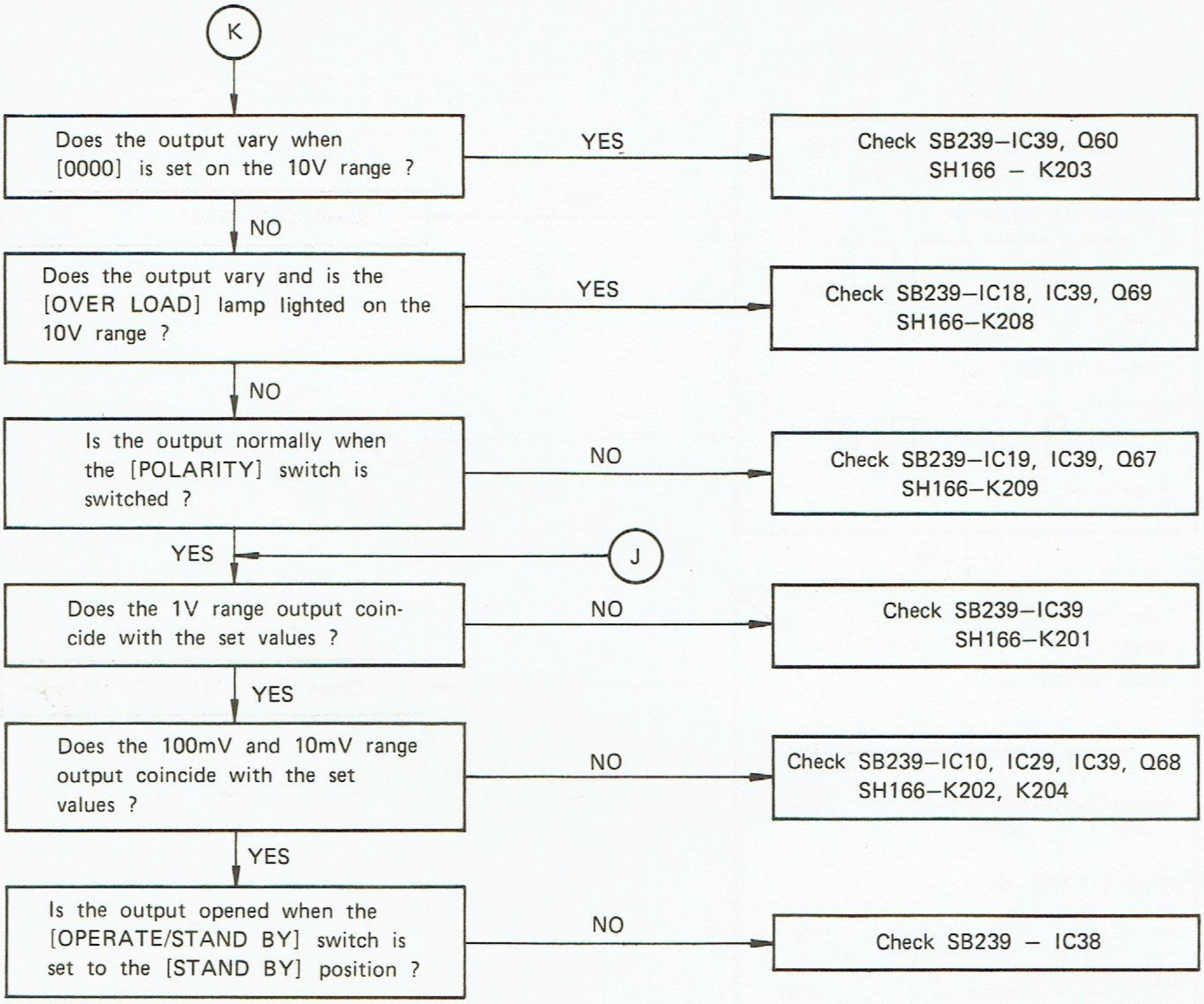
YES ↓

Does a Q8 drain current of approximately 180μA flow ?

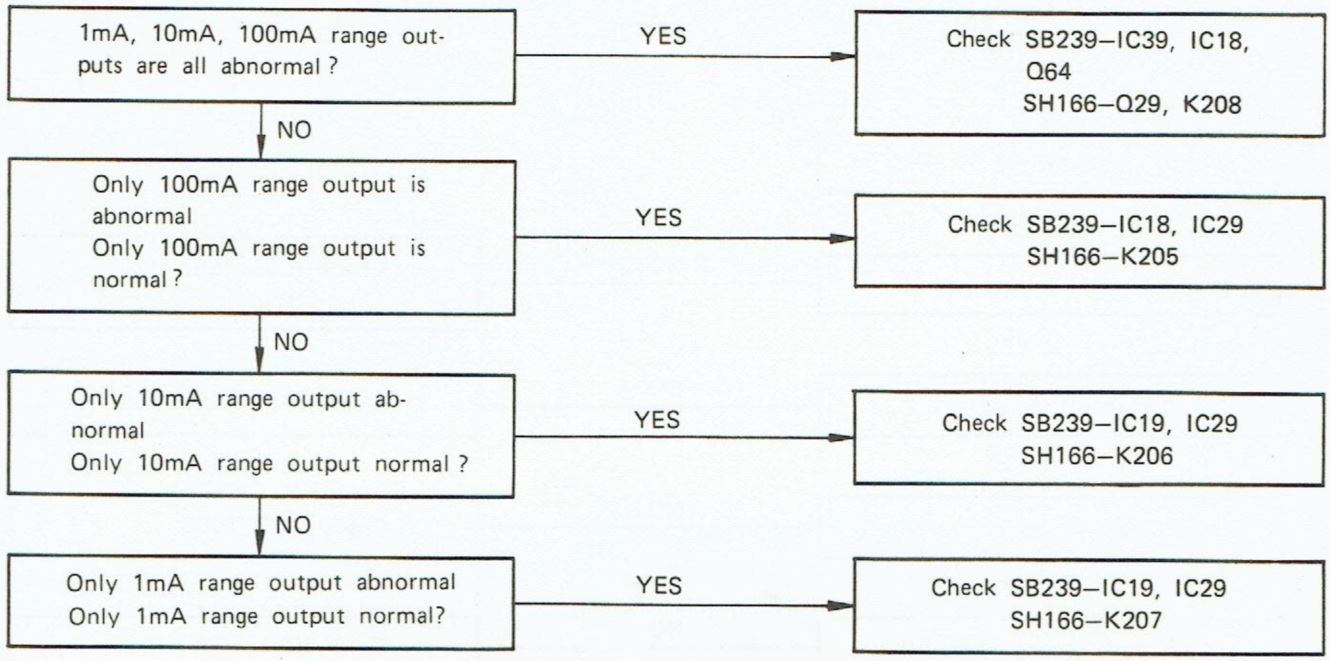
NO → Check Q8, Q9, D36

YES ↓

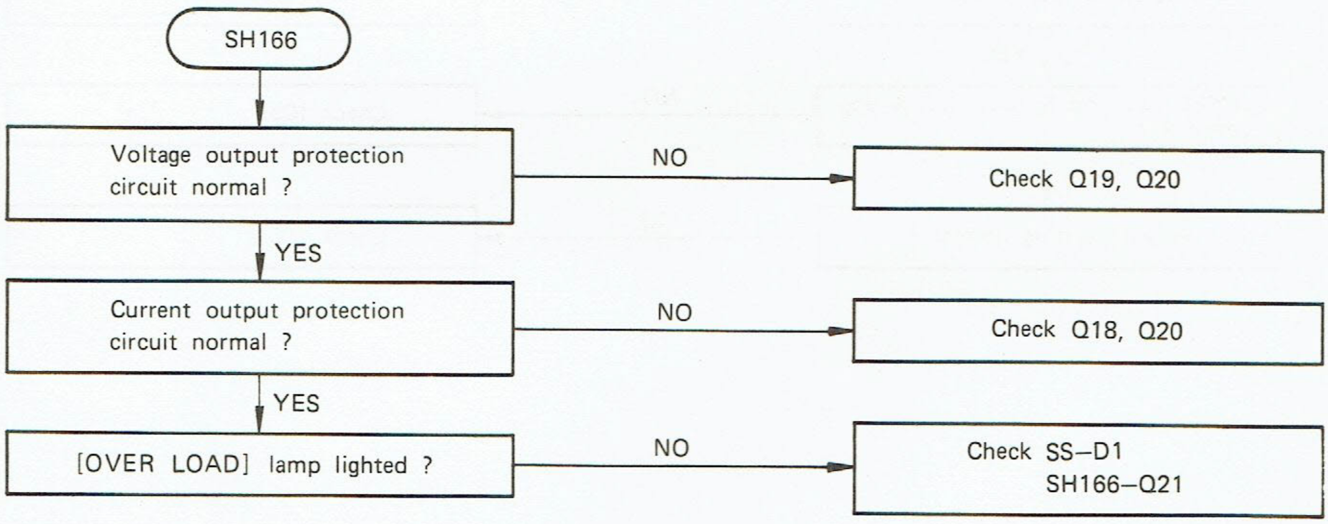
Check IC1


K
Does the output vary when [0000] is set on the 10V range ?
YES
Check SB239–IC39, Q60 SH166 – K203
NO
Does the output vary and is the [OVER LOAD] lamp lighted on the 10V range ?
YES
Check SB239–IC18, IC39, Q69 SH166–K208
NO
Is the output normally when the [POLARITY] switch is switched ?
NO
Check SB239–IC19, IC39, Q67 SH166–K209
YES
J
Does the 1V range output coin-cide with the set values ?
NO
Check SB239–IC39 SH166–K201
YES
Does the 100mV and 10mV range output coincide with the set values ?
NO
Check SB239–IC10, IC29, IC39, Q68 SH166–K202, K204
YES
Is the output opened when the [OPERATE/STAND BY] switch is set to the [STAND BY] position ?
NO
Check SB239 – IC38

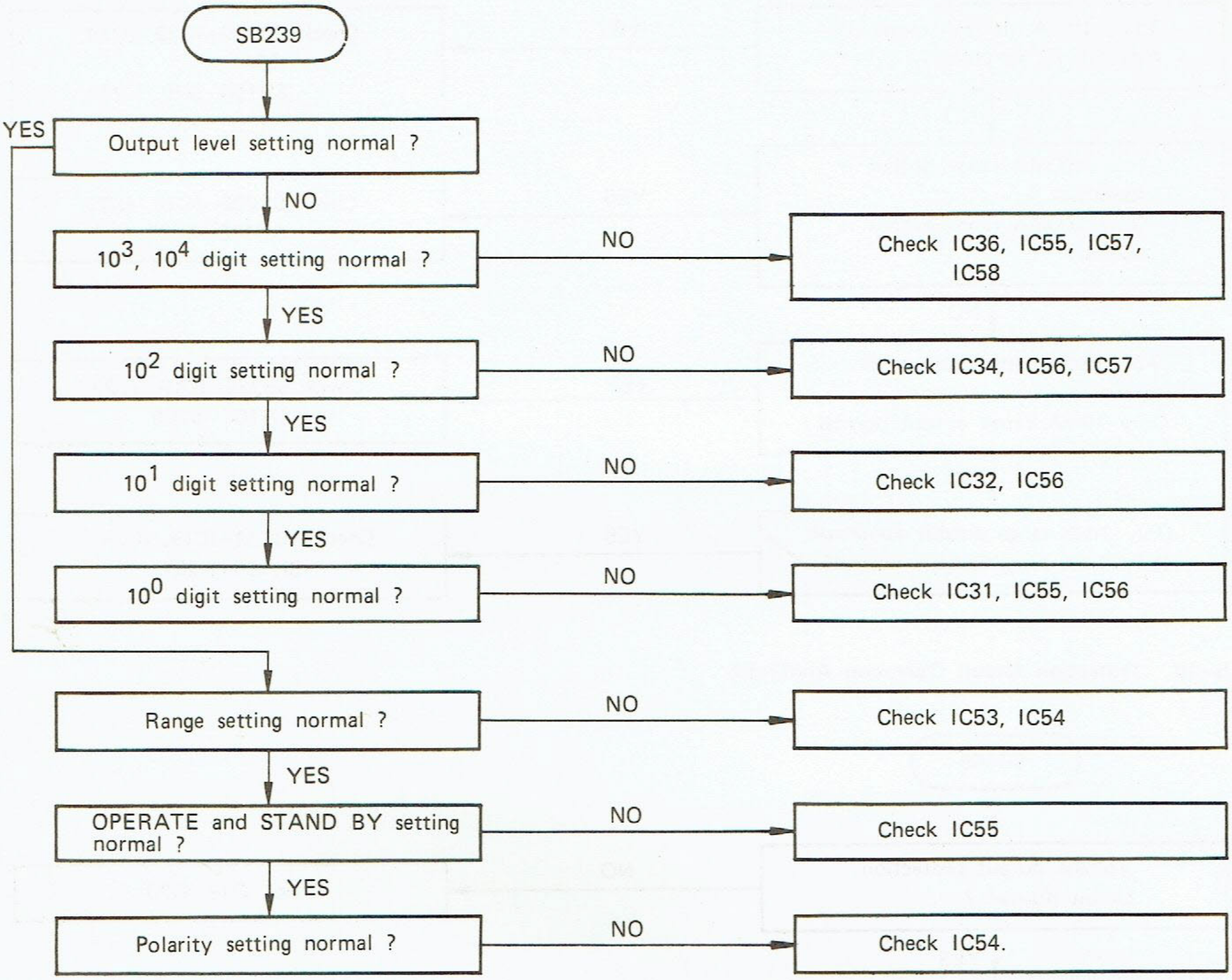
5-9 DC Current Output Abnormal



5-10 Protection Circuit Operation Abnormal



5–11 Remote Control Operation Abnormal



CHAPTER 6 CALIBRATION

6–1 Description

In order to gaurantee the accuracy described in par. 2–1, it is necessary to calibrate the **Model 6141.**

6–2 Calibration Equipment and Tool Required

Calibrator	Performance		Recommended Instrument
DC voltmeter	Resolution Full scale Ranges Accuracy	10μV (at 100mV range) 12000 indication 100mV 1 V 10 V Better than ±0.01% of reading	TAKEDA RIKEN **Model 6567**
DC ammeter	Resolution Full scale Ranges Accuracy	100nA (at 1mA range) 12000 indication 1mA 10mV 100mV Better than ±0.01% of reading	

When an ammeter as described above is not available, the DC current may be converted into DC voltage using a shunt.

Shunt 100Ω, 1KΩ, 10KΩ
Accuracy Better than ±0.005%

6–3 Precautions Concerning Calibration

(1) Calibration should be performed in the order of voltage mode, current mode.
Even when calibration of only the current mode is required, perform the calibration after verifying the calibration of the voltage mode.
Error will be produced on the current mode if the voltage mode is not perfectly calibrated.
(2) Calibration can be performed by removing the top cover of the case and adjusting through the calibration use adjustment holes.
(3) When adjusting the control at a calibration use adjustment hole, adjust as quickly as possible and verify the calibration after mounting the top cover each time an adjustment is made.
(When the top cover is removed, the temperature coefficient may increase instantly due to instantaneous change in the temperature of the inside.)
When all the calibrations have been completed, check if there is no error in the calibration of each range with the top cover fitted for 10 ~ 20 minutes.
(4) When a shunt is used for calibrating the current mode, large error may be introduced if the input impedance of the DC voltmeter is not taken into consideration.
(5) The shield cover must never be removed. If the shield cover is removed and some fault is developed, the guarantee will become invalid.
(6) Never turn controls other than those needed for the calibraton.
(7) After the calibration, the date of calibration and the next calibration period should be recorded on a card, stacker for convenience.

