ADVANTEST®
ADVANTEST CORPORATION

INSTRUCTION MANUAL
TR6142
Programmable DC Voltage Current Generator

MANUAL NUMBER EF00 9006

This product has been discontinued.
The Operation Manual is provided by ADC Corporation under the agreement with Advantest Corporation.

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Safety Summary

To ensure thorough understanding of all functions and to ensure efficient use of this instrument, please read the manual carefully before using. Note that ADC Corporation (hereafter referred to as ADC) bears absolutely no responsibility for the result of operations caused due to incorrect or inappropriate use of this instrument.

If the equipment is used in a manner not specified by ADC, the protection provided by the equipment may be impaired.

• Warning Labels

Warning labels are applied to ADC products in locations where specific dangers exist. Pay careful attention to these labels during handling. Do not remove or tear these labels. If you have any questions regarding warning labels, please ask your nearest ADC dealer. Our address and phone number are listed at the end of this manual.

Symbols of those warning labels are shown below together with their meaning.

DANGER: Indicates an imminently hazardous situation which will result in death or serious personal injury.

WARNING: Indicates a potentially hazardous situation which will result in death or serious personal injury.

CAUTION: Indicates a potentially hazardous situation which will result in personal injury or a damage to property including the product.

• Basic Precautions

Please observe the following precautions to prevent fire, burn, electric shock, and personal injury.

- Use a power cable rated for the voltage in question. Be sure however to use a power cable conforming to safety standards of your nation when using a product overseas.
- When inserting the plug into the electrical outlet, first turn the power switch OFF and then insert the plug as far as it will go.
- When removing the plug from the electrical outlet, first turn the power switch OFF and then pull it out by gripping the plug. Do not pull on the power cable itself. Make sure your hands are dry at this time.
- Before turning on the power, be sure to check that the supply voltage matches the voltage requirements of the instrument.
- Connect the power cable to a power outlet that is connected to a protected ground terminal. Grounding will be defeated if you use an extension cord which does not include a protective conductor terminal.
- Be sure to use fuses rated for the voltage in question.
- Do not use this instrument with the case open.
- Do not place anything on the product and do not apply excessive pressure to the product. Also, do not place flower pots or other containers containing liquid such as chemicals near this

product.

- When the product has ventilation outlets, do not stick or drop metal or easily flammable objects into the ventilation outlets.
- When using the product on a cart, fix it with belts to avoid its drop.
- When connecting the product to peripheral equipment, turn the power off.

- **Caution Symbols Used Within this Manual**

Symbols indicating items requiring caution which are used in this manual are shown below together with their meaning.

DANGER: Indicates an item where there is a danger of serious personal injury (death or serious injury).

WARNING: Indicates an item relating to personal safety or health.

CAUTION: Indicates an item relating to possible damage to the product or instrument or relating to a restriction on operation.

- **Safety Marks on the Product**

The following safety marks can be found on ADC products.

⚠ : ATTENTION - Refer to manual.

⏚ : Protective ground (earth) terminal.

ϟ : DANGER - High voltage.

⚡ : CAUTION - Risk of electric shock.

- **Replacing Parts with Limited Life**

The following parts used in the instrument are main parts with limited life.
Replace the parts listed below before their expected lifespan has expired to maintain the performance and function of the instrument.
Note that the estimated lifespan for the parts listed below may be shortened by factors such as the environment where the instrument is stored or used, and how often the instrument is used.
The parts inside are not user-replaceable. For a part replacement, please contact the ADC sales office for servicing.

Each product may use parts with limited life.
For more information, refer to the section in this document where the parts with limited life are described.

Main Parts with Limited Life

Part name	Life
Unit power supply	5 years
Fan motor	5 years
Electrolytic capacitor	5 years
LCD display	6 years
LCD backlight	2.5 years
Floppy disk drive	5 years
Memory backup battery	5 years

- **Hard Disk Mounted Products**

The operational warnings are listed below.

- Do not move, shock and vibrate the product while the power is turned on.
  Reading or writing data in the hard disk unit is performed with the memory disk turning at a high speed. It is a very delicate process.

- Store and operate the products under the following environmental conditions.
  An area with no sudden temperature changes.
  An area away from shock or vibrations.
  An area free from moisture, dirt, or dust.
  An area away from magnets or an instrument which generates a magnetic field.

- Make back-ups of important data.
  The data stored in the disk may become damaged if the product is mishandled. The hard disc has a limited life span which depends on the operational conditions. Note that there is no guarantee for any loss of data.

- **Precautions when Disposing of this Instrument**

When disposing of harmful substances, be sure dispose of them properly with abiding by the state-provided law.

Harmful substances: (1) PCB (polycarbon biphenyl)
(2) Mercury
(3) Ni-Cd (nickel cadmium)
(4) Other
Items possessing cyan, organic phosphorous and hexadic chromium and items which may leak cadmium or arsenic (excluding lead in solder).

Example: fluorescent tubes, batteries

Environmental Conditions

This instrument should be only be used in an area which satisfies the following conditions:

- An area free from corrosive gas
- An area away from direct sunlight
- A dust-free area
- An area free from vibrations
- Altitude of up to 2000 m

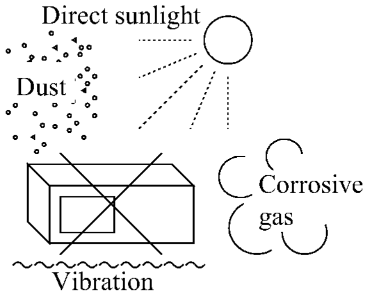
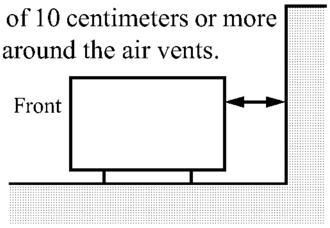


Figure-1 Environmental Conditions

- Operating position

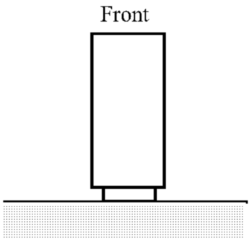
A clear space of 10 centimeters or more must be kept around the air vents.



The instrument must be used in a horizontal position.
To prevent the internal temperature from rising, cooling fans are installed in some instruments.
The air vents on the case must be unblocked.

Figure-2 Operating Position

- Storage position



This instrument should be stored in a horizontal position.
When placed in a vertical (upright) position for storage or transportation, ensure the instrument is stable and secure.

-Ensure the instrument is stable.
-Pay special attention not to fall.

Figure-3 Storage Position

- The classification of the transient over-voltage, which exists typically in the main power supply, and the pollution degree is defined by IEC61010-1 and described below.

  Impulse withstand voltage (over-voltage) category II defined by IEC60364-4-443

  Pollution Degree 2

Types of Power Cable

Replace any references to the power cable type, according to the following table, with the appropriate power cable type for your country.

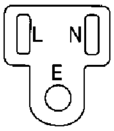
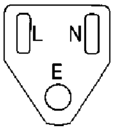
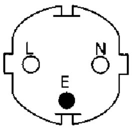
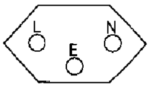
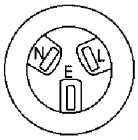
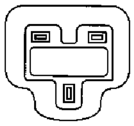
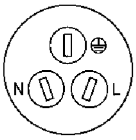
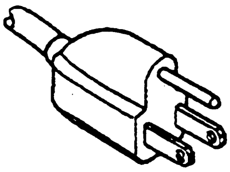
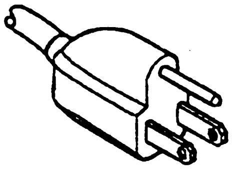
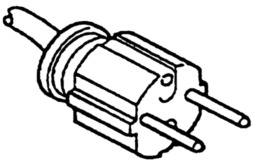
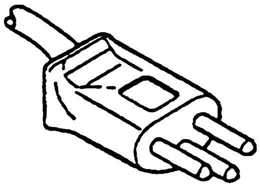
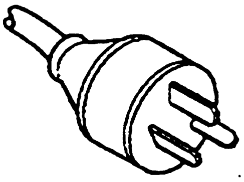
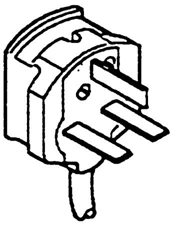
Plug configuration	Standards	Rating, color and length	Model number (Option number)
	PSE: Japan Electrical Appliance and Material Safety Law	125 V at 7 A Black 2 m (6 ft)	Straight: A01402 Angled: A01412
	UL: United States of America CSA: Canada	125 V at 7 A Black 2 m (6 ft)	Straight: A01403 (Option 95) Angled: A01413
	CEE: Europe DEMKO: Denmark NEMKO: Norway VDE: Germany KEMA: The Netherlands CEBEC: Belgium OVE: Austria FIMKO: Finland SEMKO: Sweden	250 V at 6 A Gray 2 m (6 ft)	Straight: A01404 (Option 96) Angled: A01414
	SEV: Switzerland	250 V at 6 A Gray 2 m (6 ft)	Straight: A01405 (Option 97) Angled: A01415
	SAA: Australia, New Zealand	250 V at 6 A Gray 2 m (6 ft)	Straight: A01406 (Option 98) Angled: ---------
	BS: United Kingdom	250 V at 6 A Black 2 m (6 ft)	Straight: A01407 (Option 99) Angled: A01417
	CCC:China	250 V at 10 A Black 2 m (6 ft)	Straight: A114009 (Option 94) Angled: A114109

Table of Power Cable options

There are six power cable options (refer to following table).
Order power cable options by Accessory Codes.