6–4 Preparations for Calibration

(1) Calibration should be performed under the following environmental conditions.

(a)	Ambient temperature range	:	+23°C ±2°C
(b)	Humidity	:	Less than 70%
(c)	Power supply	:	AC115V ±10%, 50/60Hz
(d)	Place	:	Perform calibration at a place where electromagnetic induction, electrostatic induction, dust, vibration, shock, etc. are very small.

(2) The **Model 6141** should be allowed a warm up time of more than 1 hour.
Warm up must be performed with the top cover of the case mounted.
(3) Allow the specified warm up time for each calibrating instrument used.
(4) The ratings of **Model 6141** are specified for 6 months, but when using at one-day accuracy, it is necessary to calibrate each time when using.
Generally, if calibrated every 6 months, the specifications of **Model 6141** can be maintained in optimum condition.

6–5 Method of Calibration

When the top cover of the **Model 6141** is removed, a shield cover as shown in Fig. 6–3 will appear.
The top cover can be removed by removing the two screws (left, right) at the rear.
Among the various adjustment holes, the adjustment use controls of LINEAR, I LIMIT, and V LIMIT must never be touched.
The DC voltmeter and DC ammeter used for calibration should be used after verifying that their zero and full scale calibrations have been performed.

1. Voltage mode

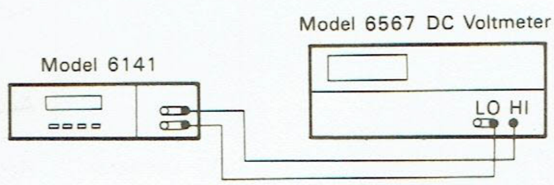


Fig. 6–1 Voltage Output Mode Connections

(1) Zero adjustment

Order	DC voltmeter (Model 6567)	Model 6141		
	Range	Range	Setting	Adjustment point
1	10V	10V	0.000	10V ZERO (1)
2	1V	1V	.0000	1V ZERO (2)

* Perform the above operations repeatedly for 2 ~ 3 times so that the indication of the DC voltmeter becomes zero on either range.

(2) Full scale calibration

Order	DC voltmeter (Model 6567)	Model 6141		
	Range	Range	Setting	Adjustment point
1	1 V	1 V	1.0000	1 V F.S. (3)
2	10 V	10 V	10.000	10 V F.S. (4)
3	100mV	100mV	100.00	100mV F.S. (5)

2. Current mode

There are two methods of calibrating the current mode, one using a DC ammeter and the other using a DC voltmeter and shunt.

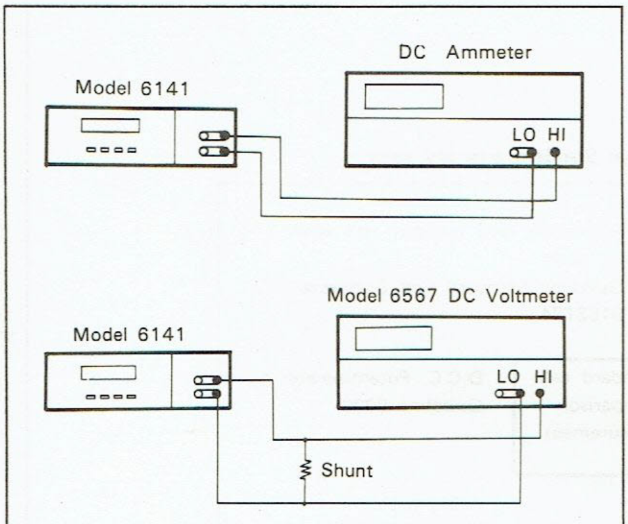


Fig. 6–2 Current Output Mode Connections

Order	Calibrator			Model 6141		
	DC voltmeter	DC voltmeter and shunt				
	Range	Shunt	Range	Range	Setting	Adjustment point
1	100mA	100 Ω	10V	100mA	100.00	100mA F.S. (6)
2	10mA	1kΩ	10V	10mA	10.000	10mA F.S. (7)
3	1mA	10kΩ	10V	1mA	1.0000	1mA F.S. (8)

6–6 Location of Calibration Controls

Refer to Fig. 6–3.

No.	Function	No.	Function
1	10V ZERO	5	100mV F.S.
2	1V ZERO	6	100mA F.S.
3	1V F.S.	7	10mA F.S.
4	10V F.S.	8	1mA F.S.

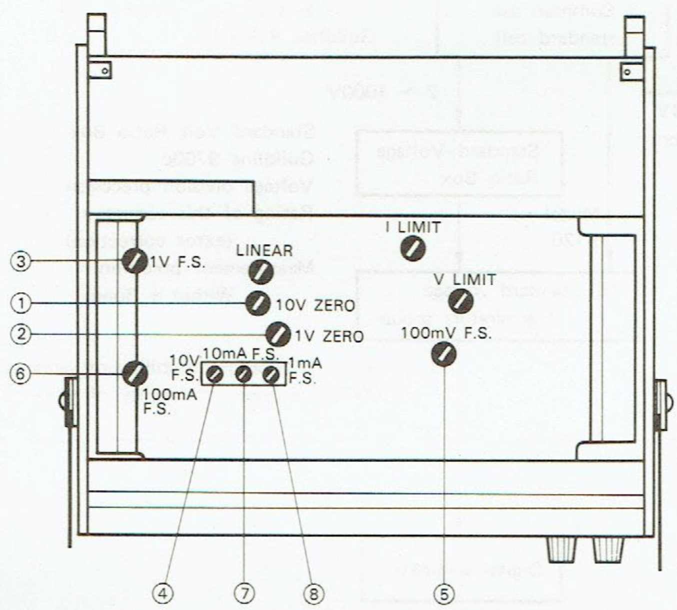


Fig. 6–3 Location of Calibration Controls

DC Voltage Standard Control System

For highly accurate voltage and resistance-standard-control, this company installed standard apparatus (standard generator made by Guidline Co. of Canada and being used in NBS of America) in the year 1966 and has been using it for tests and inspections to assure the quality of all digital voltmeters and voltage generators. Accuracy of standard voltage generators is 0.0005%, accuracy of standard resistance units 0.0001% and that of AC standard voltage generators 0.01%. These standard generators are kept in constant temperature chambers of + 23°C ± 0.5°C and the standard resistors in oil baths of + 25°C ± 0.03°C. Using these standard generators, the company produces digital voltmerers and voltage generators under strict standards control to assure highly enhanced reliability of the products. Therefore, the accuracy of measurement of the measurement data obtained using these highly accurate instruments is fully guaranteed.

System diagram of the Standard Control System used by this company is shown in Fig. 6–4.

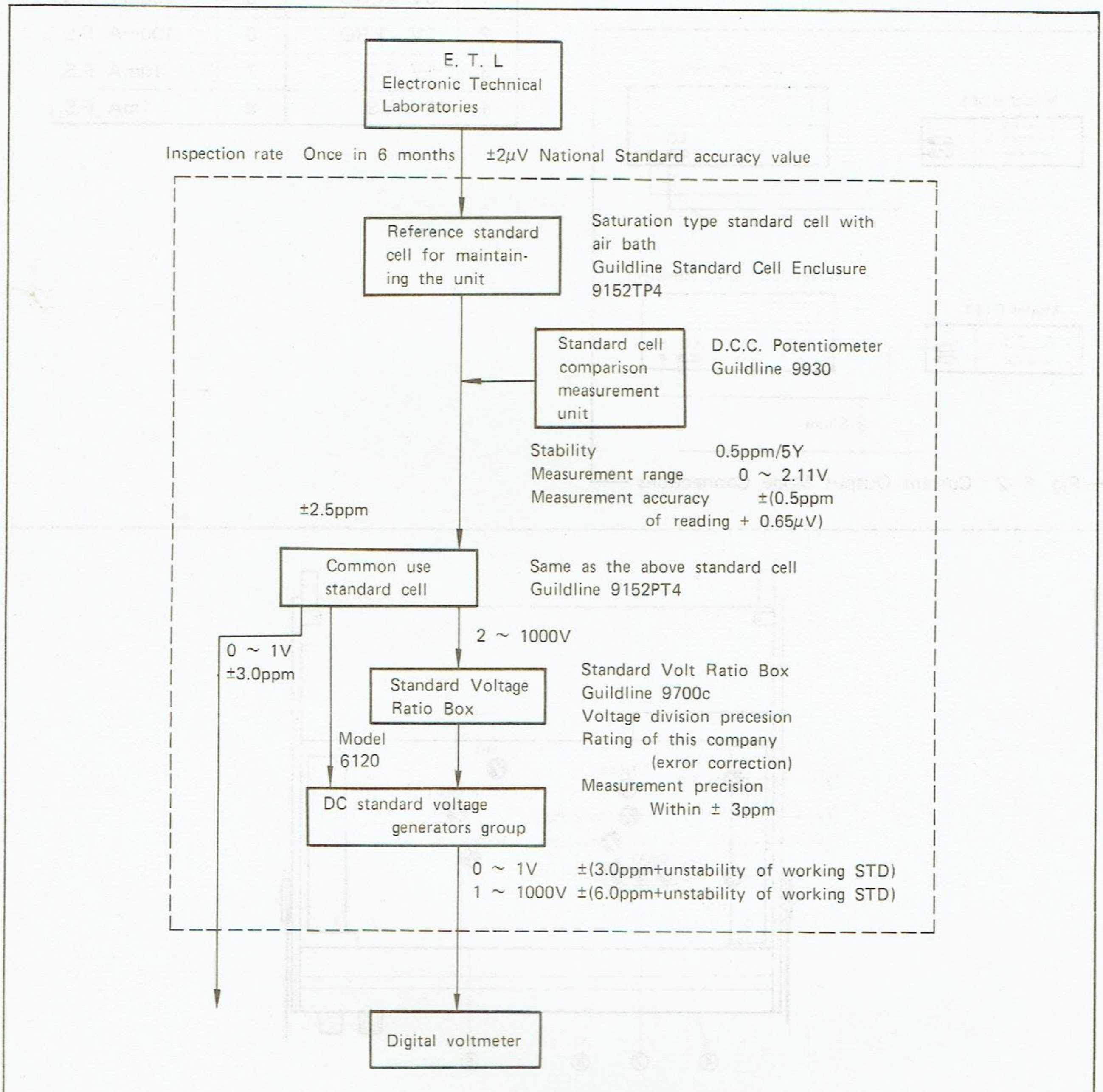
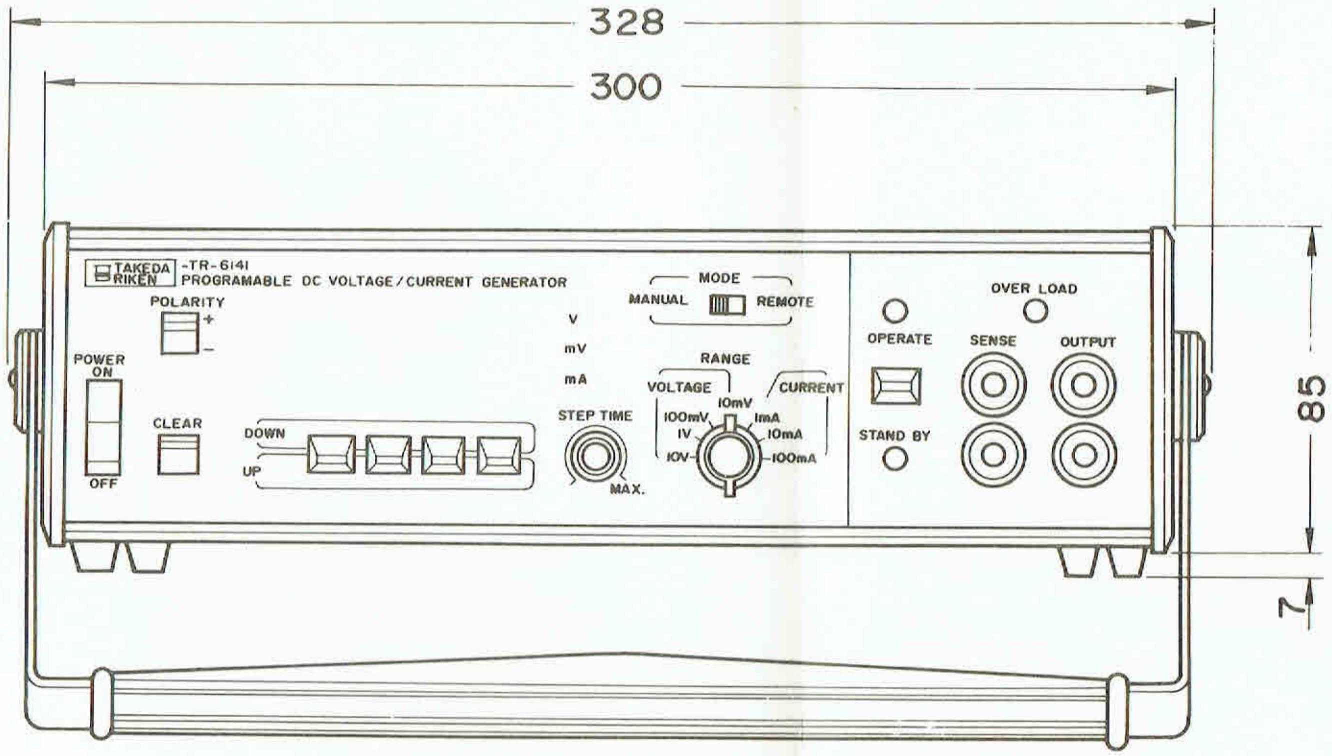
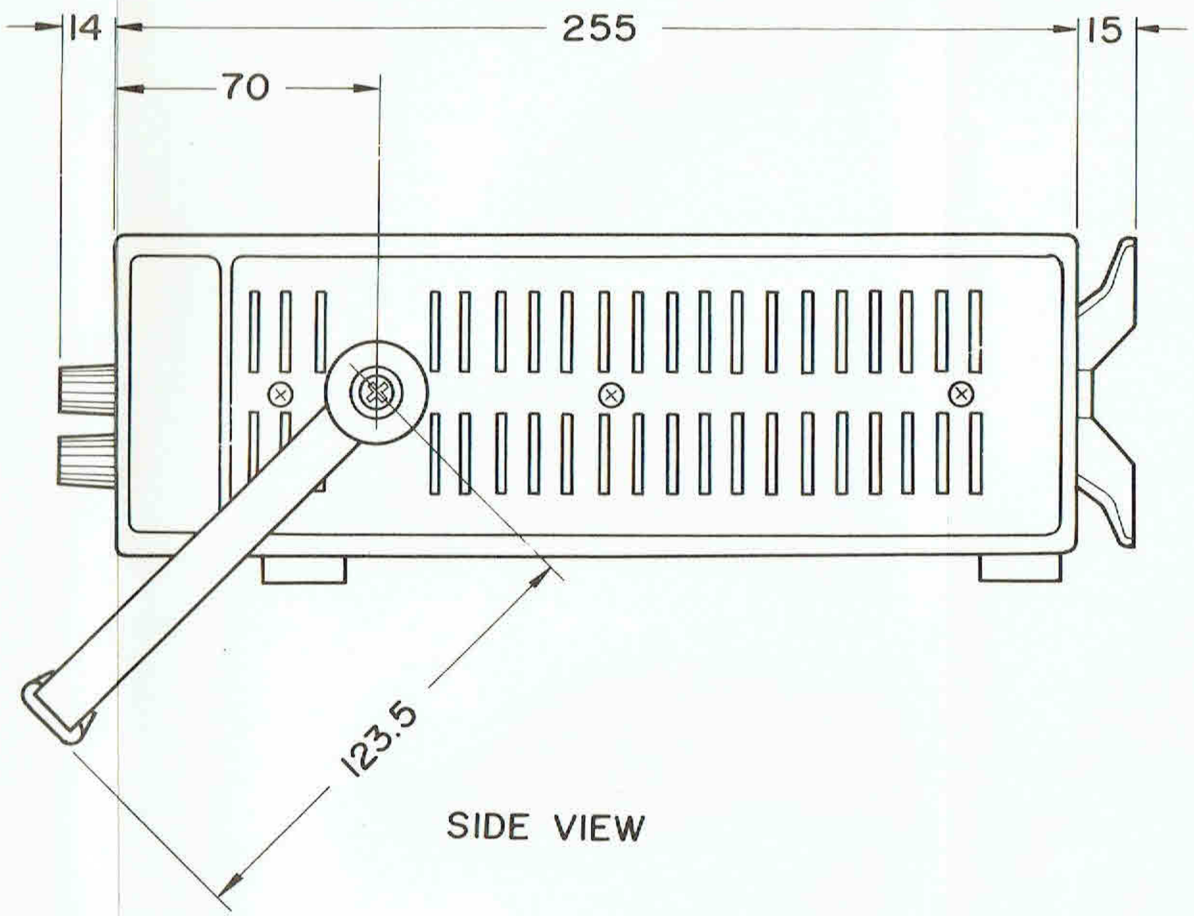