	Plug Configuration	Standards	Rationg, Color and Length	Accessory Codes (Option Number)
1		JIS: Japan Law on Electrical Appliances	125V at 7A Black 2m (6ft)	Straight: A01402 (Standard) Angled: A01412
2		UL: United States of America CSA: Canada	125V at 7A Black 2m (6ft)	Straight: A01403 (Option 95) Angled: A01413
3		CEE: Europe VDE: Germany OVE: Austria SEMKO: Sweden DEMKO: Denmark KEMA: Holland FIMKO: Finland NEMKO: Norway CEBEC: Belgium	250V at 6A Gray 2m (6ft)	Straight: A01404 (Option 96) Angled: A01414
4		SEV: Switzerland	250V at 6A Gray 2m (6ft)	Straight: A01405 (Option 97) Angled: A01415
5		SAA: Australia, New Zealand	250V at 6A Gray 2m (6ft)	Straight: A01406 (Option 98) Angled: ———
6		BS: United Kingdom	250V at 6A Black 2m (6ft)	Straight: A01407 (Option 99) Angled: A01417

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SECTION 1

GENERAL INFORMATION

1-1. GENERAL

Unlike conventional voltage generators of the resistance division type, the TR6142 Programmable DC Voltage/Current Generator employs a pulse width modulation (PWM) technique, which is well-known in the communication and magnetic recording fields, for voltage division based on the time division method.

Adoption of the time division method permits the TR6142 to output accurate DC voltage and current levels using digital techniques.

The TR6142 has BCD and GPIB remote control functions so it can be incorporated into larger systems as standard.

It also has an automatic scanning function for simple automated measurements in the stand-alone mode.

The TR6142 permits direct data setting using the ten numerical keys to make it easier to control. Data, once set, is held ever if the power is turned off. Furthermore, the TR6142 can be used as a versatile calibrator, a test power supply, or a line power supply by storing various parameters in the internal 160-channel memory.

1-2. FEATURES

(1) The resolution is 1 μV for DC voltages and 0.1 μA for DC currents. The output stability is high.

(2) A maximum of 160 output channels can be programmed in the internal memory. The stored contents are held ever if the power is turned off.

(3) A continuous function permits continuous variation of the output by simply pressing a numerical key for any digit.

(4) GPIB and parallel external control functions are provided as standard.

1-3. SPECIFICATIONS

The electrical performance and general specifications of the TR6142 are shown below.

1-3-1. Electrical Performance

Output range:

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

Total accuracy:

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

Note: The performance is guaranteed for six months for operation at a temperature of +23°C ±5°C with a relative humidity of 70% or less, and under constant power supply and load conditions.
The current range is guaranteed for positive polarity.
The range error is due to zero-point fluctuations.

Daily stability:

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

Note: The stability is guaranteed for operation at a temperature of +23°C ±5°C with a relative humidity of 70% or less, and under constant power supply and load conditions.
The current range is guaranteed for positive polarity.
The range error is due to zero-point fluctuations.

Temperature coefficient (per degree centigrade):

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

Note: The temperature coefficient is guaranteed for operation at temperatures between 0°C to and +40°C.
The current range is guaranteed for positive polarity.
The range error is due to zero-point fluctuations.

Noise:

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

Note: The current range is guaranteed for positive polarity.

Output impedance and maximum load:

Range	Output impedance	Maximum load
10 mV	Approx. 2 Ω	20 kΩ load or one whose error falls within ±0.01%
100 mV	Approx. 2 Ω	
1 V	0.4 mΩ or less	120 mA
10 V	4 mΩ or less	
1 mA	100 MΩ or more	10 V output follow-up voltage
10 mA		
100 mA		

1-3-2. General Specifications

Overload protection circuit:

An automatic-reset overload protection circuit is incorporated. The OVERLOAD lamp on the front panel comes on when an overload occurs (except when in the 10 mV and 100 mV ranges).

Current limiter : The current limiter can be set within the range of 5 mA to 120 mA by turning the CURRENT LIMIT knob.

Load regulation : ±0.005% of each range with the maximum load (excluding the 10 mV and 100 mV ranges)

Response time : The time required to be within 0.1% of the full-scale value for a variation from zero to the full-scale value ... up to 150 ms.

Warm-up time : Approx. 10 minutes (taken to satisfy the specified accuracy)

Dielectric strength:
500 Vdc between the output terminals and the chassis

Output : Floating system

Output voltage/current setting:
  Manual setting : Continuously variable setting for all digits by pushbuttom keys or direct value setting
  Remote setting : Possible by using GPIB or negative-logic parallel signals at TTL level

Internal memory : The internal memory can store a maximum of 160 channels of output voltage/current values set manually or by remote operation. A backup EEPROM is provided.

Scanning mode :
  Random scan : Channels are specified as desired.
  Step scan : The channel number is incremented by one each time the STEP key is pressed.
  Single scan : Channels are automatically scanned from the first to the last at step-time intervals. The scanning ends with the last channel.
  Repeat scan : Channels are scanned in the same way as the single scan, except that the scanning returns from the last channel to the first channel. The scanning continues until the STOP or HOLD key is pressed.

Step time : The step time can be set within the range of 0.1 to 10.0 s in 0.1 s steps.
(The setting range is from 0.2 to 10.0 s for automatic scanning.)

Ready output : The READY terminal on the rear panel outputs a negative-logic pulse at TTL level with a width of about 10 ms about 150 ms after setting has been completed (in the OPERATE state only).

Step input : In the step scan mode, the step input signal calls channels from the internal memory one at a time. In the single and repeat scan modes, it performs scanning hold/start operations.

Lock function release:
The step input signal is a negative-logic pulse at TTL level having a minimum width of 50 ms, which is applied to the EXT.STEP input terminal on the rear panel.

GPIB : Interface system conforming to the IEEE 488-1978 standard.
(A 24-pin connector of Amphenol-type is used.)

Interface functions: SH1, AH1, T6, L3, RL2, PP0, DC1, DT1, C0, and E1

Talker specifying function:
Output of the panel set value

BCD control : Output level, polarity, range, operate/standby
(A 36-pin connector of Amphenol-type is used.)

Indicators : Seven-segment LED indicators which are each 10 mm by 6mm.

Operational environment:
Temperature : 0°C to +40°C
Relative humidity: 85% or less

Storage temperature:
-25°C to +70°C

Power requirements: 100 Vac ±10%, 50/60 Hz
(120, 200, 220 Vac ±10%, and 240 Vac $^{+4}_{-10}$% power supplies are also available.)
Power consumption is approx. 25 VA for maximum load.

External dimensions:
Approx. 240(W) x 88(H) x 360(D) mm

Weight : Approx. 5 kg

Accessories	: A02017	Panel mount kit
	A02621J	Rack mount kit (JIS)
	A02621	Rack mount kit (EIA)

1-4. ACCESSORIES SUPPLIED

(1)	Power cable (MP-43)	1
(2)	Fuse (EAWK0.315A or EAWK0.16A)	2
(3)	Instruction manual	1

MEMO

SECTION 2

OPERATING PROCEDURE

2-1. INSPECTION

Upon receiving the TR6142, unpack it and check for any damage sustained in transit.
If damage is discovered or if the operations do not conform to the specifications, notify your nearest ADVANTEST representative.

2-2. STORAGE

If the TR6142 is not going to be operated for a long period of time, pack it in a vinyl sack or a cardboard box and store it in a place with low humidity and away from the direct sunlight.
The allowable storage temperature range is from $-25^{\circ}C$ to $+70^{\circ}C$.
It is advisable to keep the cardboard box and packing materials in which the TR6142 was first delivered, for possible later use for storage or transfer to another location.

2-3. PREPARATIONS AND PRECAUTIONS BEFORE USE

(1) Power voltage

Check the power voltage designation above the power cable connector outlet on the rear panel.
The fuse rating differs according to the power voltage as follows:

- 100 Vac ±10%, 120 Vac ±10% .....
  0.315A slow blow (stock no. EAWK0.315A)
- 200 Vac ±10%, 220 Vac ±10%, 240 Vac $^{+4}_{-10}$% .....
  0.16A slow blow (stock no. EAWk0.16A)

(2) Power cable

The power cable of the TR6142 has a three-prong plug.
The round prong in the center is a ground prong which grounds the chassis when the plug is inserted into a three-prong AC receptacle.

When using a two-prong adapter to connect the cable to the AC receptacle, ground the ground lead of the adapter or the GND terminal on the rear panel (see Figure 2-1). Note that a two-prong adapter cannot be used for a power voltage exceeding 125 Vac.

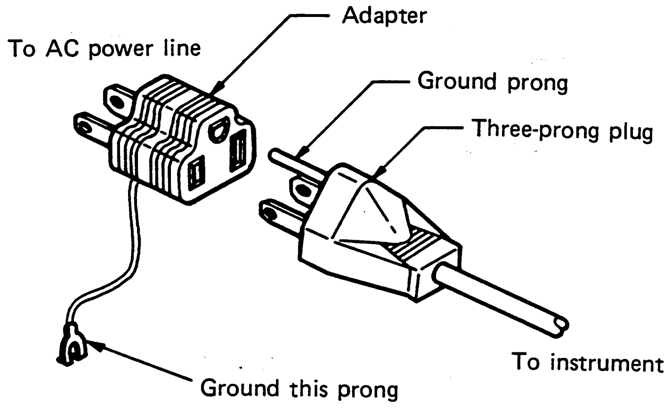


Fig. 2-1 Power cable

(3) Warm-up time
After setting the POWER switch to ON and switching the OPERATE/STANDBY key to STANDBY, leave the instrument to warm up for 10 minutes or more so that the accuracy shown in Section 1-3 can be obtained.

(4) Operating environment
Use the TR6142 in a place free from the direct sunlight, at a temperature between 0°C and +40°C, and at a relative humidity not exceeding 85%.
Do not place the TR6142 on a device that generates heat since it is not provided with a cooling fan.

(5) Handle the instrument carefully without bumping or knocking it too hard.

2-4. "OPERATE/STANDBY" FUNCTIONS

The OPERATE/STANDBY key provided on the front panel of the TR6142 has the following functions:

(1) Procedures to place the TR6142 in the STANDBY state

① Turn the power on.

② Set the instrument to the STANDBY state.

- a. MANUAL mode (REMOTE lamp off)
  Press the OPERATE/STANDBY key when the instrument is in the OPERATE state (when the OPERATE lamp is on).
- b. BCD REMOTE mode
  Apply a +5 V (logical 0) signal to the OPERATE terminal (pin 29) of the BCD REMOTE connector.
- c. GPIB REMOTE mode
  Input an H, C, DCL, or SDC command.
- d. Switch from the voltage range to the current range and vice versa when the instrument is in the OPERATE state.

The instrument outputs the set voltage or current to the output terminals when its operating state is changed from STANDBY to OPERATE.

(2) Procedures for changing from the STANDBY to OPERATE state in each mode

① MANUAL mode (REMOTE lamp off)
Press the OPERATE/STANDBY key when the instrument is in the STANDBY state (when the STANDBY lamp is on).

② BCD REMOTE mode
Apply a 0 V (logical 1) signal to the OPERATE terminal (pin 29) of the BCD REMOTE connector.

③ GPIB REMOTE mode
Input an E or GET command.

NOTE

Do not place the instrument in the OPERATE state when using the current output range without connecting a load to the output terminals, because a voltage of 10 V to 13 V will present at the output terminals.

2-5. RANGE SWITCHING NOISE

Switching the range in the OPERATE state will cause a switching noise due to the relay operation in the circuit. Therefore, use the instrument in the same range when there is a possibility of damaging the load with the switching noise.

2-6. SETTLING TIME

The time required for the instrument to reach the final value of a certain set voltage (or current) after the setting is made is called the settling time (or response time).
The TR6142 is designed to take less than 150 ms to be within 0.1% of the full-scale value for a variation from zero to the full-scale value.
Give careful consideration to the settling time when using the remote control functions of the instrument or when using a high-speed D/A converter.
Figure 2-2 shows the settling time for a variation in any range from zero to the full-scale value or from a certain value to another by 1/10 of the full-scale value.
The horizontal and vertical axes in this figure represent time and percentage of variation, respectively.

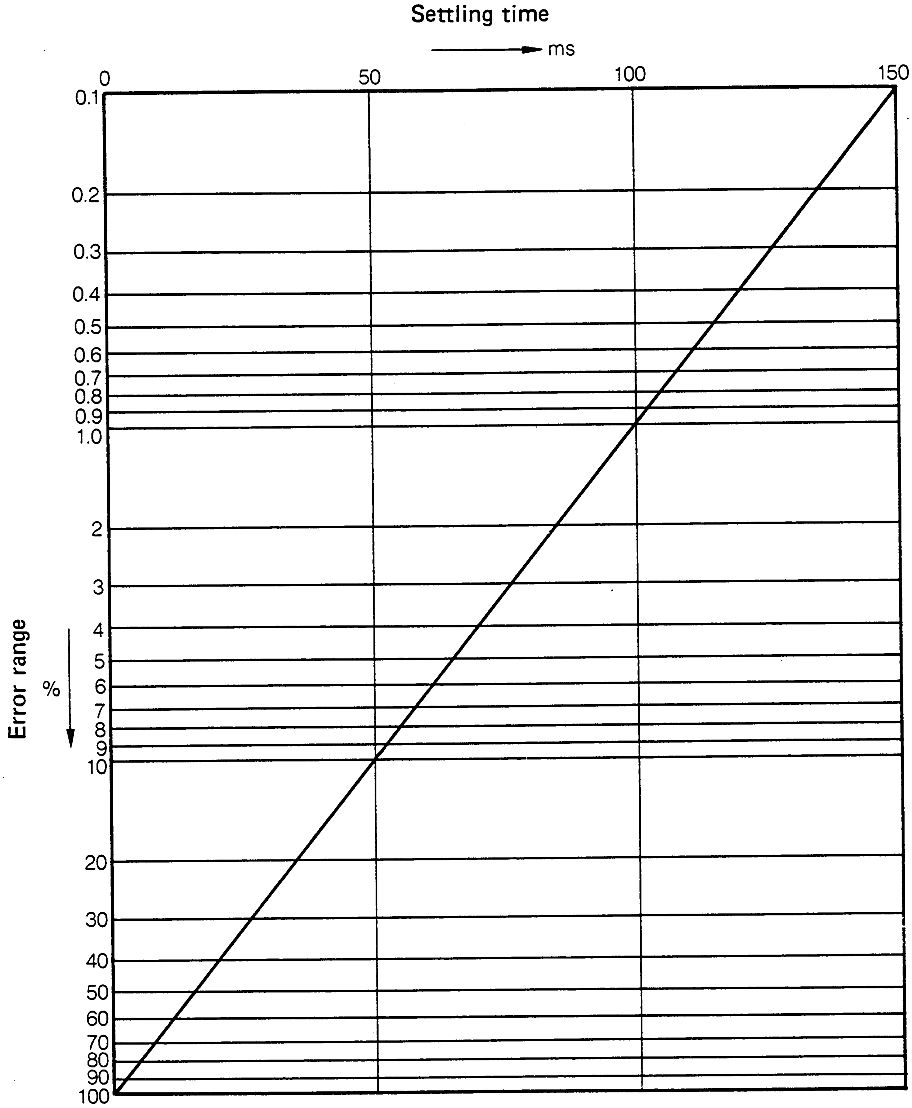


Fig. 2-2 Settling time

2-7. OVERLOAD PROTECTION

The overload protection circuit in the TR6142 activates when the maximum load current (adjustable) flows in the voltage range or the maximum output follow-up voltage is produced in the current range. This circuit then limits the output and the OVERLOAD lamp comes on.
Table 2-1 lists the maximum load values for the operation of the overload protection circuit.

NOTE

The overload protection circuit does not activate in the 10mV and 100mV ranges of the voltage range.

Table 2-1 Maximum load to activate the overload protection circuit

Range	Maximum load
10 mV	The overload protection circuit does not activate.
100 mV	
1 V	Approx. 5 mA to 120 mA
10 V	Approx. 5 mA to 120 mA
1 mA	Approx. 10 V
10 mA	
100 mA	

WARNING

Do not apply a voltage or current exceeding the maximum load value to the output terminals since it will damage the TR6142.

NOTE

The output of the TR6142 does not satisfy the specifications when the OVERLOAD lamp comes on.
Therefore, in this case, immediately disconnect and check the load.

2-8. PANEL DESCRIPTIONS

Figure 2-3 shows the front and rear panels. Panel descriptions are given below in the encircled number order.

-- Front panel --

① POWER switch

This switch is used to supply the power to the instrument.
Pressing this switch down sets it to ON, supplying the power to the entire circuit, lighting the STANDBY lamp, and placing the instrument in the STANDBY state.
Setting this switch to OFF turns the power off.

② Numerical △▽ keys (Numerical keys)

These keys are used to set the output level.
Pressing any key on the △ side (upper row) increments the indicator digit corresponding to that key. Pressing any key on the ▽ side (lower row) decrements the indicator digit.
These keys are also used for direct setting of numerical values and setting of channels, step time, and output modes in combination with the DATA, MEM, and STEP keys.

③ Range setting keys (Numerical keys)

These keys are used to set the output level range.
Pressing the key on the △ side increments the range one step.
Pressing the key on the ▽ side decrements the range one step. (Use the V, mV, and mA keys for voltage and current range switching.)

④ MEM (Memory) key

This key is used to retrieve the memory contents and to program them (call mode). It is also used to stop automatic scanning.

⑤ DATA key

This key is used to enable direct setting of the output level with the numerical keys. A desired output level can be set by pressing the DATA key and then pressing the appropriate numerical keys.

⑥ STEP key

This key is used to set the step time. Pressing the STEP key causes the instrument to present the currently set step time in the indicator. The user can then change the step time using the numerical keys.
This key can be used also to set the decimal point, to increment the channel number, and to start and temporally halt the automatic scanning in combination with the DATA and MEM keys.

⑦ V, mV, and mA keys

These keys are used to set the unit of the voltage or current range after the output level has been set with the numerical keys.

Pressing each of these keys alone selects the range as follows:

V ... 1 V range
mV ... 10 mV range
mA ... 1 mA range

These keys are also used to specify the first channel, last channel, and scan mode, respectively.

⑧ SENSE switch

Setting this switch to INT (▨) position internally short-circuits the OUTPUT and SENSE terminals, so that a two-terminal connection can be made. Set this switch to INT when the load current is low or when the voltage loss in the power cable is small.

Setting this switch to EXT (▨) position opens the circuit between the OUTPUT and SENSE terminals, so that a four-terminal connection can be made.

⑨ CURRENT LIMIT knob

This knob is used for current limiting adjustments.

Turning this knob clockwise increases the current limit. The adjustable range is from approx. 5 mA to 120 mA.

NOTE

Since the attenuator is internally connected, the knob must be set to approx. 60mA at the 100mV range and 10mV range.

⑩ SENSE terminals

These terminals are used for the voltage output.

For normal operations, set the SENSE switch to INT to internally short-circuit these terminals to the OUTPUT terminals.

When the TR6142 is to be connected to a load located at some distance away, set the SENSE switch to EXT and make a four-terminal connection.

⑪ OUTPUT terminals

These terminals are used for the current output.
For normal operations, set the SENSE switch to INT to internally short-circuit these terminals to the SENSE terminals.
When the TR6142 is to be connected to a load located at some distance away, set the SENSE switch to EXT and make a four-terminal connection.