Fig. 6–4 DC Voltage Standard Control System

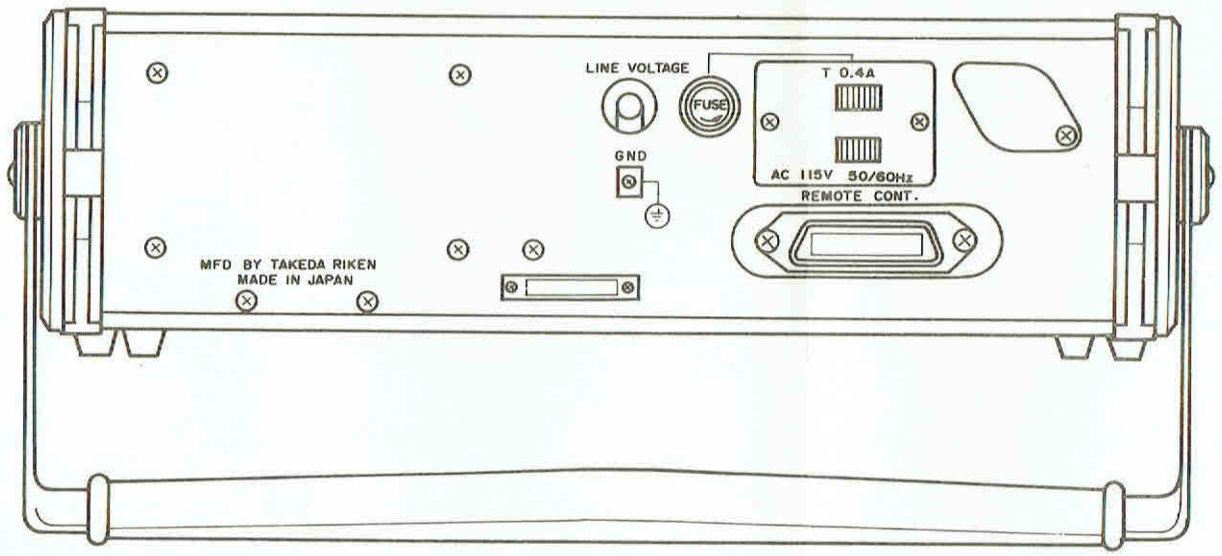
CHAPTER 7 PARTS LIST AND CIRCUIT DIAGRAM



FRONT VIEW



SIDE VIEW



REAR VIEW

0540502-002C

Fig. 7-1

-TR-6141
EXTERNAL VIEW

MECHANICAL PARTS LIST

Parts No.	Stock No.	Description	Quantity
1	M5X6 Truss Head	Screw	2
2		Flat Washer	2
3		Film	2
4	781-6047E	Clutch Cover	2
5	401-9470	Cover Reinforcement Plate	2
6	501-5388	Spring	2
7	404-5833	Handle Metal Fitting	1
8	782-5312	Handle	1
9	781-6017B	Fixed Clutch	2
10	781-6018B	Movable Clutch	2
11	526-6064A	Shaft	2
12	482-9329A	Slide Plate	2
13	482-9330	Side Plate	2
14	M3X4 Oval Countersunk Head	Screw	10
15	501-6052A	Frame	2
16	M3X10 Countrsunk Head	Screw	9
17	781-6252	Floating Spacer	4
18	781-6251	Floating	4
19	401-3190A	Shield Case	1
20	781-5328A	Knob STEP TIME	1
21	781-6071B	Knob RANGE	1
22	112-5334B	Filter Panel	1
23	401-3189	Sub-panel	1
24	SP-603 (Black)	Power Switch POWER	1

Parts No.	Stock No.	Description	Quantity
25	M3X8 Pan Head	Screw	4
26	MSHA-206N (Gray)	Padle Switch POLARITY	1
27	M3X6 Countersunk Head	Screw	2
28	SP-2025 (Gray)	Padle Switch CLEAR	1
29	SP-2028 (Gray)	Padle Switch UP/DOWN OPERATE/STAND BY	1 4
30	1P-TR (Red)	Binding Post	2
31	1P-TB (Black)	Binding Post	2
32	781-5456	LED Holder LED Cap LED	3 3 3
33	M2X4 Countersunk Head	Screw	4
34	RV16YN15SB200kΩ	Switch furnished as a Unit with Volume	1
35	SL-73	Slide Switch	1
36	YSNH-148	Rotary Switch	1
37	HP-4N	Nylon Clip	1
38	HP-2N	Nylon Clip	1
39	M3X8 Countersunk Head	Screw	10
40	401-3076	Filter Retainer	2
41	M3X6 Pan Head	Screw	22
42	382-5078A	Top Cover	1
43	411-3188A	Shield Cover	1
44	SH166	Assembly, Circuit Board ANALOG SECTION	1

Parts No.	Stock No.	Description	Quantity
45	SB239	Assembly, Circuit Board LOGIC SECTION	1
46	382-5079A	Bottom Cover	1
47	M3X10 Pan Head	Screw	6
48	S2HB-10	Diode	1
49	401-3184	Diode installed Plate	1
50	111-5344	Rear Panel	1
51	HP-3N	Nylon Clip	2
52	25LASN4700	ELECT Capacitor	1
53	SCT-6L5NU1	Tight Lug	1
54	ME-2020	Line Filter	1
55	782-6076	Foot	2
56	M3X15 Pan Head	Screw	2
57	M3X18 Pan Head	Screw	3
58	Z2-104P	Transistor Cover	1
59	M3X12 Pan Head	Screw	1
60		Mylar Base	1
61	F-7155	Fuse Holder	1
62	BU-3270	Cord Stopper	1
63	MP-20	Power Cord	1
64	TOP-23A	Earth Terminal GND	1
65	M4X10 Countersunk Head	Screw	4
66	ESD-27D	Switch	2

Parts No.	Stock No.	Description	Quantity
67	TP-962	Power Tranceformer	1
68	2SD82	Transistor	1
69	401-3185	Connector installed Plate	1
70	PNC6-15P-2.5DS	Connector	1
71	531-5698	Spacer	2
72	PCN6-15S-2.5E	Connector	1
73	SG140	Assembly, Circuit Board DISPLAY SECTION	1

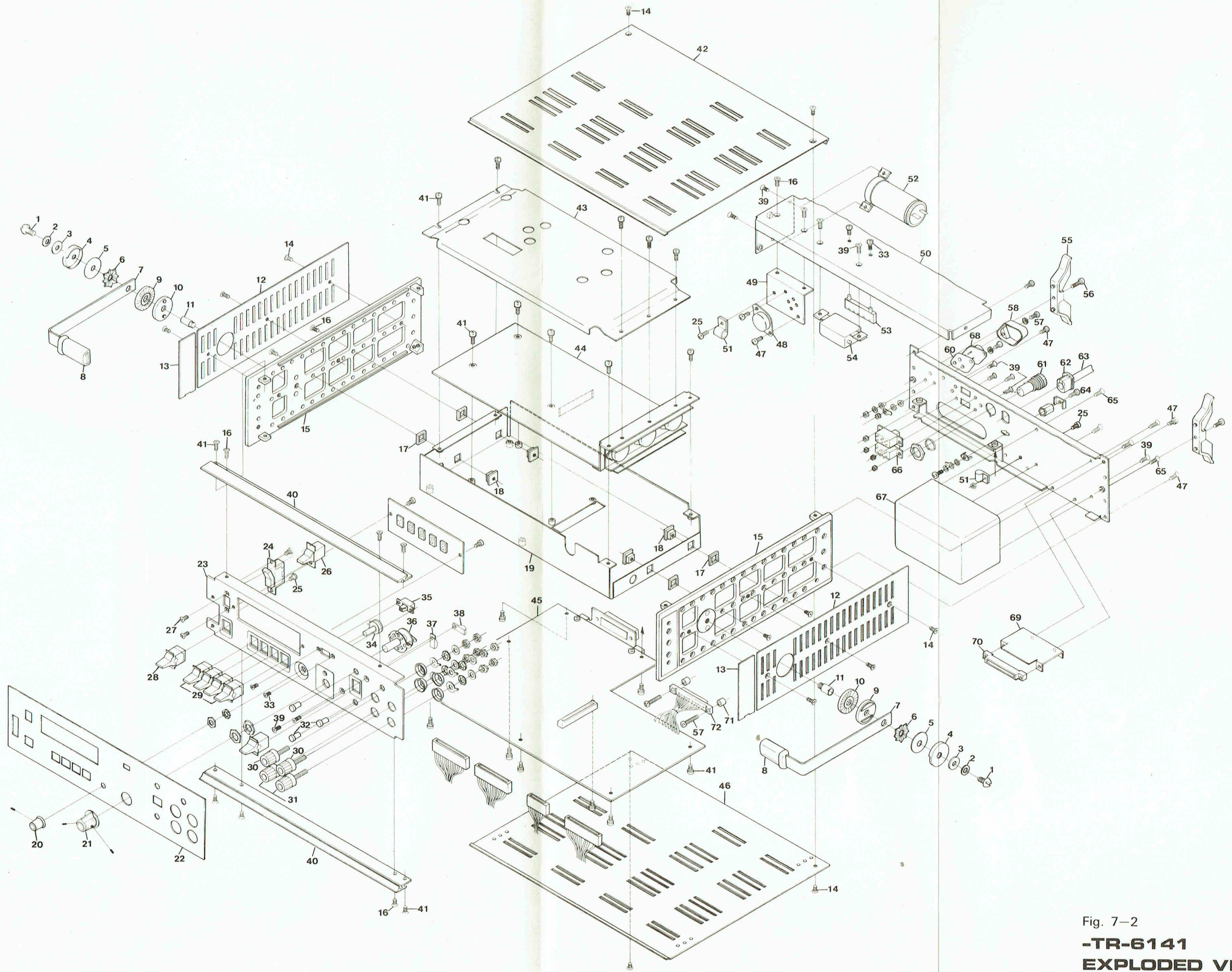


Fig. 7—2

-TR-6141
EXPLODED VIEW

MODEL 6141 SCHEMATIC SECTION

Parts No.	Stock No.	Description	
6141-SS-Q1	2SD82	Transistor SI NPN	
6141-SS-D1 thru " D3	SLP-24B	Diode Light Emitting	
6141-SS-D4	S2HB-10	Diode SI	
6141-SS-R1	RV16YN15SB200KΩ	R:VAR 200KΩ	
6141-SS-C1	25LASN4700	C:FXD ELECT 4700µF ±20% 25V	
6141-SS-S1	PS-603 (BLACK)	Seesaw Switch	
" S2	SP-2025 (GRAY)	Seesaw Switch	
" S3	MSHA-206N (GRAY)	Rocker Switch	
" S4 thru " S7	SP-2025 (GRAY)	Paddle Switch	
" S8	YSNH-148	Rotary Switch	
" S9	SL-73 (BLACK)	Slide Switch	
" S10	SP-2028 (GRAY)	Paddle Switch	
" S11	ESD-27D	Slide Switch	
6141-SS-S12	ESD-27D	Slide Switch	
6141-SS-J1 thru " J4	1P-TB	Binding Post	
" J5	JWH-263	Connector	
" J6	JWH-270	Connector	
" J7	PCN6-15P-2.5DS	Connector	
" J8		Not assigned	
6141-SS-J9	PCN6A-10S-2.5E	Connector	
6141-SS-T1	TP-962	Transformer	
6141-SS-FL1	ME-2020	Line Filter	
6141-SS-P1	TOP-23A	Earth Terminal	
6141-SS-F1	19195-400mA	Fuse (slow blow) (AC90V ~ 110V)	

Parts No.	Stock No.	Description	
	19195-200mA	Fuse (slow blow)(AC200V ~ 230V)	
	F-7155	Fuse Holder	

MODEL 6141 ANALOG SECTION
SH166

Parts No.	Stock No.	Description	
6141-SH166-IC1 thru 6141-SH166-IC4	LM301A	IC:Operational Amplifier	
6141-SH166-Q8	LTS3948/SF83022	FET	
" Q9	2SC372 (G)	Transistor SI NPN	
" Q10	2N4393	FET	
" Q11	3N4393	FET	
" Q12	2SC372 (G) Y	Transistor SI NPN	
" Q13	2SC372 (G) Y	Transistor SI NPN	
" Q14	MPS840	FET	
" Q15 thru " Q17	2SC372 (G)	Transistor IS NPN	
" Q18	2SA473 (O-Y)	Transistor SI PNP	
" Q19	2SA495 (G)	Transistor SI PNP	
" Q20 thru " Q25	2SC372	Transistor SI NPN	
" Q26 thru " Q28	2SD315	Transistor SI NPN	
6141-SH166-Q29	2SA495 (G)	Transistor SI PNP	
6141-SH166-D30	02Z7.5A	Diode Zener	
" D31	ZD-2C	Diode Zener	
" D32 thru " D35	1S953	Diode SI	
" D36	1S1544A	Diode SI	
" D37	1S1544A	Diode SI	
" D38	02Z7.5A	Diode Zemer	
" D39	02Z7.5A	Diode Zener	
" D40		Not assigned	
" D41	1S953	Diode SI	
" D42	1S953	Diode SI	
" D43	F-14B	Diode SI	
" D44	1S953	Diode SI	
6141-SH166-D45	1S953	Diode SI	