⑫ OVERLOAD lamp

This is an overload indicator lamp. When this lamp comes on, immediately disconnect and check the load.

⑬ Indicators

The indicators indicate the set output level, polarity, and range.
The polarity indication is given for negative polarity only.
Three LEDs on the right hand side are provided to indicate each of the units V, mV, and mA.

⑭ POLARITY keys

These keys are used to set the polarity of the output level.
Pressing the 0 key clears the setting values.

⑮ OPERATE/STANDBY key

This key is used for output control.
When the STANDBY lamp is on, pressing this key lights the OPERATE lamp and transfers the set output level to the output terminals.
When the OPERATE lamp is on, pressing this key lights the STANDBY lamp and opens the circuit between the output terminals.

⑯ REMOTE lamp

This lamp lights when the instrument is operated not from the front panel but according to control signals from an external controller. When this lamp is on, the instrument cannot be operated with the key switches on the front panel.

⑰ LOCAL key

When the instrument is in the remote control mode (REMOTE lamp is on), pressing this key clears external control and enables setting from the front panel. The instrument is placed in the local control mode at power-on time (GPIB REMOTE settings).

⑱ SRQ lamp

This lamp indicates that the instrument is issuing a service request to the controller.

⑲ LISTEN lamp

This lamp indicates that the instrument is in the listener mode and ready to receive data.

-- Rear panel --

⑳ GPIB connector

This is a 24-pin connector for an IEEE 488 bus.

This is a piggyback connector permitting stacked connections of standard bus cables, but do not stack more than two connectors.

㉑ GND terminal

This terminal is used to ground the TR6142 chassis. When using a two-prong adapter to connect the power cable to an AC power receptacle, ground either the lead of the two-prong adapter or the GND terminal.

㉒ Power connector

This is a connector for the AC power cable. The AC power voltage is normally set to 100 Vac ±10%.

Connect the power connector to an AC power receptacle using the power cable (MP-43) supplied with this instrument.

㉓ BCD REMOTE connector

Remote control signals are applied to this connector when bit 7 of the address switch on the rear panel is set to BCD REMOTE and the LOCAL switch is pressed to place the instrument in the BCD REMOTE mode (REMOTE lamp comes on.).

㉔ EXT. STEP input terminal

This connector is used to receive signals to start step and automatic scanning operations and to stop continuous data setting operations.

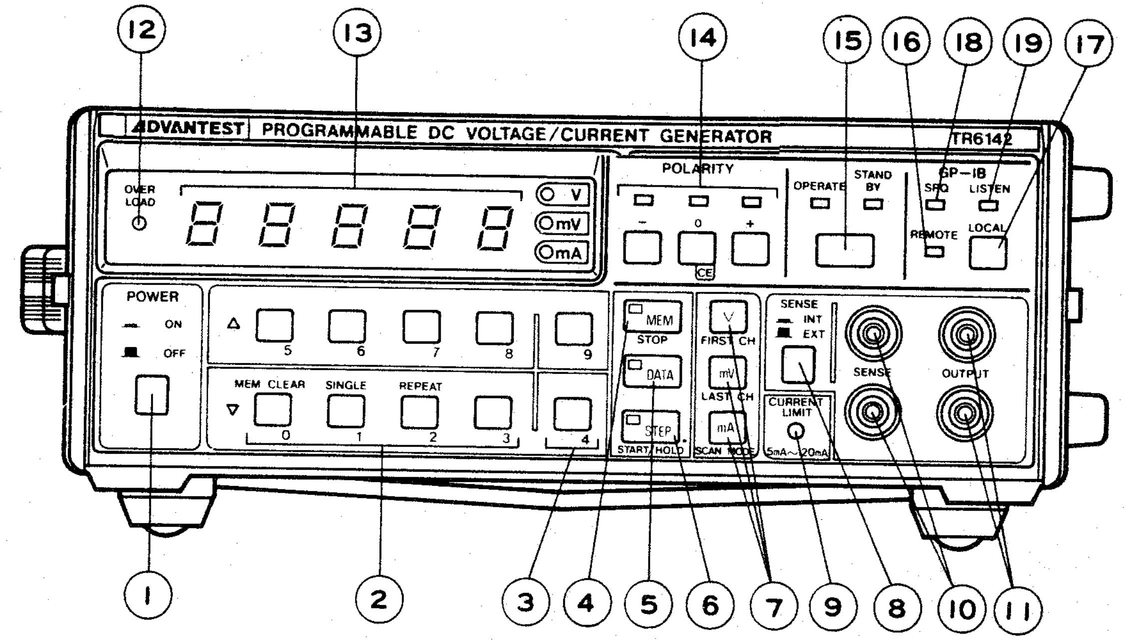
㉕ READY output terminal

This connector outputs the setting completion signal.

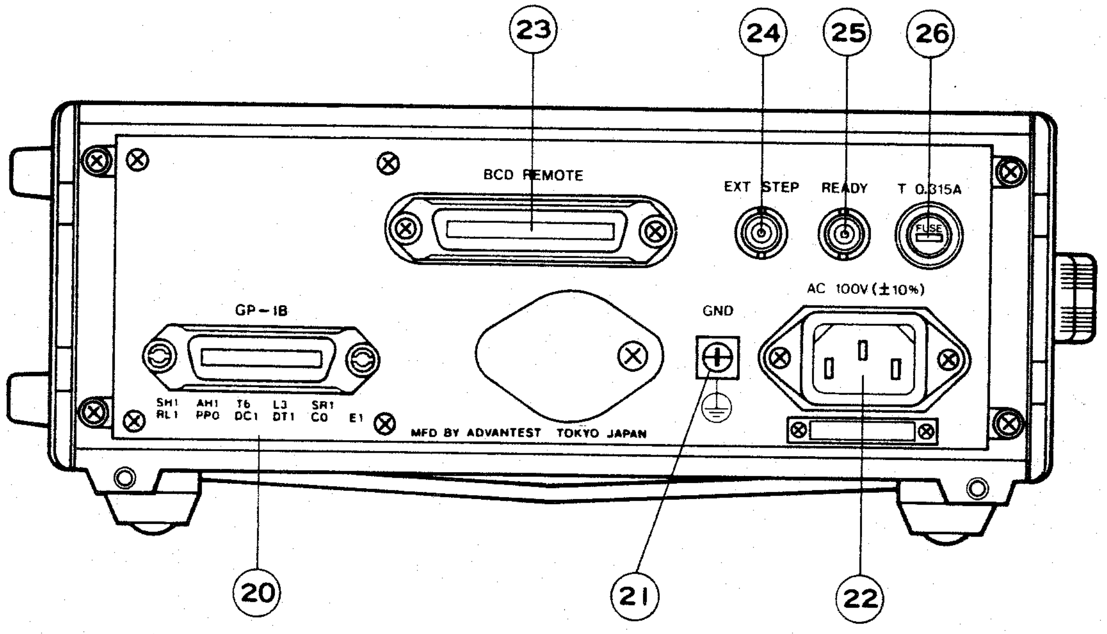
㉖ Fuse

This is a power fuse. A 0.315 A slow-blow fuse is used for a power voltage of 100 Vac.

The fuse can be removed by turning the cap in the direction of the arrow.



FRONT VIEW



REAR VIEW

Fig. 2-3 Front and rear panels

2-9. POWER CONNECTION AND WARM-UP

Check that the POWER switch on the front panel is set to OFF before connecting the power cable to an AC power receptacle.
Then, set the POWER switch to ON and check that the STANDBY lamp comes on.
Leave the instrument to warm up for 10 minutes or more.

2-10. TWO/FOUR-TERMINAL CONNECTIONS

The TR6142 has + and - OUTPUT terminals and + and - SENSE terminals, a total of four output terminals.
Normally, the SENSE switch is set to INT so that the OUTPUT and SENSE terminals of the same polarity are short-circuited (see Figure 2-4).
When the output terminals of the TR6142 are connected to a load located some distance away and when the 1V or 10V range is to be used, set the SENSE switch to EXT and make a four-terminal connection (see Figure 2-5).
If the load current Io is greater than the voltage detection current Is in Figure 2-4, errors will be reduced by making a four-terminal connection (Is max. = 220μA).

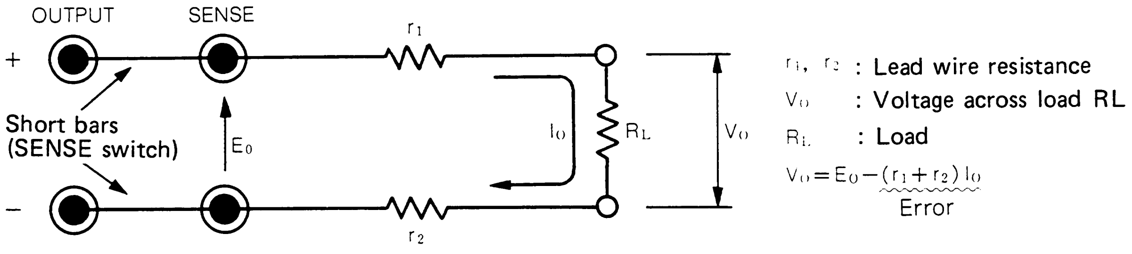


Fig. 2-4 Two-terminal connections

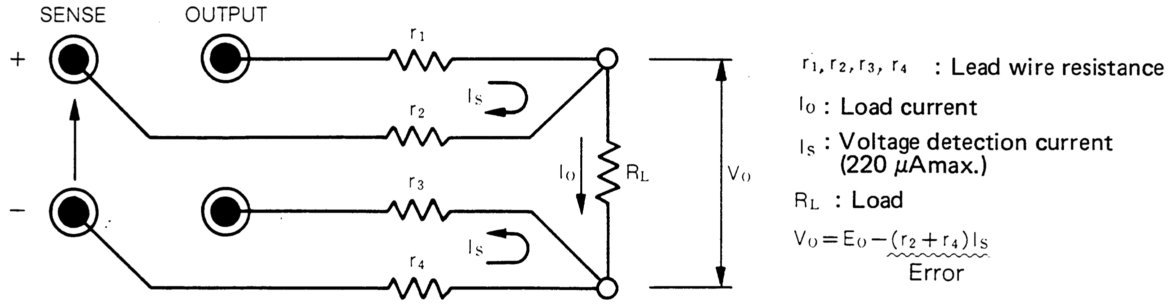


Fig. 2-5 Four-terminal connections

2-11. MANUAL OPERATIONS

This subsection describes the procedures for manually setting the output level, mode, and the range. Perform the following steps in this order, referring to Figure 2-6.