Parts No.	Stock No.	Description	
6141-SH166-D46	02Z7.5A	Diode Zener	
" D47 thru " D55	1S953	Diode SI	
" D56	W-005M	Diode SI	
" D57	W-005M	Diode SI	
" D58	02Z9.1A	Diode Zener	
6141-SG166-D59	1S953	Diode SI	
6141-SH166-R60	R25 470KΩJ	R:FXD CAR 470KΩ ±5% 1/4W	
" R61	EF1/4 43KΩF	R:FXD Metal FLM 43KΩ ±1% 1/4W	
" R62	EF1/4 43KΩF	R:FXD Metal FLM 43KΩ ±1% 1/4W	
" R63	RF1/4N 75ΩSJ	R:FXD Metal FLM 75Ω ±5% 1/4W	
" R64	RF1/4N 75ΩSJ	R:FXD Metal FLM 75Ω ±5% 1/4W	
" R65	EF1/4 18KΩF	R:FXD Metal FLM 18KΩ ±1% 1/4W	
" R66	EF1/4 820ΩF	R:FXD Metal FLM 820Ω ±1% 1/4W	
" R67 thru " R71	R25 47KΩJ	R:FXD CAR 47KΩ ±5% 1/4W	
" R72	EF1/4 47KΩF	R:FXD Metal FLM 47KΩ ±1% 1/4W	
" R73	RF1/4N 1.2KΩTF	R:FXD Metal FLM 1.2KΩ ±1% 1/4W	
" R74	X13T 50Ω	R:VAR WW 50Ω ±10%	
" R75	R25 1.8KΩJ	R:FXD CAR 1.8KΩ ±5% 1/4W	
" R76	R25 4.7KΩJ	R:FXD CAR 4.7KΩ ±5% 1/4W	
" R77	R25 10KΩJ	R:FXD CAR 10KΩ ±5% 1/4W	
" R78	R25 8.2KΩJ	R:FXD CAR 8.2KΩ ±5% 1/4W	
" R79	R25 8.2KΩJ	R:FXD CAR 8.2KΩ ±5% 1/4W	
" R80	R25 10KΩJ	R:FXD CAR 10KΩ ±5% 1/4W	
" R81	R25 4.7KΩJ	R:FXD CAR 4.7KΩ ±5% 1/4W	
" R82	R25 820ΩJ	R:FXD CAR 820Ω ±5% 1/4W	
" R83	R25 2.7KΩJ	R:FXD CAR 2.7KΩ ±5% 1/4W	
" R84	R25 2.7KΩJ	R:FXD CAR 2.7KΩ ±5% 1/4W	
" R85		Not assigned	
" R86	X13T 200Ω	R:VAR WW 200Ω ±10%	
" R87	WRS1-27 A	R:FXD WW	
6141-SH166-R88	WRB-5 43KΩFY	R:FXD WW 43KΩ ±1% 1/2W	

Parts No.	Stock No.	Description	
6141-SH166-R89	WRB-5 43KΩFY	R:FXD WW 43KΩ ±1% 1/2W	
" R90		Not assigned	
" R91		Not assigned	
" R92	EF1/4 18KΩF	R:FXD Metal FLM 18KΩ ±1% 1/4W	
" R93	EF1/4 820ΩF	R:FXD Metal FLM 820Ω ±1% 1/4W	
" R94	R25 10KΩJ	R:FXD Metal FLM 10KΩ ±5% 1/4W	
" R95	X13T 20Ω	R:VAR WW 20Ω ±10%	
" R96	RF1/4 39ΩSJ	R:FXD Metal FLM 39Ω ±5% 1/4W	
" R97	RF1/4 39ΩSJ	R:FXD Metal FLM 39Ω ±5% 1/4W	
" R98	RF1/4 18ΩSJ	R:FXD Metal FLM 18Ω ±5% 1/4W	
" R99	RF1.4 18ΩSJ	R:FXD Metal FLM 18Ω ±5% 1/4W	
" R100	RF1/4 2.2KΩTF	R:FXD Metal FLM 2.2KΩ ±1% 1/4W	
" R101	R25 4.7KΩJ	R:FXD CAR 4.7KΩ ±5% 1/4W	
" R102	R25 2.2KΩJ	R:FXD CAR 2.2KΩ ±5% 1/4W	
" R103	R25 10KΩJ	R:FXD CAR 10KΩ ±5% 1/4W	
" R104	R25 3.9KΩJ	R:FXD CAR 3.9KΩ ±5% 1/4W	
" R105	RF1/4N39ΩSJ	R:FXD Metal FLM 39Ω ±5% 1/4W	
" R106	RF1/4N39ΩSJ	R:FXD Metal FLM 39Ω ±5% 1/4W	
" R107	R25 6.8KΩJ	R:FXD CAR 6.8KΩ ±5% 1/4W	
" R108	X13T 10Ω	R:VAR WW 10Ω ±10%	
" R109	R50 4.7KΩJ	R:FXD CAR 4.7KΩ ±5% 1/2W	
" R110	X13T 500Ω	R:VAR WW 500Ω ±10%	
" R111	R25 10KΩJ	R:FXD CAR 10KΩ ±5% 1/4W	
" R112	R25 10KΩJ	R:FXD CAR 10KΩ ±5% 1/4W	
" R113	R25 8.2KΩJ	R:FXD CAR 8.2KΩ ±5% 1/4W	
" R114	R25 33KΩJ	R:FXD CAR 33KΩ ±5% 1/4W	
" R115 thru " R117	WRL-1 596.4ΩBY	R:FXD WW 596.4Ω ±0.1% 1/5W	
" R118	WRL-0 1ΩFY	R:FXD WW 1Ω ±1% 1/2W	
" R119	WRL-0 2ΩFY	R:FXD WW 2Ω ±1% 1/2W	
" R120	X13T 20KΩ	R:VAR WW 20KΩ ±10%	
" R121	RF1/4N 15KΩSJ	R:FXD Metal FLM 15KΩ ±5% 1/4W	
" R122	WRL-0 2ΩFY	R:FXD WW 2Ω ±1% 1/2W	
6141-SH166-R123	WRL-0 10KΩAAY	R:FXD WW 10KΩ ±0.025% 1/50W	

Parts No.	Stock No.	Description	
6141-SH166-R124	WRL-1 89.95KΩAAY	R:FXD WW 89.95KΩ ±0.025% 1/50W	
" R125	X13T 100Ω	R:VAR WW 100Ω ±10%	
" R126	WRB-0 19.93KΩAY	R:FXD WW 19.93KΩ ±0.05% 1/10W	
" R127	X13T 100Ω	R:VAR WW 100Ω ±10%	
" R128	X13T 20KΩ	R:VAR WW 20KΩ ±10%	
" R129	RF1/4N 68KΩSJ	R:FXD Metal FLM 68KΩ ±5% 1/4W	
" R130	WRL-1 2.287KΩBY	R:FXD WW 2.287KΩ ±0.1% 1/5W	
" R131	X13T 20KΩ	R:VAR WW 20KΩ ±10%	
" R132	RF1/4N 15KΩSJ	R:FXD Metal FLM 15KΩ ±5% 1/4W	
" R133	WRL-1 204ΩBY	R:FXD WW 204Ω ±0.1% 1/4W	
" R134	WRB-1 20ΩBY	R:FXD WW 20Ω ±0.1% 1/5W	
" R135	R25 1.2kΩJ	R:FXD CAR 1.2KΩ ±5% 1/4W	
" R136	R25 2.7KΩJ	R:FXD CAR 2.7KΩ ±5% 1/4W	
" R137	R25 4.7KΩJ	R:FXD CAR 4.7KΩ ±5% 1.4W	
" R138	R25 2.7KΩJ	R:FXD CAR 2.7KΩ ±5% 1/4W	
" R139	R25 2.2KΩJ	R:FXD CAR 2.2KΩ ±5% 1/4W	
" R140	EF1/4 10KΩF	R:FXD Metal FLM 10KΩ ±1% 1/4W	
" R141	3321H-1-502	R:VAR 5KΩ ±20% 1/2W	
" R142	EF1/4 10KΩF	R:FXD Metal FLM 10KΩ ±1% 1/4W	
" R143	R25 2.7KΩJ	R:FXD CAR 2.7KΩ ±5% 1/4W	
" R144	R25 4.7KΩJ	R:FXD CAR 4.7KΩ ±5% 1/4W	
" R145	R25 4.7KΩJ	R:FXD CAR 4.7KΩ ±5% 1/4W	
" R146	EF1/4 10KΩF	R:FXD Metal FLM 10KΩ ±1% 1/4W	
" R147	EF1/4 10KΩF	R:FXD Metal FLM 10KΩ ±1% 1/4W	
" R148	EF1/4 30KΩF	R:FXD Metal FLM 30KΩ ±1% 1/4W	
" R149	EF1/4 10KΩF	R:FXD Metal FLM 10KΩ ±1% 1/4W	
" R150	X13T 20Ω	R:VAR WW 20Ω ±10%	
" R151	RF1/4N 18ΩSJ	R:FXD Metal FLM 18Ω ±5% 1/4W	
" R152	RF1/4N 18ΩSJ	R:FXD Metal FLM 18Ω ±5% 1/4W	
" R153	RF1/4N 180ΩTF	R:FXD Metal FLM 180Ω ±1% 1/4W	
" R154	R25 150ΩJ	R:FXD CAR 150Ω ±5% 1/4W	
" R155	R25 680ΩJ	R:FXD CAR 680Ω ±5% 1/4W	
6141-SH166-R156	R25 18KΩJ	R:FXD CAR 18KΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
6141–SH166–C157	SC80YZ103P	C:FXD CER 0.01μF +100, –0% 50V	
" C158	FC50SL330K	C:FXD CER 33pF ±10% 50V	
" C159	SC80YZ103P	C:FXD CER 0.01μF +100, –0% 50V	
" C160	MC13.5YZ104P	C:FXD CER 0.1μF +100, –0% 25V	
" C161	MC13.5YZ104P	C:FXD CER 0.1μF +100, –0% 25V	
" C162	MFL05S1K	C:FXD Polyester FLM 0.01μF ±10% 50V	
" C163	MFL05S22K	C:FXD Polyester FLM 0.022μF ±10% 50V	
" C164	MFL05S22K	C:FXD Polyester FLM 0.022μF ±10% 50V	
" C165	MFL05S47K	C:FXD Polyester FLM 0.047μF ±10% 50V	
" C166	MFL05S68K	C:FXD Polyester FLM 0.068μF ±10% 50V	
" C167	FC80SL221K	C:FXD CER 220pF ±10% 50V	
" C168	FC80SL221K	C:FXD CER 220pF ±10% 50V	
" C169	FC80SL101K	C:FXD CER 100pF ±10% 50V	
" C170	FC80SL101K	C:FXD CER 100pF ±10% 50V	
" C171 thru " C173		Not assigned	
" C174	FC100SL471K	C:FXD CER 470pF ±10% 50V	
" C175	SC80YZ103P	C:FXD CER 0.01μF +100, –0% 50V	
" C176	SC80YZ103P	C:FXD CER 0.01μF +100, –0% 50V	
" C177	FC50SL330K	C:FXD CER 33pF ±10% 50V	
" C178	MC13.5YZ104P	C:FXD CER 0.1μF +100, –0% 25V	
" C179	MC13.5YZ104P	C:FXD CER 0.1μF +100, –0% 25V	
" C180	SC100YZ223P	C:FXD CER 0.022μF +100, –0% 50V	
" C181		Not assigned	
" C182	FNXHS2W1K	C:FXD Polyester 1μF ±10% 200V	
" C183	FNXHS2P22K	C:FXD Polyester 0.22μF ±10% 200V	
" C184	FNXHS2P22K	C:FXD Polyester 0.22μF ±10% 200V	
" C185	35TA330	C:FXD ELECT 330μF ±20% 35V	
" C186	FC50SL330K	C:FXD CER 33pF ±10% 50V	
" C187	SC120YZ473P	C:FXD CER 0.047μF +100, –0% 50V	
" C188	25VBSN33	C:FXD ELECT 33μF ±20% 25V	
" C189	35TA220	C:FXD ELECT 220μF ±20% 35V	
" C190	FC50SL330K	C:FXD CER 33pF ±10% 50V	
6141–SH166–C191	SC120YZ473P	C:FXD CER 0.047μF +100, –0% 50V	

Parts No.	Stock No.	Description	
6141-SH166-C192	25VBSN33	C:FXD ELECT 33μF ±20% 25V	
" C193	50VBSN10	C:FXD ELECT 10μF ±20% 50V	
" C194	SC70YZ222P	C:FXD CER 0.0022μF +100, -0% 50V	
" C195	MC13.5YZ104P	C:FXD CER 0.1μF +100, -0% 25V	
" C196	SC70YZ222P	C:FXD CER 0.0022μF +100, -0% 50V	
" C197 thru " C200	MC13.5YZ104P	C:FXD CER 0.1μF +100, -0% 25V	
" C201 thru " C219		Not assigned	
6141-SH166-C220	MC13.5YZ104P	C:FXD CER 0.1μF +100, -0% 25V	
6141-SH166-K201	AE1324	Relay	
" K202	RABK-4B-DC24V-107	Relay	
" K203	RABK-4B-DC24V-107	Relay	
" K204 thru " K207	AE1324	Relay	
" K208	RABK-4B-DC24V-107	Relay	
6141-SH166-K209	RABK-4B-DC24V-107	Relay	
6141-SH166-J214	PCN6A-20P-2.5DS	Connector	
6141-SH166-J215	PCN6A-20P-2.5DS	Connector	

MODEL 6141 LOGIC SECTION
SB239

Parts No.	Stock No.	Description
6141-SB239-IC1	SN7405N	IC:Hex Inverter with Open-Collector Output
" IC2	SN7410N	IC:Triple 3-Input NAND Gate
" IC3	SN7400N	IC:Quadruple 2-Input NAND Gate
" IC4	SN7402N	IC:Quadruple 2-Input NOR Gate
" IC5	SN74121N	IC:Monostable Multivibrator
" IC6	SN7400N	IC:Quadruple 2-Input NAND Gate
" IC7	SN7400N	IC:Quadruple 2-Input NAND Gate
" IC8 thru " IC10	SN7404N	IC:Hex Inverter
" IC11 thru " IC14	SN7447N	IC:BCD-to-Seven-Segment Decoder/ Driver with 15V Output
" IC15	SN7405N	IC:Hex Inverter with Open-Collector Output
" IC16 thru " IC19	SN7404N	IC:Hex Inverter
" IC20	SN7410N	IC:Triple 3-Input NAND Gate
" IC21	SN7405N	IC:Hex Inverter with Open-Collector Output
" IC22	SN7410N	IC:Triple 3-Input NAND Gate
" IC23	SN7410N	IC:Quadruple 2-Input NAND Gate
" IC24	SN7405N	IC:Hex Inverter with Open-Collector Output
" IC25	SN7400N	IC:Quadruple 2-Input Positive NAND Gate
" IC26	SN7405N	IC:Hex Inverter with Open-Collector Output
" IC27	SN7410N	IC:Triple 3-Input NAND Gate
" IC28	SN7400N	IC:Quadruple 2-Input NAND Gate
" IC29	SN7406N	IC:Hex Inverter Buffer/Driver with Open-Collector High-Voltage Output
" IC30	SN7410N	IC:Triple 3-Input NAND Gate
" IC31	SN74192N	IC:Synchronous Up-Down Decade Counter
6141-SB239-IC32	SN74192N	IC:Synchronous Up-Down Decade Counter