① Connect the power cable to an AC power receptacle and then set the POWER switch to ON.
Leave the instrument to warm up for 10 minutes or more.

② Connect the output terminals to the load with connection cables.
Voltage mode ... SENSE terminals
Current mode ... OUTPUT terminals
For normal operations, set the SENSE switch to INT to internally short-circuit the SENSE and OUTPUT terminals.
Make a four-terminal connection if long connection cables must be used in the voltage output mode.

③ Set the output range with the range setting keys or the ENTER key (V, mV, or mA).
(When using the memory, select the call mode by pressing the MEM key.)

④ Set the output level with the numerical keys.

⑤ Set the polarity of the output level with a POLARITY key.

⑥ Press the OPERATE/STANDBY key to select the OPERATE state.

⑦ The set output level is then transferred to the output terminals.

⑧ If automatic scanning is required, press the START/HOLD (STEP) key to start automatic scanning.

⑨ If the OVERLOAD lamp comes on, immediately disconnect and check the load.

NOTE

Loose connections of cables to the output terminals may cause large output voltage errors or an unstable output.

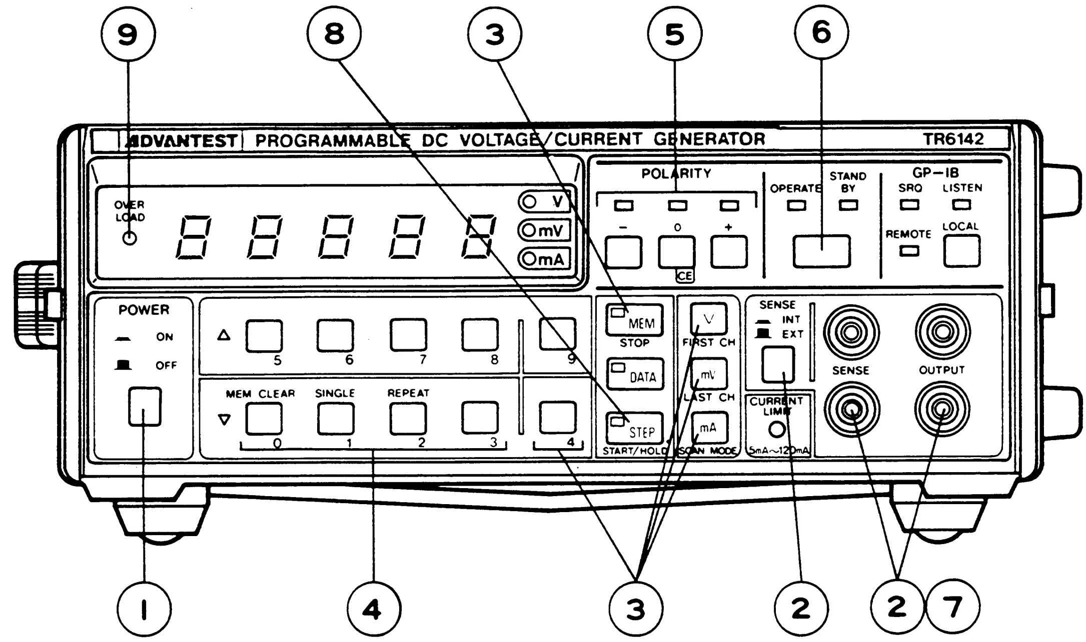


Fig. 2-6 Manual operations

2-12. PANEL KEY OPERATIONS

The numerical keys are used to manually set the output level.

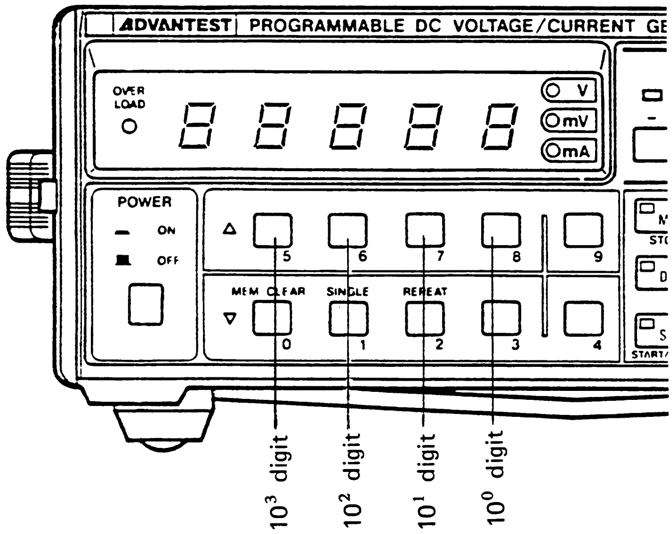


Fig. 2-7 Numerical keys

2-12-1. Continuous Mode

In the continuous mode, displayed value in each indicator digit is directly incremented or decremented when the corresponding numerical key is pressed. The instrument is placed in the continuous mode at power-on time.
Each key is interlocked with the higher-order digit indicators to enable carrying up to and down from those digits to be performed. Pressing a numerical key on the △ side increments the indicator value toward the full-scale value, and pressing a numerical key on the ▽ side decrements the indicator value toward zero. The value cannot be incremented over 11999 or decremented below 0000.

(1) Step-by-step setting

Pressing a numerical key for a instance (not exceeding 500 ms) increments or decrements the set value by some set step values. Figure 2-8 shows the variation of the set value from 0008 when the numerical △▽ key on the △ side which corresponds to the 10^0 digit (the least significant digit) is pressed intermittently to increment the value step by step.

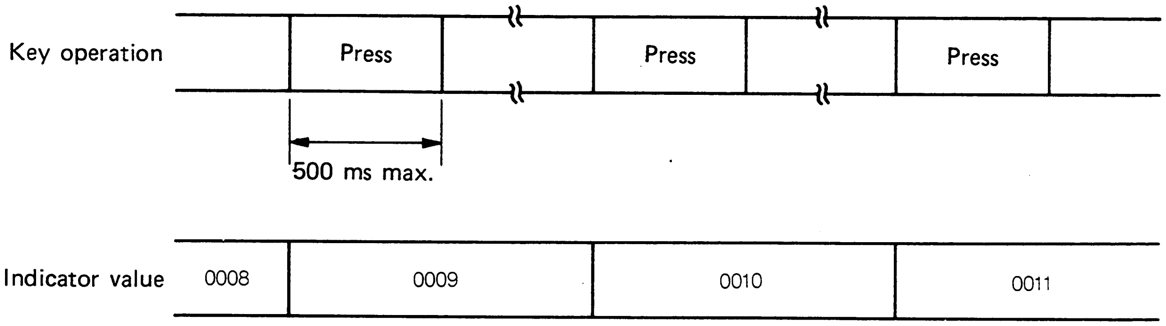


Fig. 2-8 Step-by-step setting example

(2) Continuous varying setting

If a numerical △▽ key is pressed and held, the indicator value continuously varies according to the interval (from 0.1 s to 10 s) set in the step time setting mode after the initial 500 ms (for the first step of variation) has elapsed.

The indicator value, once it starts to vary continuously, continues to vary even when the numerical key △▽ is released (lock function). This operation stops when the numerical key △▽ is pressed again or when any other key is pressed.

This operation can also be stopped by applying a signal (turning the signal level from high to low) to the EXT. STEP input terminal on the rear panel.

Figure 2-9 shows the variation of the set value from 11999 when the numerical △ ▽ key on the ▽ side corresponding to the 10^3 digit (the most significant digit) is pressed and held.

NOTE

The 0 and 5 keys for the 10^3 digit can vary the setting value from 0xxx to 11xxx.

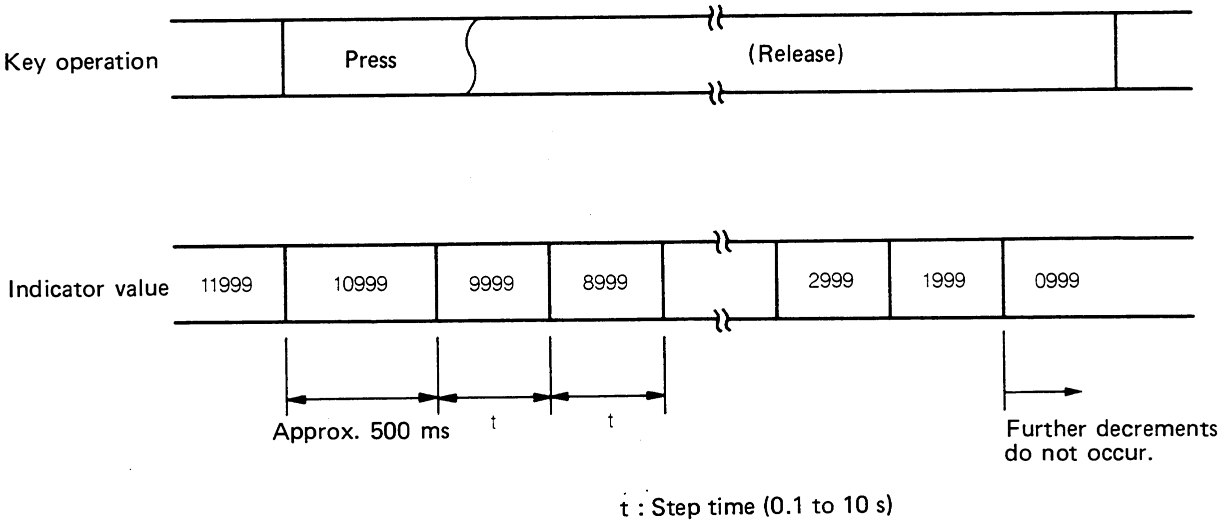


Fig. 2-9 Continous varying setting

2-12-2. Direct setting using numerical keys

The output level can be set directly by pressing the DATA key (the built-in LED comes on), inputting data using the numerical keys, then pressing the ENTER key (that is, one of the V, mV, and mA keys).