Parts No.	Stock No.	Description	
6141-SB239-IC33	SN408N	IC:Quadruple 2-Input Positive NAND Gate	
" IC34	SN74192N	IC:Synchronous Up/Down Decade Counter	
" IC35	SN7408N	IC:Quadruple 2-Input Positive NAND Gate	
" IC36	SN174193N	IC:Synchronous Up/Down Decade Counter	
" IC37	LM301A	IC:Operational Amplifier	
" IC38	SN7408N	IC:Quadruple 2-Input Positive NAND Gate	
" IC39	SN7406N	IC:Hex Inverter Buffer/Driver with Open-Collector High-Voltage Output	
" IC40	SN7410N	IC:Triple 3-Input NAND Gate	
" IC41 thru " IC43	SN74192N	IC:Synchronous Up/Down Decade Counter	
" IC44	SN7490N	IC:Decade Counter	
" IC45	SN74193N	IC:Synchronous Up/Down Decader Counter	
" IC46	SN473N	IC:Dual J-K Master-Slave Flip-Flop	
" IC47	SN7473N	IC:Dual J-K Master-Slave Flip-Flop	
" IC48	SN7404N	IC:Hex Inverter	
" IC49	SN7493N	IC:4-Bit Binary Counter	
" IC50	SN7490N	IC:Decade Counter	
" IC51	SN7490N	IC:Decade Counter	
" IC52	SN7420N	IC:Dual 4-Input NAND Gate	
" IC53 thru " IC57	SN7404N	IC:Hex Inverter	
6141-SB239-IC58	SN7486N	IC:Quadruple 2-Input Exclusive-OR-Gate	
6141-SB239-Q60 thru " Q63	2SC372	Transistor SI NPN	
" Q64	2SD315	Transistor SI NPN	
" Q65 thru 6141-SB239-Q70	2SC372 (G)	Transistor SI NPN	

Parts No.	Stock No.	Description	
6141-SB239-Q71	2SH20GR	UJT	
" Q72	2SC372 (G)	Transistor SI NPN	
6141-SB239-Q73	2SC372 (G)	Transistor SI NPN	
6141-SB239-D75	02Z 11A	Diode Zener	
" D76	W-005	Diode SI	
" D77 thru " D80	1S953	Diode SI	
" D81	DAP-4	Diode SI	
" D82	DAP-4	Diode SI	
" D83	1S953	Diode SI	
6141-SB239-D84	1S953	Diode SI	
6141-SB239-R87	R25 220ΩJ	R:FXD CAR 220Ω ±5% 1/4W	
" R88	R25 220ΩJ	R:FXD CAR 220Ω ±5% 1/4W	
" R89	R25 3.3KΩJ	R:FXD CAR 3.3KΩ ±5% 1/4W	
" R90	R25 2.7KΩJ	R:FXD CAR 2.7KΩ ±5% 1/4W	
" R91	R25 2.7KΩJ	R:FXD CAR 2.7KΩ ±5% 1/4W	
" R92	3321H-1-202	R:VAR 2KΩ ±20% 1/2W	
" R93	R25 3.9KΩJ	R:FXD CAR 3.9KΩ ±5% 1/4W	
" R94	R25 4.7KΩJ	R:FXD CAR 4.7KΩ ±5% 1/4W	
" R95	R25 100ΩJ	R:FXD CAR 100Ω ±5% 1/4W	
" R96 thru " R98	R25 4.7KΩJ	R:FXD CAR 4.7KΩ ±5% 1/4W	
" R99	R25 15KΩJ	R:FXD CAR 15KΩ ±5% 1/4W	
" R100 thru " R102	R25 3.3KΩJ	R:FXD CAR 3.3KΩ ±5% 1/4W	
" R103	R25 390Ω	R:FXD CAR 390Ω ±5% 1/4W	
" R104	R25 33KΩJ	R:FXD CAR 33KΩ ±5% 1/4W	
" R105	R25 10KΩJ	R:FXD CAR 10KΩ ±5% 1/4W	
" R106	R25 150KΩJ	R:FXD CAR 150KΩ ±5% 1/4W	
" R107	R25 100KΩJ	R:FXD CAR 100KΩ ±5% 1/4W	
" R108	R25 100KΩJ	R:FXD CAR 100KΩ ±5% 1/4W	
6141-SB239-R109	R25 390ΩJ	R:FXD CAR 390Ω ±5% 1/4W	

Parts No.	Stock No.	Description	
6141-SB239-R110	R25 470ΩJ	R:FXD CAR 470Ω ±5% 1/4W	
" R111		Not assigned	
" R112	R25 22ΩJ	R:FXD CAR 22Ω ±5% 1/4W	
" R113	R25 150ΩJ	R:FXD CAR 150Ω ±5% 1/4W	
" R114	R25 47KΩJ	R:FXD CAR 47KΩ ±5% 1/4W	
" R115	R25 8.2KΩJ	R:FXD CAR 8.2KΩ ±5% 1/4W	
" R116	MR6-3	R:FXD COM 10KΩ	
" R117	MR6-3	R:FXD COM 10KΩ	
" R118	R25 820ΩJ	R:FXD CAR 820Ω ±5% 1/4W	
" R119	R25 820ΩJ	R:FXD CAR 820Ω ±5% 1/4W	
" R120	R25 10KΩJ	R:FXD CAR 10KΩ ±5% 1/4W	
" R121	MR6-3	R:FXD COM 10KΩ	
" R122	MR6-3	R:FXD COM 10KΩ	
" R123	R25 22KΩJ	R:FXD CAR 22KΩ ±5% 1/4W	
" R124		Not assigned	
" R125		Not assigned	
" R126 thru " R130	MR6-3	R:FXD COM 10KΩ	
" R131 thru " R134	R25 1.8KΩJ	R:FXD CAR 1.8KΩ ±5% 1/4W	
" R135 thru " R171	R25 820ΩJ	R:FXD CAR 820Ω ±5% 1/4W	
" R172		Not assigned	
" R173	R25 6.8KΩJ	R:FXD CAR 6.8KΩ ±5% 1/4W	
" R174	R25 6.8KΩJ	R:FXD CAR 6.8KΩ ±5% 1/4W	
" R175	R25 560ΩJ	R:FXD CAR 560Ω ±5% 1/4W	
" R176	R25 33KΩJ	R:FXD CAR 33KΩ ±5% 1/4W	
" R177	R25 1.5KΩJ	R:FXD CAR 1.5KΩ ±5% 1/4W	
" R178	R25 10KΩJ	R:FXD CAR 10KΩ ±5% 1/4W	
" R179	R25 3.3KΩJ	R:FXD CAR 3.3KΩ ±5% 1/4W	
6141-SB239-R180	R25 270ΩJ	R:FXD CAR 270Ω ±5% 1/4W	
6141-SB239-C181	FC50SL330K	C:FXD CER 33pF ±10% 50V	
6141-SB239-C182	SC120YZ470P	C:FXD CER 47pF +100, -0% 50V	

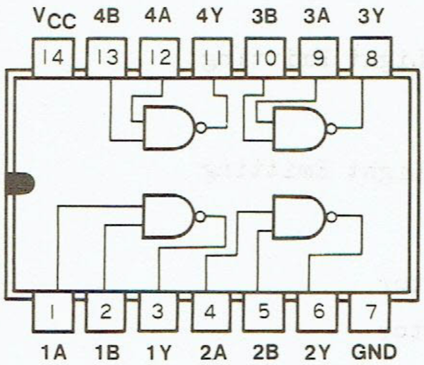
Parts No.	Stock No.	Description	
6141-SB239-C183	SC70YZ222P	C:FXD CER 0.0022μF +100, -0% 50V	
" C184	DT1002-336M	C:FXD ELECT TANTAL 33μF ±20% 10V	
" C185	SL50TA220	C:FXD ELECT 220μF ±20% 50V	
" C186	SL50TA10	C:FXD ELECT 10μF ±20% 50V	
" C187 thru " C207	SC120YZ473P	C:FXD CER 0.047μF +100, -0% 50V	
" C208	DT3502-105M	C:FXD ELECT TANTAL 1μF ±20% 35V	
" C209	FC90SL331K	C:FXD CER 330pF ±10% 50V	
" C210	DT1002-106M	C:FXD ELECT TANTAL 10μF ±20% 10V	
" C211	DT2002-105M	C:FXD ELECT TANTAL 1μF ±20% 20V	
" C212	DT3502-335M	C:FXD ELECT TANTAL 3.3μF ±20% 35V	
" C213	DT3502-105M	C:FXD ELECT TANTAL 1μF ±20% 35V	
" C214		Not assigned	
" C215		Not assigned	
" C216	SC120YZ473P	C:FXD CER 0.047μF +100, -0% 50V	
" C217	SC120YZ473P	C:FXD CER 0.047μF +100, -0% 50V	
" C218	FC50SL330K	C:FXD CER 33pF ±10% 50V	
" C219	FC80SL181K	C:FXD CER 180ΩF ±10% 50V	
" C220	FC80SL101K	C:FXD CER 100ΩF ±10% 50V	
" C221	FC80SL101K	C:FXD CER 100ΩF ±10% 50V	
" C222	SC80YZ103P	C:FXD CER 0.01μF +100, -0% 50V	
" C223	DT3502-105M	C:FXD ELECT TANTAL 1μF ±20% 35V	
" C224	DT1002-106M	C:FXD ELECT TANTAL 10μF ±20% 10V	
" C225	DT1002-106M	C:FXD ELECT TANTAL 10μF ±20% 10V	
6141-SB239-C226	FC80SL221K	C:FXD CER 220pF ±10% 50V	
6141-SB239-L227	LF-6	L:FXD Coil	
6141-SB239-J234	5048-19A	Connector	
" J235	5048-19A	Connector	
" J236	5048-10A	Connector	
" J237	5048-19A	Connector	
" J238	PCN6A-20S-2.5DS	Connector	
" J239	PCN6-15S-2.5E	Connector	
6141-SB239- J240	57-40360	Connector	

Parts No.	Stock No.	Description	
6141-SB239-T245	TP-838A 491-9151	Pulse Transformer Core Holder	

MODEL 6141 DISPLAY SECTION
SG140

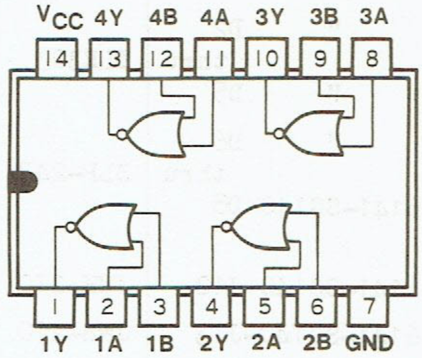
Parts No.	Stock No.	Description	
6141-SG140-D1	TLR304	Diode Light Emitting	
" D2 thru " D5	TLR303	Diode Light Emitting	
" D6 thru 6141-SG140-D8	SLP-24B	Diode Light Emitting	
6141-SG140-J12	JWH-270	Connector	
6141-SG140-J13	JWH-270	Connector	

SN7400N
QUADRUPLE 2-INPUT POSITIVE NAND GATES



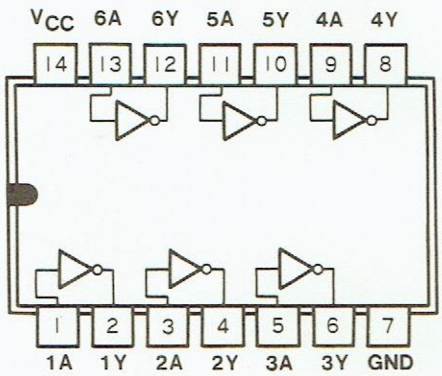
positive logic: $Y = \overline{AB}$

SN7402N
QUADRUPLE 2-INPUT POSITIVE NOR GATES



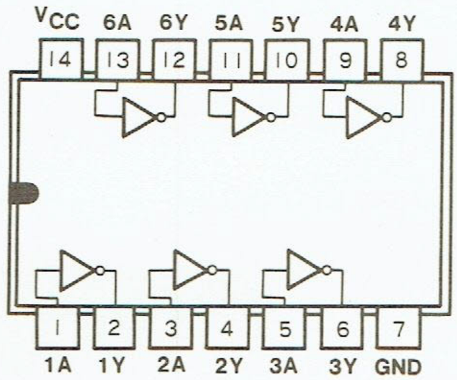
positive logic: $Y = \overline{A + B}$

SN7404N
HEX INVERTERS



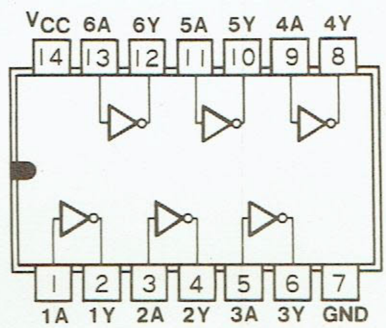
positive logic: $Y = \overline{A}$

SN7405N
HEX INVERTERS (WITH OPEN-COLLECTOR OUTPUT)



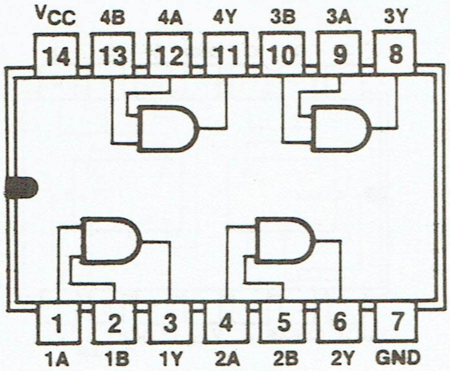
positive logic: $Y = \overline{A}$

SN7406N
HEX INVERTER BUFFERS/DRIVERS WITH OPEN-COLLECTOR HIGH-VOLTAGE OUTPUTS



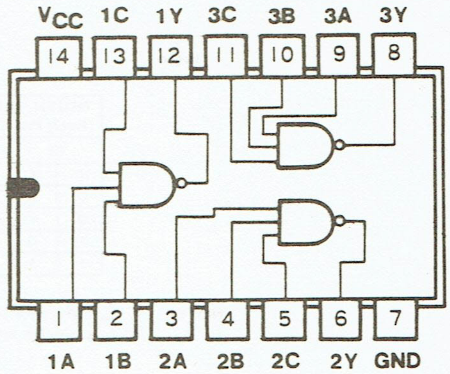
positive logic: $Y = \overline{A}$

SN7408N
QUADRUPLE 2-INPUT POSITIVE AND GATES



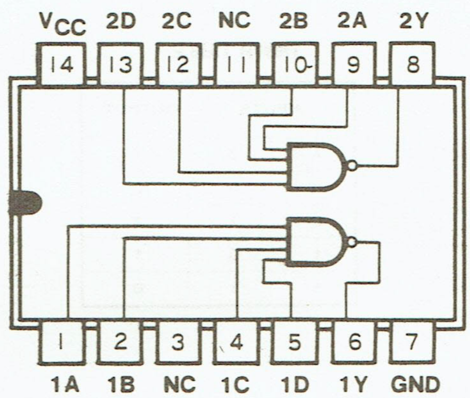
Positive Logic: Y = AB

SN7410N
TRIPLE 3-INPUT POSITIVE NAND GATES



positive logic: $Y = \overline{ABC}$

SN7420N
DUAL 4-INPUT POSITIVE NAND GATES



NC — No internal Connection

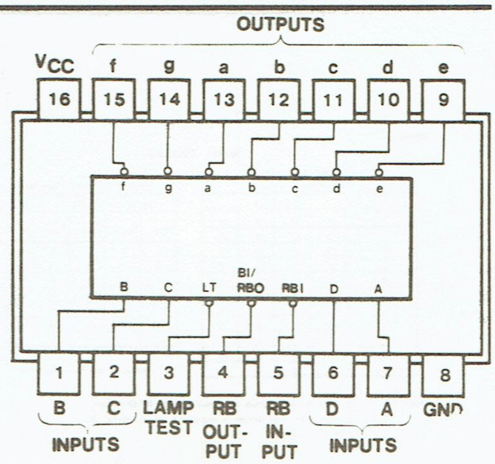
positive logic: $Y = \overline{ABCD}$

SN7447AN
BCD-TO-SEVEN-SEGMENT DECODER/DRIVERS

TRUTH TABLE

DECIMAL OR FUNCTION	LT	RBI	D	C	B	A	BI/RBO	a	b	c	d	e	f	g	NOTE
	INPUTS							OUTPUTS							
0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1
1	1	X	0	0	0	1	1	1	0	0	1	1	1	1	1
2	1	X	0	0	1	0	1	0	0	1	0	0	1	0	
3	1	X	0	0	1	1	1	0	0	0	0	1	1	0	
4	1	X	0	1	0	0	1	1	0	0	1	1	0	0	
5	1	X	0	1	0	1	1	0	1	0	0	1	0	0	
6	1	X	0	1	1	0	1	1	1	0	0	0	0	0	
7	1	X	0	1	1	1	1	0	0	0	1	1	1	1	
8	1	X	1	0	0	0	1	0	0	0	0	0	0	0	
9	1	X	1	0	0	1	1	0	0	0	1	1	0	0	
10	1	X	1	0	1	0	1	1	1	1	0	0	1	0	
11	1	X	1	0	1	1	1	1	1	0	0	1	1	0	
12	1	X	1	1	0	0	1	1	0	1	1	1	0	0	
13	1	X	1	1	0	1	1	0	1	1	0	1	0	0	
14	1	X	1	1	1	0	1	1	1	1	0	0	0	0	
15	1	X	1	1	1	1	1	1	1	1	1	1	1	1	
BI	X	X	X	X	X	X	0	1	1	1	1	1	1	1	2
RBI	1	0	0	0	0	0	0	1	1	1	1	1	1	1	3
LT	0	X	X	X	X	X	1	0	0	0	0	0	0	0	4