Set the polarity using the POLARITY + or - key.

Pressing the POLARITY 0 key clears the setting values and the value 0 is displayed.

The decimal point can be set by pressing the STEP key.

The range setting is determined by the input data value, the decimal point position, and the ENTER key. Table 2-2 lists the relationships between the input data and range setting.

Table 2-2 Relationships between input data and range setting

Data	Range setting	Indication (full-scale)
DATA ○○. ●●● mV	10 mV	○ 11.999 ● mv ○
DATA ○○○. ●● mV	100 mV	○ 119.99 ● mv ○
DATA ○○○○. ● mV	1 V	● V 1.1999 ○ ○
DATA ○○○○ ● mV	10 V	● V 11.999 ○ ○
DATA ○. ●●●● V	1 V	● V 1.1999 ○ ○
DATA ○○. ●●● V	10 V	● V 11.999 ○ ○
DATA ○. ●●●● mA	1 mA	○ 1.1999 ○ ● mA
DATA ○○. ●●● mA	10 mA	○ 11.999 ○ ● mA
DATA ○○○. ●● mA	100 mA	○ 119.99 ○ ● mA

○ is omissible for value 0.
● must be specified for any value.

2-12-3. Panel Settings Storing Operations

In the continuous mode, the output range and data values currently set in the instrument can be stored in the internal memory by pressing the DATA and then the MEM key. Thereafter, the output range and data values stored in the memory are automatically set in the instrument and are displayed on the indicator when the POWER switch is set to ON.

Table 2-3 Normal initial values at power-on

Parameter	Initial value
Range	Panel settings stored in memory
Output data	
Step time	---
Data stored in memory (all channels)	---
First channel	---
Last channel	---
Automatic scan mode	---
Remote mode (BCD REMOTE setting)	---

Note: --- indicates that the value set before power-off is held.

2-12-4. Step Time Setting

Set the step time in the continuos varying setting mentioned in item 2-12-1. (2).

The step time can be set by pressing the STEP key (the LED within the key comes on with the set value and the unit s displayed), inputting a step time value using the numerical keys, then pressing the STEP key again.

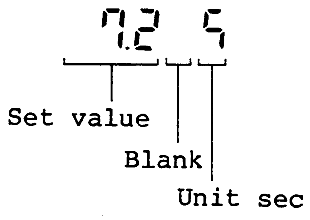
A step time within a range of 0.1s to 10.0s (or 0.2s to 10.0s for automatic scanning) can be set in 0.1s steps.

For example, to set a step time of 7.2 s, press the keys as follows:

STEP □ □ □ STEP

0 7 2

The set value is displayed as follows:

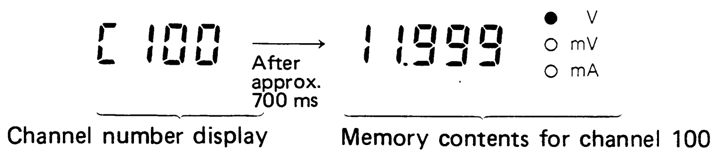


2-12-5. Scanning Mode Operation

Call Mode (initial state in Scanning mode)

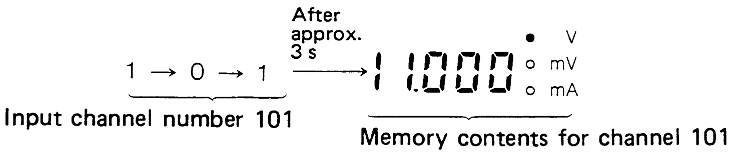
In the continuous mode, pressing the MEM key lights the built-in LED and displays the contents of the internal memory to indicate that the instrument has been placed in the call mode for output.

When the instrument is placed in the call mode, the first channel number, which has already been set, appears first, and the memory contents for that channel are displayed after about 700 ms.



(1) Calling memory contents by specifying a channel number (Random scan)

In the call mode, input a channel number using the numerical keys. For a channel number consisting of two or more digits, complete the key-in operation within 3 s. The memory contents for the specified channel are displayed about 3 s after the last digit is input.



The POLARITY (+, 0, and -) keys function in the same way as in the continuous mode, but they do not affect the memory contents.

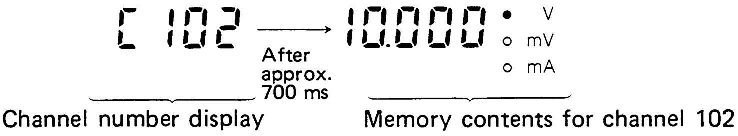
(2) Setting data for a channel

Follow the procedures in item 2-12-2. "Direct setting using numerical keys".

Pressing an ENTER key stores the output level in the memory, displays the channel number and set data again, and then resumes the call mode.

(3) Sequential scanning by manual operation (step scan)

When the STEP key is pressed in the call mode, the subsequent channel number is displayed, and then the memory contents for that channel are displayed.

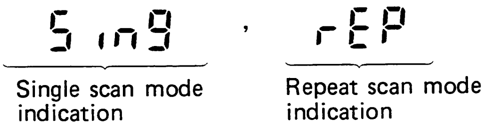


The POLARITY (+, 0 and -) keys function in the same way as in the continuous mode, but they do not affect the memory contents.

Press the STOP (MEM) key to return to the continuous mode.

(4) Setting the scan mode and starting automatic scanning

When the SCAN MODE (mA) key is pressed in the call mode or scanning stops, the current scan mode (single or repeat scan) is indicated.



To start scanning in the indicated mode, press the START/HOLD (STEP) key.

To change the scan mode before starting scanning, press the numerical key 1 (single scan mode) or 2 (repeat scan mode) to select the desired mode, and then press the START/HOLD (STEP) key.

(5) Halting automatic scanning

Pressing the START/HOLD (STEP) key during automatic scanning causes the current scan mode to be indicated, halting the automatic scanning. It does not initialize the channel increment.

Pressing the STOP (MEM) key during automatic scanning places the instrument in the call mode.

Re-pressing the START/HOLD (STEP) key in the halt state restarts and continues automatic scanning.

Pressing the STOP (MEM) key in the halt state places the instrument in the call mode.

(6) Specifying the first channel

Pressing the FIRST CH (V) key in the call mode causes the first channel which has already been set to be indicated.

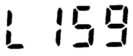
(Indicates that channel 100 is the first channel.)

Input a channel number with the numerical keys to change the first channel. After the key-in, press the START/HOLD (STEP) key if automatic scanning is to be performed. To set the last channel and scan mode, press the LAST CH (mV) and SCAN MODE (mA) keys, respectively.

To return to the call mode, press the STOP (MEM) key. To return to the continuous mode, press the STOP (MEM) key twice.

(7) Specifying the last channel

Pressing the LAST CH (mV) key in the call mode causes the last channel which has already been set to be indicated.



(Indicates that channel 159 is the last channel.)

Input a channel number with the numerical keys to change the last channel. After the key-in, press the START/HOLD (STEP) key if automatic scanning is to be performed. To set the first channel and scan mode, press the FIRST CH (V) and SCAN MODE (mA) keys, respectively.

To return to the call mode, press the STOP (MEM) key. To return to the continuos mode, press the STOP (MEM) key twice.

(8) Checking a channel in the halt state

If the DATA key is pressed while the scanning is halted by pressing the START/HOLD (STEP) key, the channel number which was being scanned at the halt time and the memory contents for that channel are displayed, and the instrument is then placed in the scanning mode.

(9) *How to return to the continuous mode (how to end the scanning mode)

Press the MEM key in the call mode, and the lamp goes off to return the continuous mode. The set value is the final value in the scannnng mode.

2-12-6. MEMORY CLEAR OPERATIONS

Setting the POWER switch to ON while pressing the MEM CLEAR (0) key initializes the internal memory.
The indicators display "CLEA" until the initialization is completed. After the initialization, each parameter of the instrument is set to the value listed in Table 2-4 when the POWER switch is set to ON.

Table 2-4 Initial values at power-on with MEM CLEAR

Parameter	Initial value
Range	1 V range
Output data	.0000
Step time	0.1 s
Data stored in memory (all channels)	No data
First channel	Channel 0
Last channel	Channel 159
Automatic scan mode	Single scan
Remote mode	Remote clear

2-13. EXT.STEP OPERATIONS

The following three functions can be remotely controlled by applying control signals to the EXT.STEP input terminal on the rear panel:

(1) Triggering step scanning in the call mode

(2) Starting/halting automatic scanning

(3) Stopping continuous varying setting operations (continuous mode)
This operation is stopped when the control signal level changes from 0 to 1.

2-13-1. EXT.STEP Input Control Signals

The EXT.STEP input signals for remote-controlling the three functions above must be relay contact signals, open-collector TTL IC outputs, or transistor outputs.