NOTES
1. BI/RBO is wire AND logic serving as blanking input (BI) and/or ripple-blanking output (RBO). The blanking input (BI) must be open or held at a logical 1 when output functions 0 through 15 are desired, and the ripple blanking input (RBI) must be open or at a logical 1 if blanking of a decimal 0 is not desired. X = input may be high or low.
2. When a logical 0 is applied directly to the blanking input (forced condition) all segment outputs go to a logical 0 regardless of the state of any other input condition.
3. When the ripple-blanking input (RBI) and inputs A, B, C and D are at logical 0, with the lamp test input at logical 1, all segment outputs go to a logical 1 and the ripple blanking output (RBO) goes to a logical 0 (response condition).
4. When the blanking input/ripple blanking output (BI/RBO) is open or held at a logical 1, and a logical 0 is applied to the lamp test input, all segment outputs go to a logical 0.



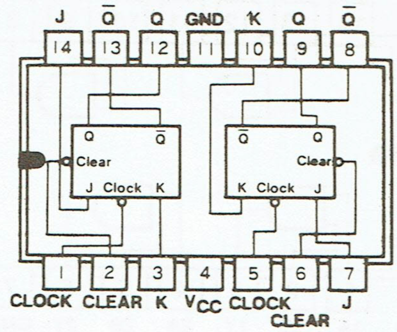
positive logic: see truth table

SN7473N
DUAL J-K MASTER-SLAVE FLIP-FLOPS

logic

TRUTH TABLE (Each Flip-Flop)		
t_n		t_{n+1}
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q}_n$

NOTES: 1. t_n = Bit time before clock pulse.
2. t_{n+1} = Bit time after clock pulse.

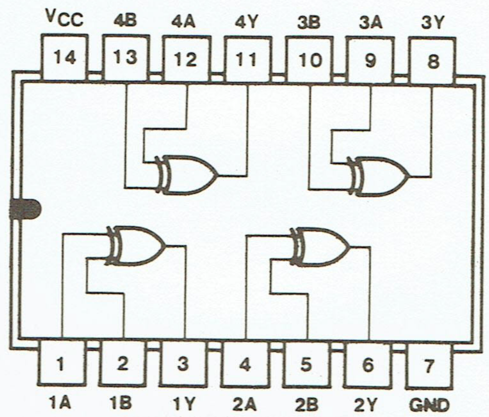


positive logic: low input to clear sets Q to logical 0.
Clear is independent of clock

SN7486N
QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES

TRUTH TABLE

INPUTS		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0



positive logic: Y = A ⊕ B

SN7490N
DECADE COUNTERS

logic

TRUTH TABLES

BCD COUNT SEQUENCE (See Note 1)

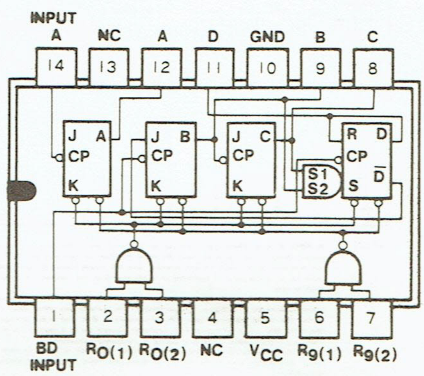
COUNT	OUTPUT			
	D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

RESET/COUNT (See Note 2)

RESET INPUTS				OUTPUT
$R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	D C B A
1	1	0	X	0 0 0 0
1	1	X	0	0 0 0 0
X	X	1	1	1 0 0 1
X	0	X	0	COUNT
0	X	0	X	COUNT
0	X	X	0	COUNT
X	0	0	X	COUNT

NC No Internal Connection

NOTES 1 Output A connected to input BD for BCD count
2 X indicates that either a logical 1 or a logical 0 may be present



positive logic: see truth table

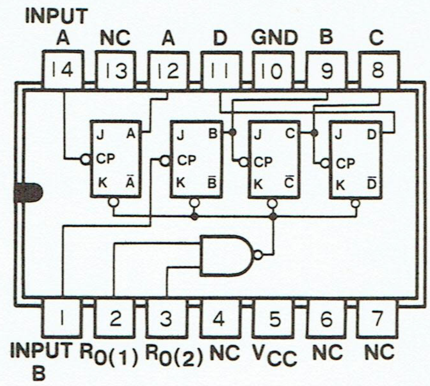
SN7493N
4-BIT BINARY COUNTERS

logic

TRUTH TABLE (See Notes 1, 2, and 3)

COUNT	OUTPUT			
	D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

NOTES
1. Output A connected to input B
2. To reset all outputs to logical 0 both $R_{0(1)}$ and $R_{0(2)}$ inputs must be at logical 1
3. Either (or both) reset inputs $R_{0(1)}$ and $R_{0(2)}$ must be at a logical 0 to count



positive logic: see truth table

NC – No internal Connection

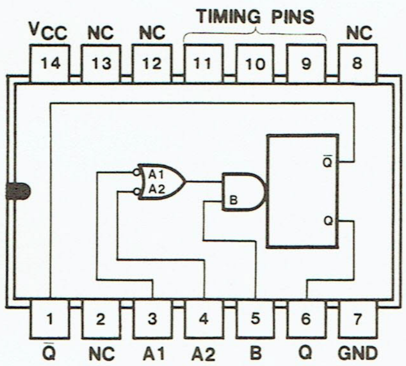
SN74121N
MONOSTABLE MULTIVIBRATORS

logic

TRUTH TABLE (See Notes 1 thru 3)

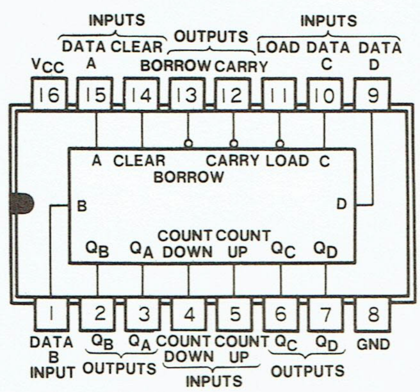
t_n INPUT			t_{n+1} INPUT			OUTPUT
A1	A2	B	A1	A2	B	
1	1	0	1	1	1	Inhibit
0	X	1	0	X	0	Inhibit
X	0	1	X	0	0	Inhibit
0	X	0	0	X	1	One Shot
X	0	0	X	0	1	One Shot
1	1	1	X	0	1	One Shot
1	1	1	0	X	1	One Shot
X	0	0	X	1	0	Inhibit
0	X	0	1	X	0	Inhibit
X	0	1	1	1	1	Inhibit
0	X	1	1	1	1	Inhibit
1	1	0	X	0	0	Inhibit
1	1	0	0	X	0	Inhibit

NOTES
1. t_n time before input transition
2. t_{n+1} time after input transition
3. X indicates that either a logical 0 or 1 may be present
4. NC No Internal Connection
5. A1 and A2 are negative-edge-triggered logic inputs, and will trigger the one snot when either or both go to logical 0 with B at logical 1
6. B is a positive Schmitt-trigger input for slow edges or level detection, and will trigger the one shot when B goes to logical 1 with either A1 or A2 at logical 0. (See Truth Table)
7. External timing capacitor may be connected between pin 10 (positive) and pin 11. With no external capacitance, an output pulse width of typically 30 ns is obtained.
8. To use the internal resistor (2 kΩ nominal), connect pin 9 to pin 14.
9. To obtain variable pulse width connect external variable resistance between pin 9 and pin 14. No external current limiting is needed.
10. For accurate repeatable pulse widths connect an external resistor between pin 11 and pin 14 with pin 9 open circuit.

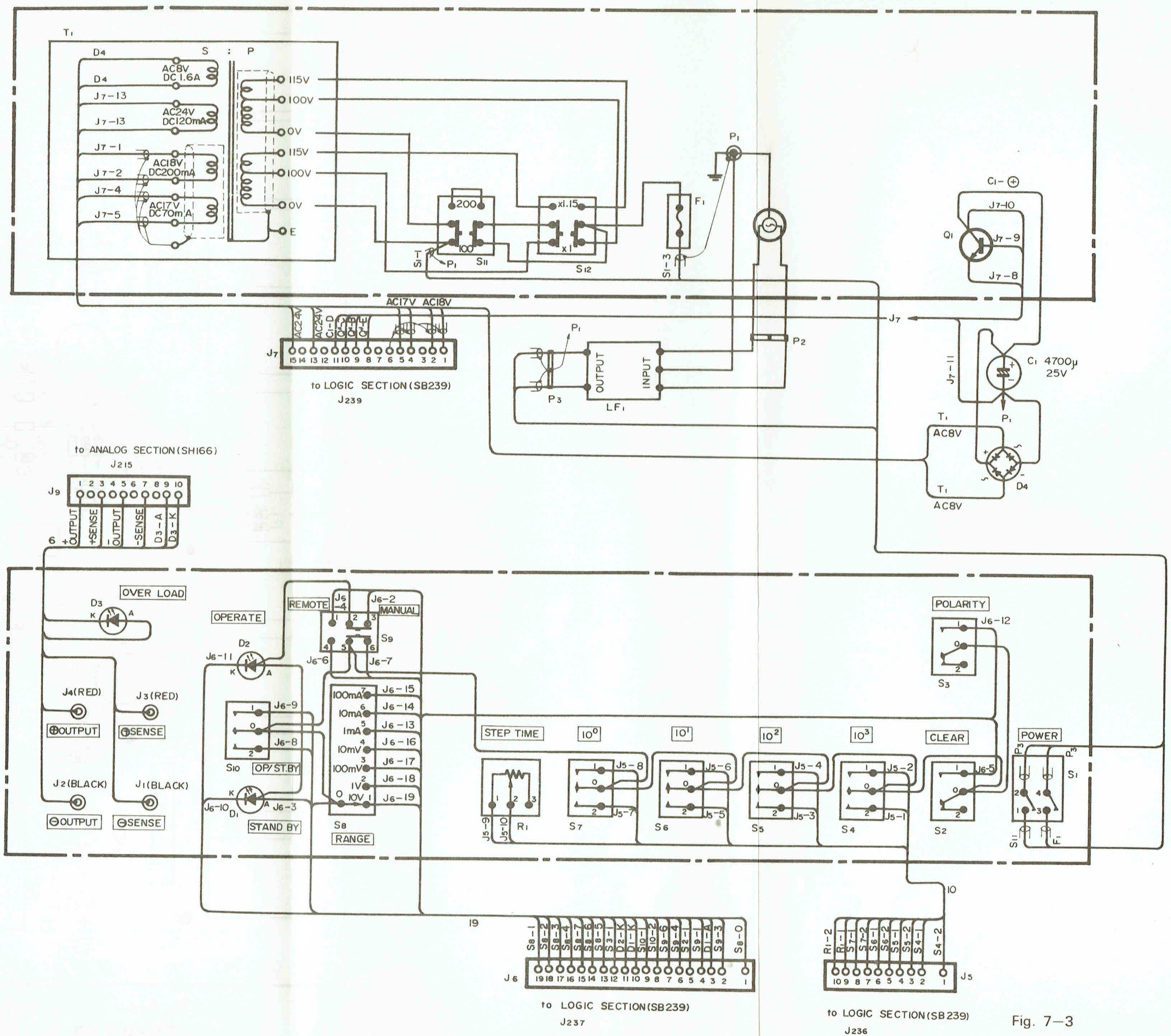


positive logic: see truth table and notes 5 and 6

SN74192N, SN74193N
SYNCHRONOUS 4-BIT UP/DOWN COUNTERS (DUAL CLOCK WITH CLEAR)