(1) Signal level

TTL level, negative logic, with a pulse width of 50 ms or more

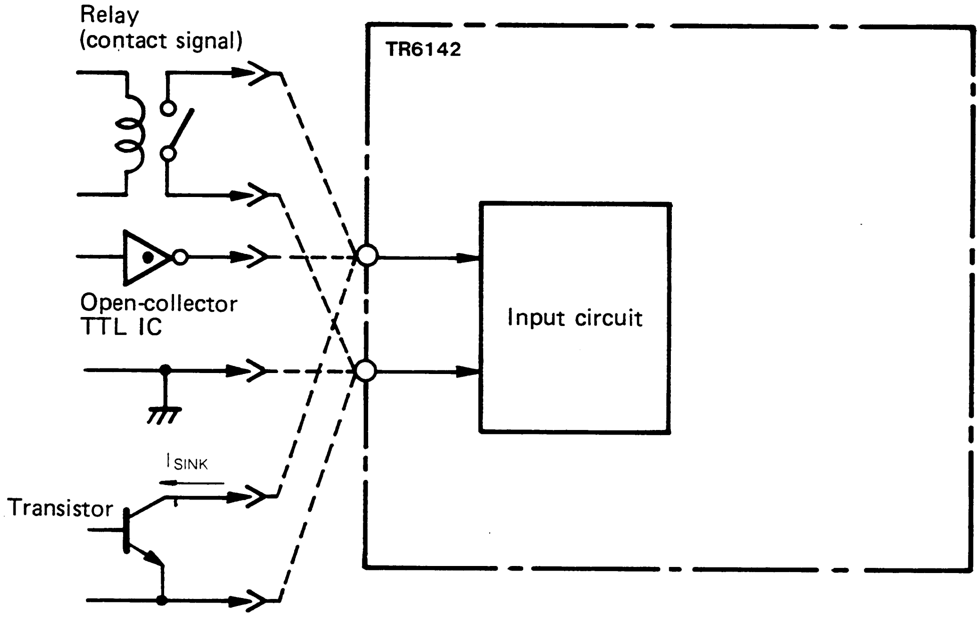
Logical 0: +2.4 V to +5.25 V or open-circuited
Logical 1: 0 V to +0.4 V or short-circuited

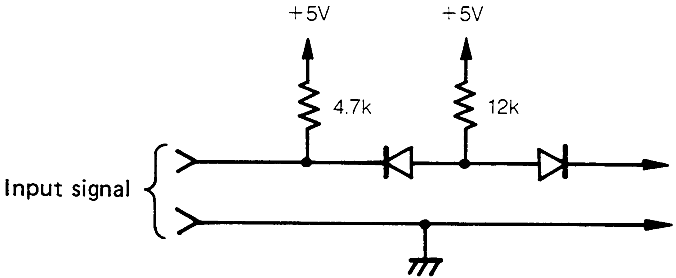
(2) Connectors to be used

- TR6142 side: JCF-AB001JX02
- Cable side : UG-88/U or equivalent

(3) EXT.STEP input control circuit

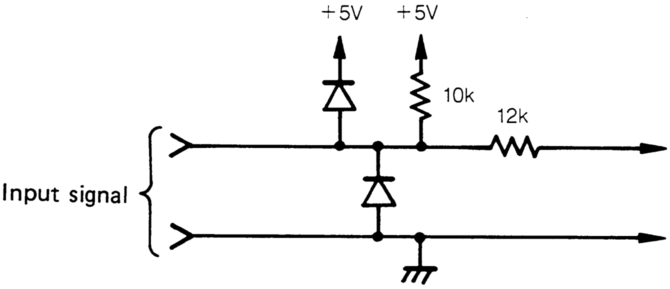
The EXT.STEP input control circuit is shown in Figure 2-10.





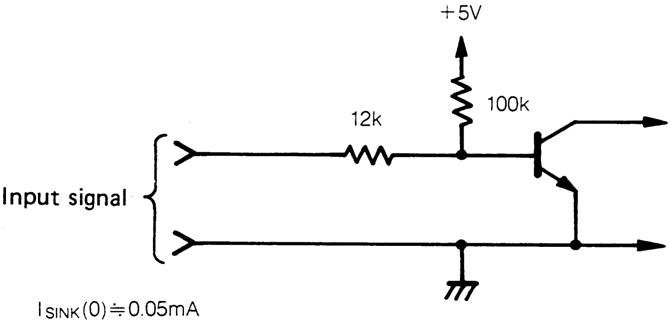
(a) EXT.STEP input circuit

$I_{SINK}(0) \fallingdotseq 1.5mA$
$I_{SINK}(1) \fallingdotseq 0.9mA$······When $V_{IN}(1)=2$ V



(b) Input circuit for a signal other than LOAD

$I_{SINK}(0) \fallingdotseq 0.5mA$
$I_{SINK}(1) \fallingdotseq 0.3mA$······When $V_{IN}(1)=2$ V



(c) LOAD signal input circuit

$I_{SINK}(0) \fallingdotseq 0.05mA$
$I_{SINK}(1) \fallingdotseq -0.1mA$······When $V_{IN}(1)=2$ V

Fig. 2-10 Control circuit

2-13-2. EXT.STEP Input Operation (step scanning)

① Perform steps ① to ③ in Section 2-11 "Manual Operation".

② Press the MEM key. (The built-in lamp comes on.)

③ Press the OPERATE/STANDBY key to select the OPERATE state. (The OPERATE lamp comes on.)

④ The channel number recalled from the memory is incremented by one each time a control signal is applied to the EXT.STEP input terminal on the rear panel.
If the channel number reaches the one for the last channel, the next channel will have the first number.

⑤ If the OVERLOAD lamp comes on, immediately disconnect and check the load.

2-13-3. EXT.STEP Input Operation (starting and halting automatic scanning)

① Perform steps ① to ③ in Section 2-11 "Manual Operation".

② Press the MEM key. (The built-in lamp comes on.)

③ Specify the first channel, last channel, and scan mode. (Do not press the START key.)

④ Press the OPERATE/STANDBY key to select the OPERATE state. (The OPERATE lamp comes on.)
If the channel number reaches the one for the last channel, the next channel will have the first number.

⑤ Apply a control signal to the EXT.STEP input terminal on the rear panel to start automatic scanning.

⑥ If the OVERLOAD lamp comes on, immediately disconnect and check the load.

⑦ During automatic scanning, applying a control signal to the EXT.STEP input terminal on the rear panel halts the automatic scanning.

2-13-4. EXT.STEP Input Operation (stopping continuous setting)

① Perform steps ① to ③ in Section 2-11 "Manual Operation".

② Press the OPERATE/STANDBY key to select the OPERATE state. (The OPERATE lamp comes on.)

③ Press and hold numerical △▽ key to start continuos varying setting. At this time, the signal applied to the EXT.STEP input terminal on the rear panel. This operation is stopped when the control signal level changes from 0 to 1.

④ Apply a control signal to the EXT.STEP input terminal to stop the continuous verying setting.

2-14. SWITCHING OF REMOTE FUNCTIONS

Switching of BCD and GPIB is enabled when the STEP and LOCAL switches are pressed in this order during the continuous mode, where the LED on the STEP switch illuminates.

BCD REMOTE set bcd

GPIB REMOTE set $\text{A-}\underbrace{\text{00}}_{\text{preset address}}$

The switching of BCD/GPIB REMOTE is enabled by pressing the LOCAL switch.

$$\text{bcd} \rightleftarrows \text{A-00}$$

The continuous mode is recovered when the STEP switch is pressed.

2-15. BCD REMOTE CONTROL OPERATIONS

The following four functions can be remotely controlled by setting "bcd" by remote function switching and applying control signals to the BCD REMOTE connector.

(1) Level setting on each digit: between 00000 and 11999

(2) Output range

(3) Polarity: logical 1 ... negative polarity
logical 0 ... positive polarity

(4) OPERATE/STANDBY:
logical 1 ... OPERATE
logical 0 ... STANDBY

2-15-1. BCD REMOTE Connector Pin Assignment

Table 2-5 lists the BCD REMOTE connector pin assignment and corresponding control signals applied to the connector pins.

Table 2-5 BCD REMOTE connector pin assignment and control signals

Pin number	Control signal		Pin number	Control signal	
1	0V (GND)		19	10 V	Output mode and range
2	1	10^0 digit	20	1 V	
3	2		21	100 mV	
4	4		22	10 mV	
5	8		23	100 mA	
6	1	10^1 digit	24	10 mA	
7	2		25	1 mA	
8	4		26	NC	
9	8		27	POLARITY	
10	1	10^2 digit	28	NC	
11	2		29	OPERATE/STANDBY	
12	4		30	NC	
13	8		31		
14	1	10^3 digit	32		
15	2		33		
16	4		34		
17	8		35		
18	1	10^4 digit	36	LOAD	

NC: non-internal connection. Do not use this pin as a junction terminal.

2-15-2. Control Signals

The four remote control functions above can be achieved by short-circuiting the relevant control terminals to the 0 V terminal (negative logic).

Apply relay contact signals, open-collector TTL IC outputs, or transistor outputs as the remote control signals.

(1) Signal level

TTL level, negative logic

Logical 0: +2.4 V to +5.25 V
Logical 1: 0 V to +0.4 V

(2) Connectors to be used

- TR6142 side: stock no. JCS-AC036JX01
- Cable side : stock no. 57-30360 (Amphenol's 36-pin connector) or equivalent

(3) Control circuit

Figure 2-10 shows the circuit for controlling the TR6142.

2-15-3. LOAD Signal

For the four functions in section 2-15, the level setting for each digit is loaded into the TR6142 by setting the LOAD terminal (pin 36) to logical 1.

In the REMOTE mode, the LOAD signal is normally set to constant logical 1, but a signal having a pulse width of 50 ms or more (see Figure 2-11) may be used instead.