logic: Low input to load sets $Q_A = A$, $Q_B = B$, $Q_C = C$, and $Q_D = D$



0540502—003A

Fig. 7–3

-TR-6141
SCHEMATIC SECTION

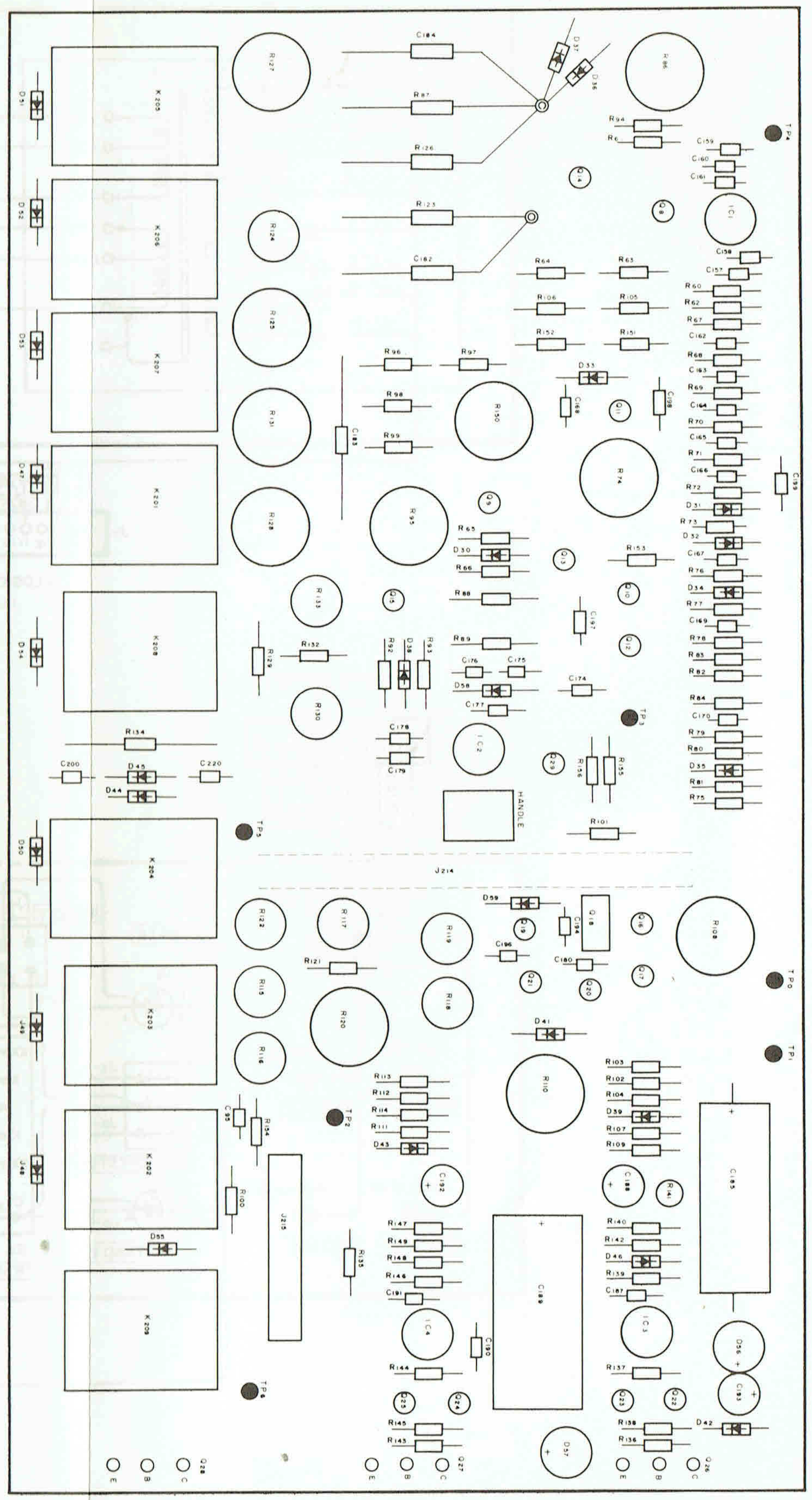
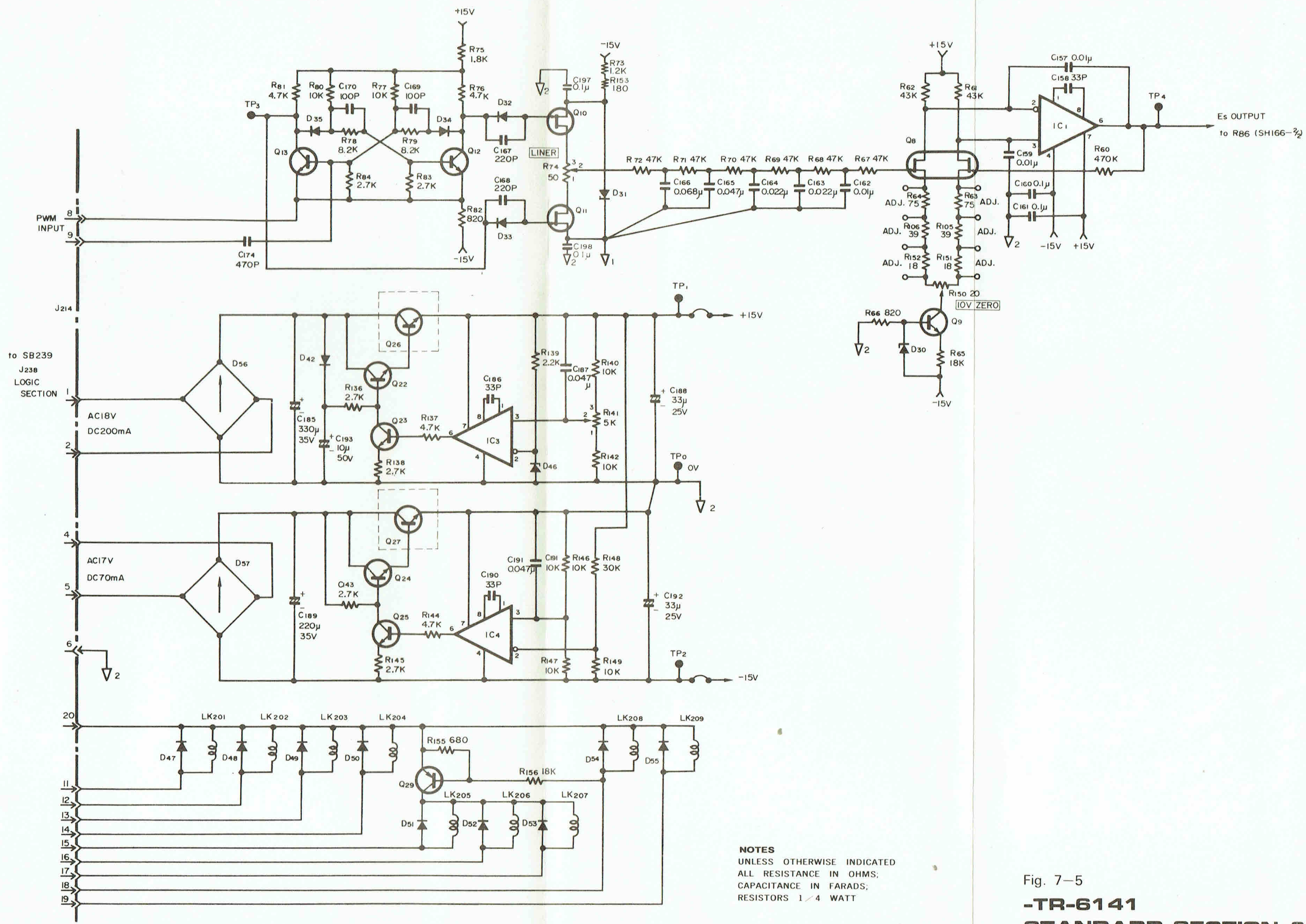


Fig. 7–4

-TR-6141

PRINTED CIRCUIT BOARD "SH166"

COMPONENT IDENTIFICATION

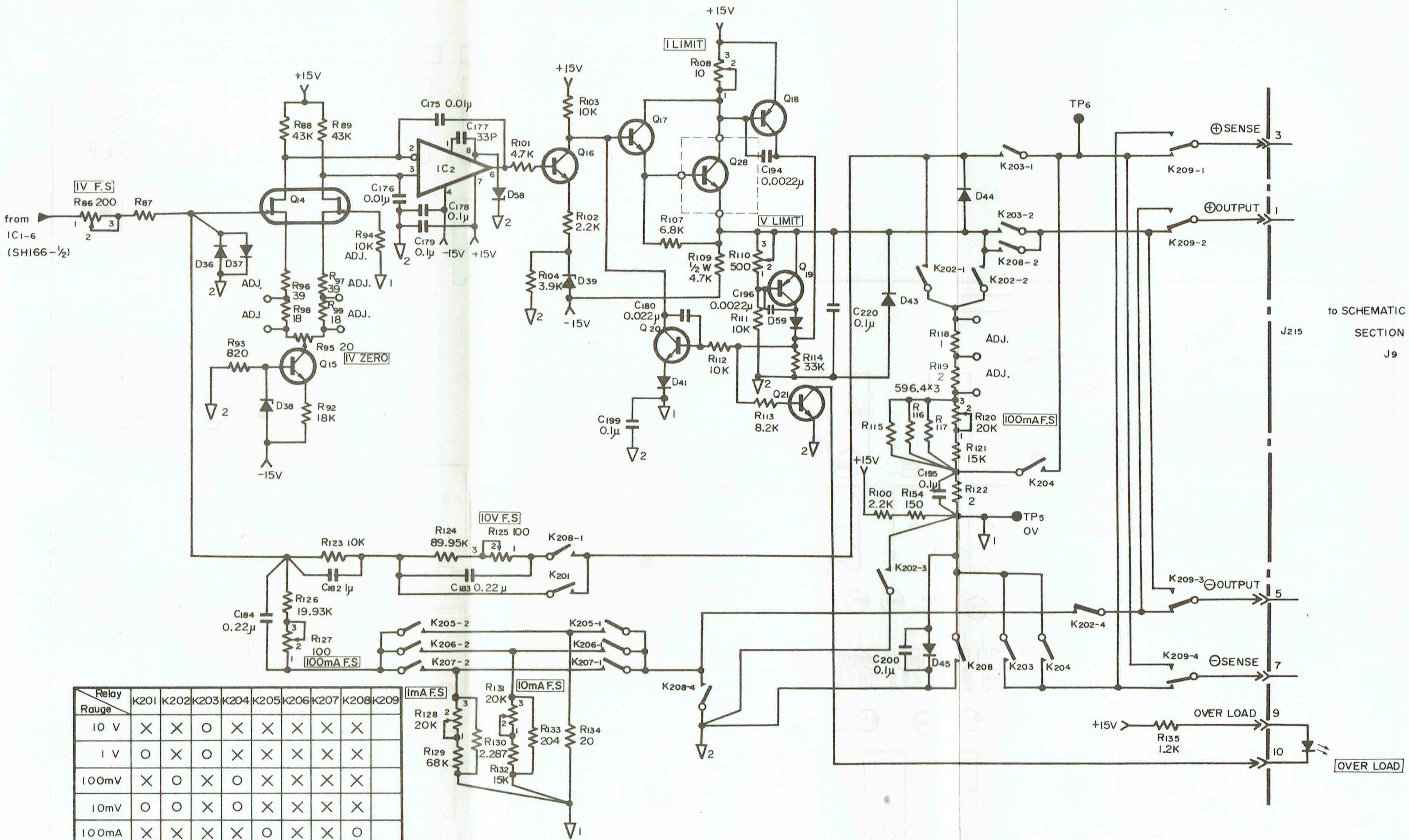


0540502-004 B

NOTES
UNLESS OTHERWISE INDICATED
ALL RESISTANCE IN OHMS;
CAPACITANCE IN FARADS;
RESISTORS 1/4 WATT

Fig. 7—5

-TR-6141
STANDARD SECTION &
POWER SUPPLY SECTION
SH166—1/2



Relay / Rauge	K201	K202	K203	K204	K205	K206	K207	K208	K209
10 V	X	X	O	X	X	X	X	X	
1 V	O	X	O	X	X	X	X	X	
100mV	X	O	X	O	X	X	X	X	
10mV	O	O	X	O	X	X	X	X	
100mA	X	X	X	X	O	X	X	O	
10mA	X	X	X	X	X	O	X	O	
1mA	X	X	X	X	X	X	O	O	
POL (−)									O

O mark : Active state   X mark : Non-active state
When set to STAND BY , the parts of O mark
at K203, K204 and K208 change X mark(non-active).

NOTES
UNLESS OTHERWISE INDICATED
ALL RESISTANCE IN OHMS;
CAPACITANCE IN FARADS;
RESISTORS 1/4 WATT

Fig. 7—6
-TR-6141
AMPLIFIER
SH166—2/2

0540502—005A

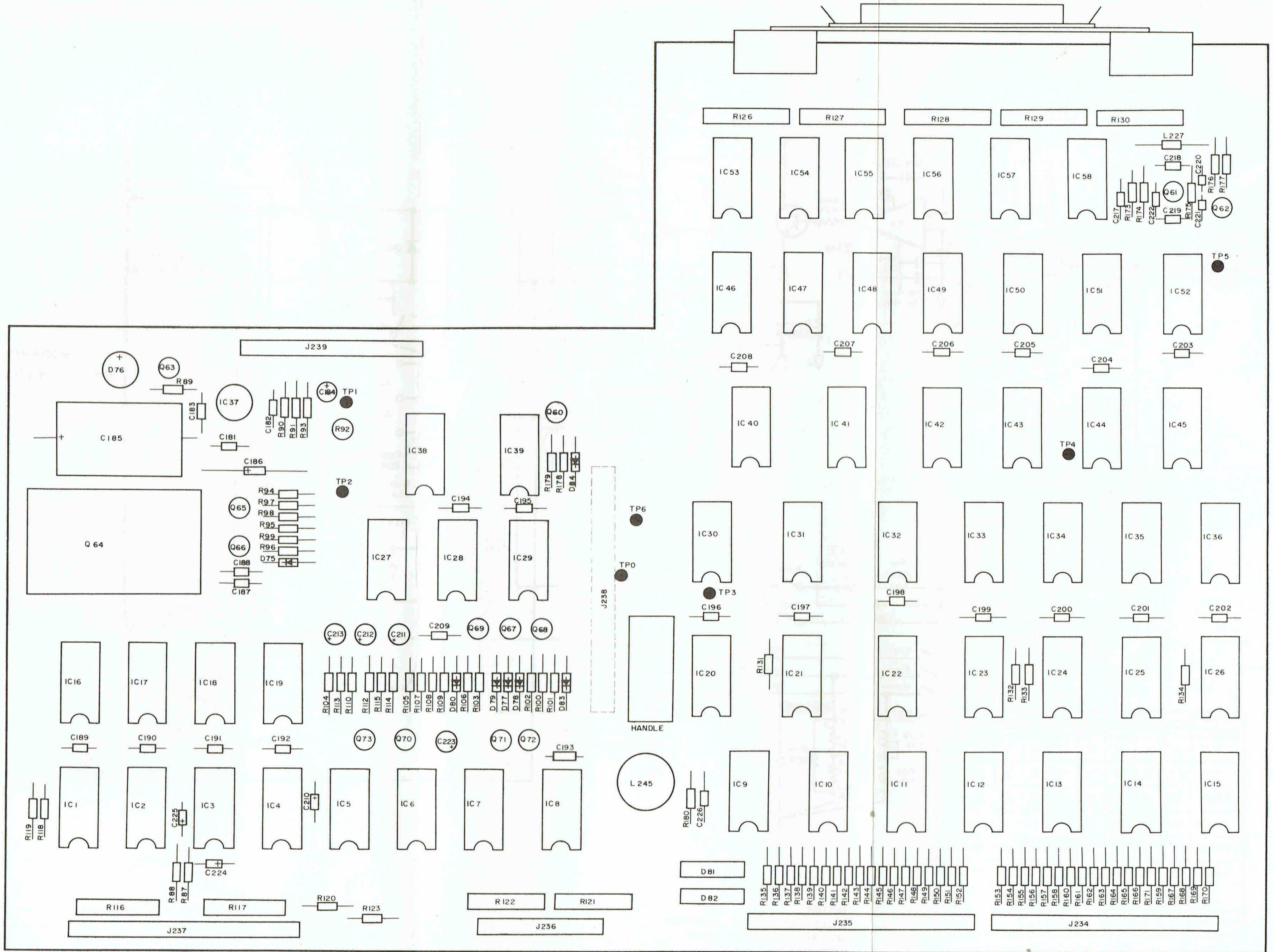
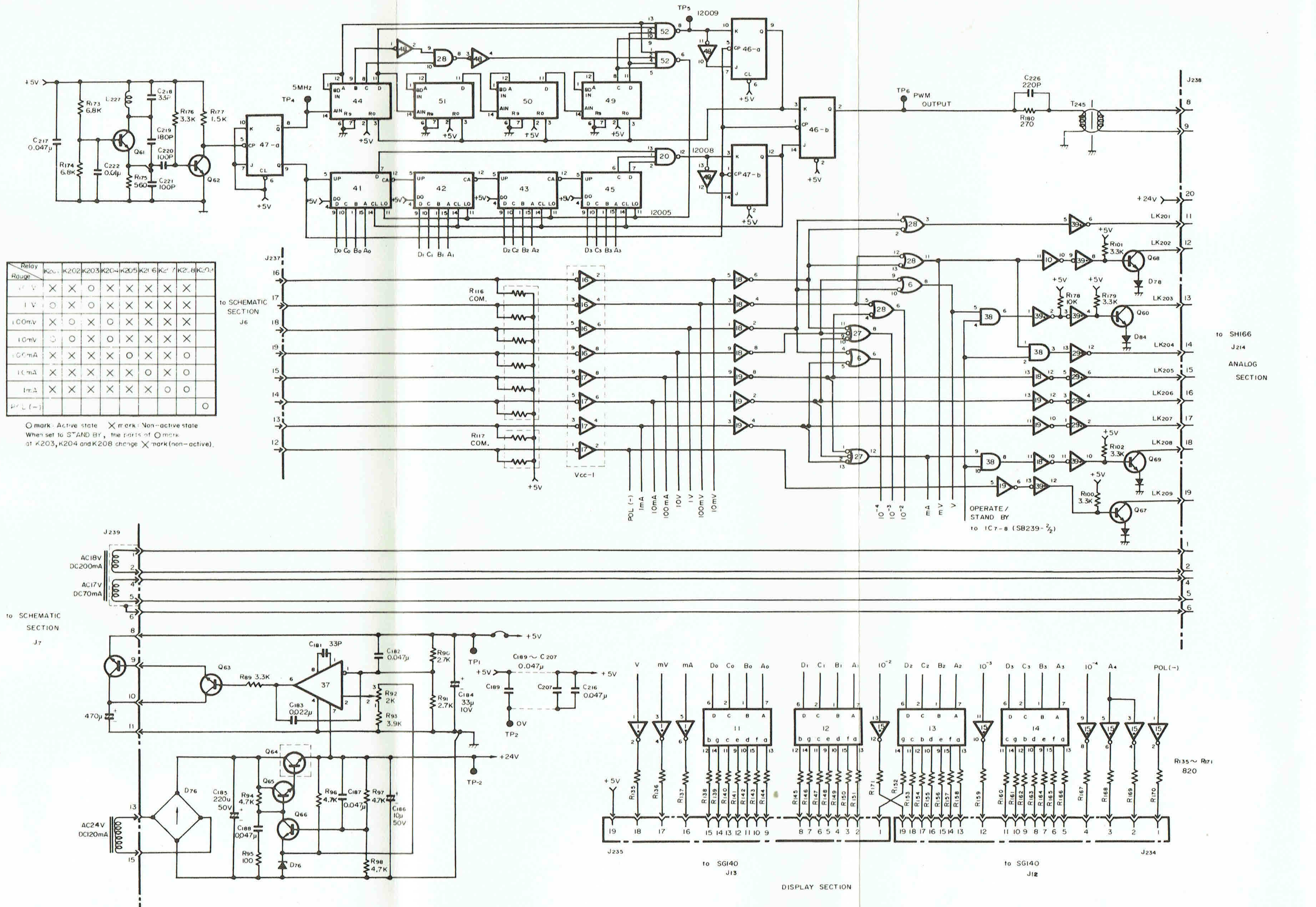


Fig. 7—7

-TR-6141

PRINTED CIRCUIT BOARD "SB239" COMPONENT IDENTIFICATION



Relay / Rouge	K201	K202	K203	K204	K205	K206	K207	K208	K209
10 V	×	×	○	×	×	×	×	×	
1 V	○	×	○	×	×	×	×	×	
100mV	×	○	×	○	×	×	×	×	
10mV	○	○	×	○	×	×	×	×	
100mA	×	×	×	×	○	×	×	○	
10mA	×	×	×	×	×	○	×	○	
1mA	×	×	×	×	×	×	○	○	
POL (−)									○

○ mark: Active state × mark: Non-active state
When set to STAND BY, the parts of ○ mark at K203, K204 and K208 change × mark (non-active).

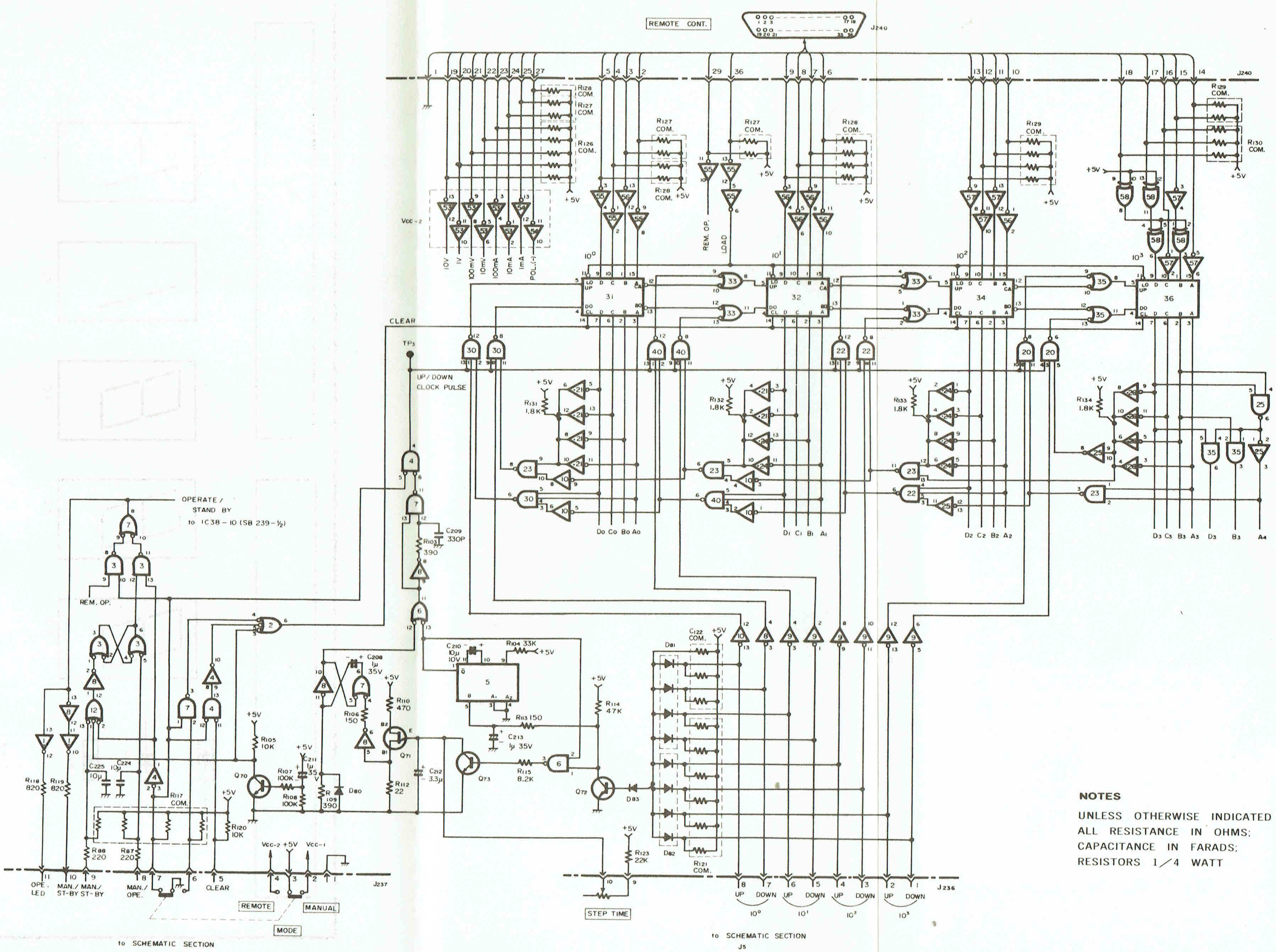
NOTES

UNLESS OTHERWISE INDICATED
ALL RESISTANCE IN OHMS;
CAPACITANCE IN FARADS;
RESISTORS 1/4 WATT

054[illegible]

Fig. 7–8

-TR-6141
LOGIC SECTION
SB239−1/2



NOTES

UNLESS OTHERWISE INDICATED
ALL RESISTANCE IN OHMS;
CAPACITANCE IN FARADS;
RESISTORS 1/4 WATT

0540502 – 007A

Fig. 7–9

-TR-6141
LOGIC SECTION
SB239 – 2/2

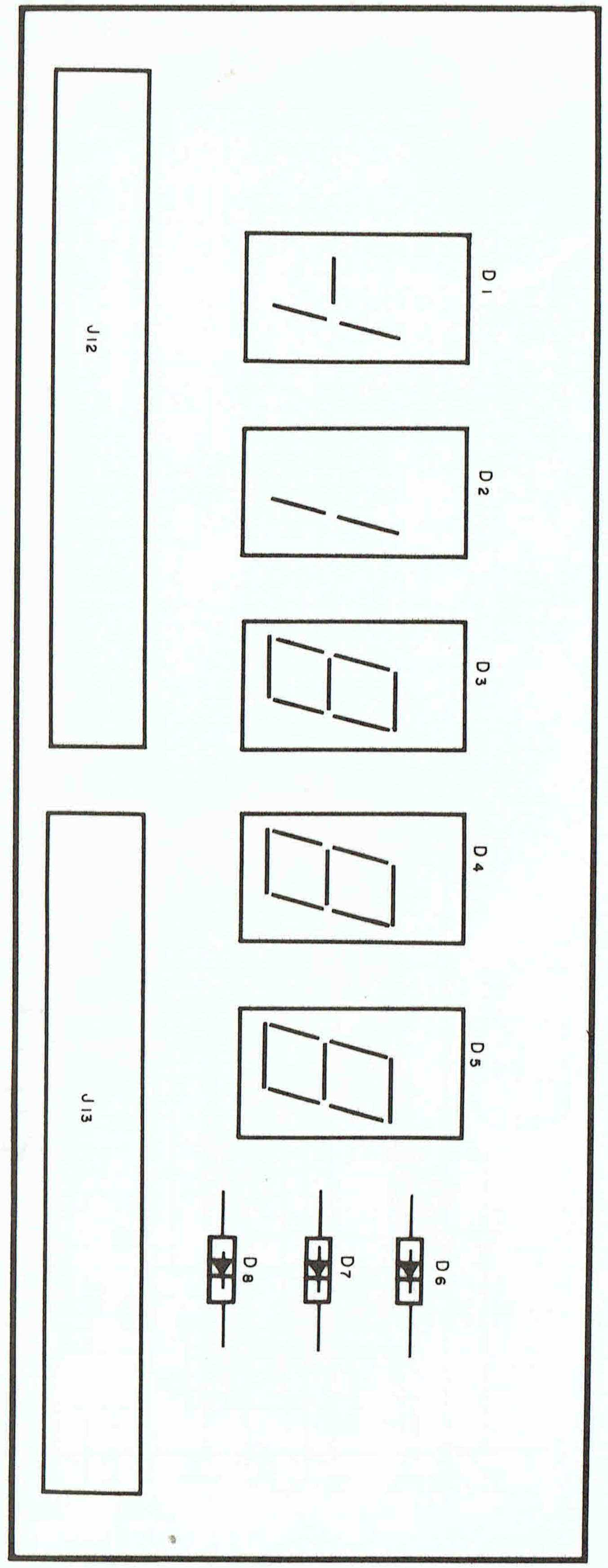


Fig. 7—10

-TR-6141

PRINTED CIRCUIT BOARD "SG140"

COMPONENT IDENTIFICATION

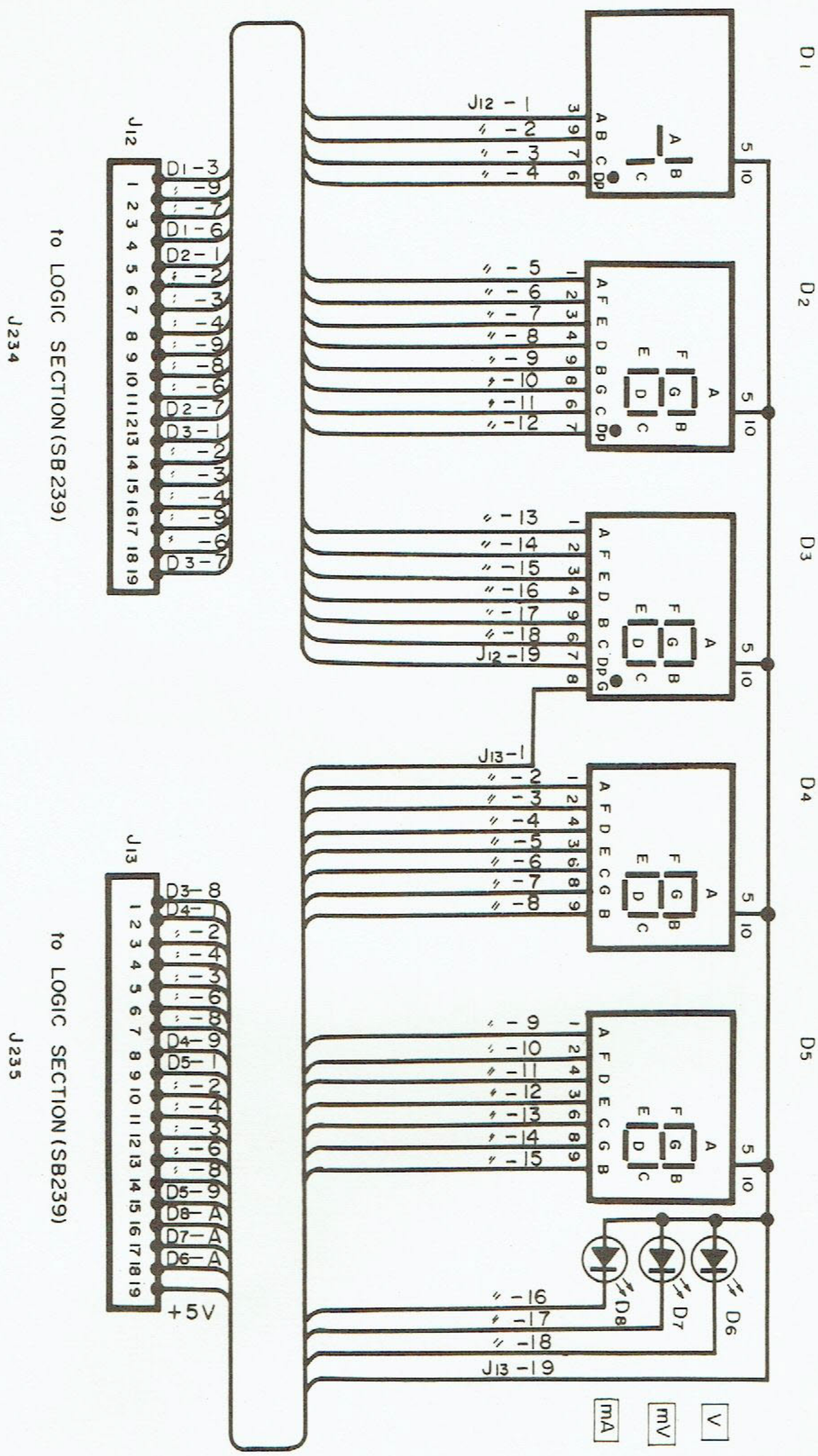


Fig. 7–11

-TR-6141
DISPLAY SECTION
SG140