In this case, the pulse signal must be applied after the level is set for each digit.

The level setting for each digit can be remotely controlled even if the REMOTE lamp on the front panel is off.

In this case, the value remotely set for each digit is loaded into the TR6142 by applying a LOAD signal having a pulse width of 50 ms or more to the LOAD terminal.

The level set for each digit using remote control function cannot be changed by means of the numerical △▽ keys on the front panel.

Furthermore, when the LOAD signal is at logical 1, the numerical △▽ keys are invalid even when the local mode is selected. (The range setting, POLARITY, and OPERATE/STANDBY keys on the front panel are valid in this case.)

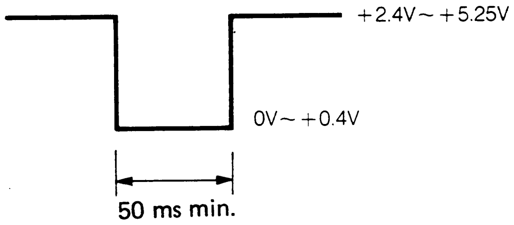


Fig. 2-11 EXT. STEP Input signal

2-15-4. Remote Control Operation

Perform the following procedures referring to Figure 2-12.

① Set " bcd " by remote function switching. The continuous mode can be recovered when the STEP switch is pressed.

② When The LOCAL key is pressed, the REMOTE lamp then comes on and setting from panel keys is disabled.

③ Connect the output terminals to the load with connection cables.

Voltage mode ... SENSE terminals
Current mode ... OUTPUT terminals

For normal operations, set the SENSE switch to INT to internally short-circuit the SENSE terminals to the OUTPUT terminals.

Make a four-terminal connection if long connection cables must be used in the voltage output mode.

④ Apply control signals to the BCD REMOTE connector on the rear panel to set the output level.

Also apply the LOAD signal to load the set level into the TR6142.

⑤ Next, set the OPERATE/STANDBY terminal of the BCD REMOTE connector to logical 1, so that the set level is output from the output terminals.

⑥ If the OVERLOAD lamp comes on, immediately disconnect and check the load.

⑦ Re-pressing the LOCAL key extinguishes the REMOTE lamp and enables manual key operation. The numerical △▽ keys cannot be used for value setting with the BCD REMOTE connector disconnected.

⑧ If the POWER switch is set to OFF without pressing LOCAL key at step ⑦ above, BCD REMOTE state is placed when the POWER is turned on next time. (except for GPIB setting)

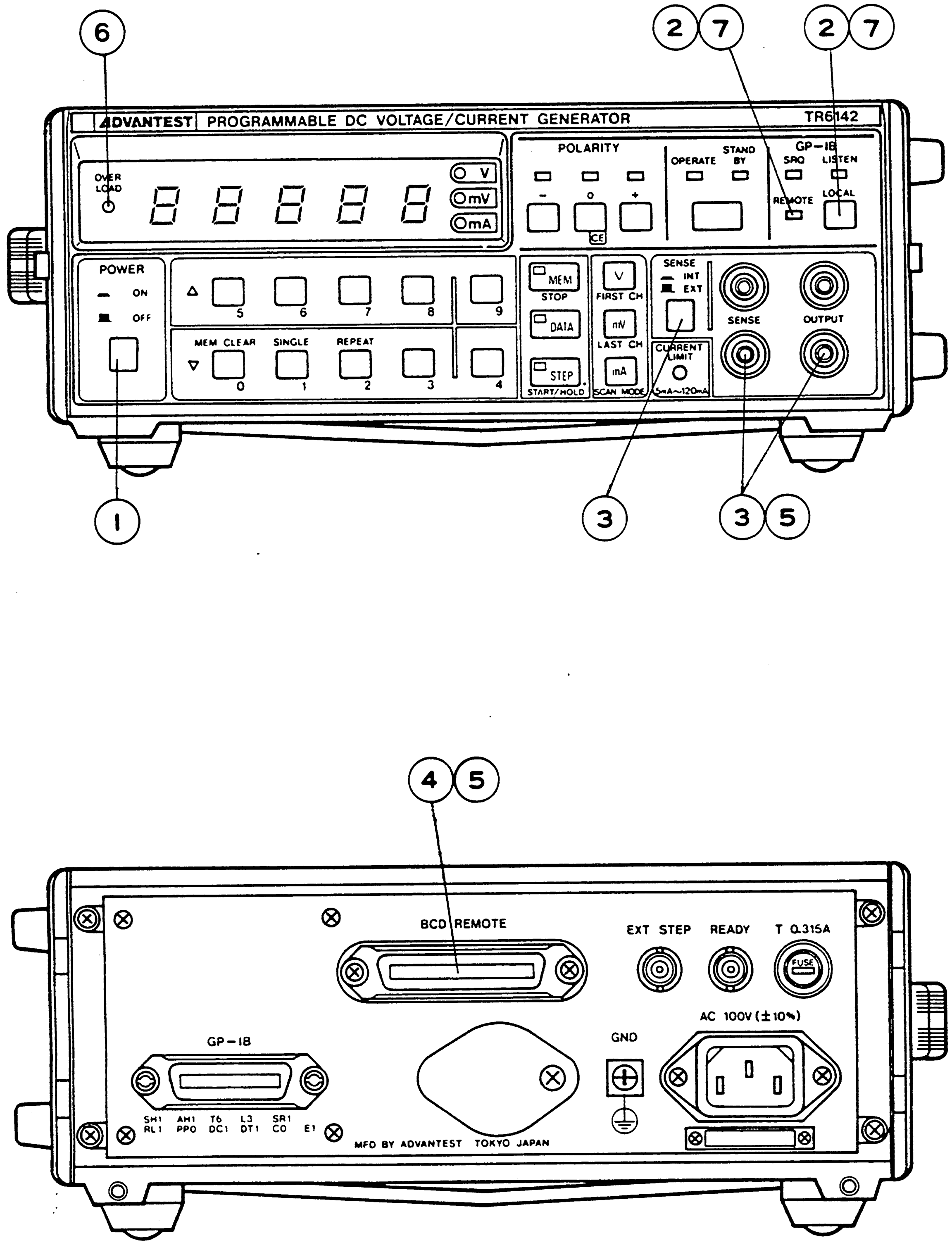


Fig. 2-12 BCD remote control operations

MEMO

SECTION 3

OPERATION CHECKS AND CALIBRATIONS

3-1. INTRODUCTION

Check that the TR6142 satisfies the electrical performance and specifications listed in Section 1-3 when it is purchased and every six months (the guarantee period) thereafter. During the inspection, check the accuracy of the DC voltage and current output in each range. Calibration is required when the accuracy of any DC voltage or current output is found to be outside the specifications.

3-2. TEST EQUIPMENT

Table 3-1 lists the recommended test equipment to be used. The actual equipment used to check the TR6142 must have performances equivalent to or better than that shown in Table 3-1.

Table 3-1 Test equipment

Test equipment	Performance	Recommended model
Digital voltmeter	Resolution: 1 μV (in the 1 V range) Full-scale: 12000 on the indicator Range : 100 mV 1 V 10 V Accuracy : Within ±0.01% of reading	TR6877 (ADVANTEST)
DC ammeter	Resolution: 100 nA (in the 1 mA range) Full-scale: 12000 on the indicator Range : 1 mA 10 mA 100 mA Accuracy : Within ±0.01% of reading	

If a DC ammeter having the performance shown in Table 3-1 is not available, it is possible to indirectly measure the current using a digital voltmeter and shunts.

Shunts: 100 Ω, 1 kΩ, 10 kΩ with accuracyies within ±0.005%

3-3. PRECAUTIONS

(1) Perform operation checks and calibrations first in the voltage mode and then in the current mode.
Check the accuracies in the voltage mode before performing operation checks and calibration in the current mode even if calibration is required in the current mode only. Calibration in the current mode will involve errors unless accurate calibration has been performed in the voltage mode.

(2) To calibrate the instrument, take it out of the case and make adjustments through the adjustment holes provided in the internal shielding cover.

(3) When turning a potentiometer provided beneath an adjustment hole to calibrate, work quickly and check the calibration results after returning the instrument to the case. (The output value may be affected by a sudden change of internal temperature when the instrument is taken out of the case.)
After completing all calibrations, leave the instrument in the case for 10 to 20 minutes and then check that the calibrations in each range have no errors.

(4) When using a digital voltmeter and shunts to calibrate in the current mode, take the input impedance of the digital voltmeter into consideration; otherwise, a large error may result.
For example, if a shunt of 10 kΩ is used and the input impedance of the digital voltmeter is 10 MΩ, the calibration error is 0.1%.

(5) Do not remove the internal shielding cover. The manufacturer is not responsible problems caused by the removal of this cover.

(6) Do not turn any potentiometer other than those related to the calibration.

(7) It is advisable to attach a card or sticker, indicating the date of calibration and the date scheduled for the next calibration, to the instrument after the calibration has been completed.

3-4. PREPARATIONS FOR CALIBRATION

(1) The operation checks and calibrations must be performed in the following environment:

① Ambient temperature: +23°C ±2°C

② Relative humidity : 70% or less

③ Power supply : 100 Vac ±10%, 50/60 Hz

④ Environment : A room least affected by electromagnetic induction, electrostatic induction, dust, vibration.

(2) Warm up the TR6142 for at least one hour without taking it out of the case.

(3) Warm up the test equipment according to their specifications.

(4) It is stipulated that the TR6142 be calibrated every six months; however, it must be calibrated each operating day if it is to be used within the specified daily accuracy.
Under normal circumstances, calibration performed every six months is enough to satisfy the specifications.

3-5. OPERATION CHECKING PROCEDURES

(1) Measurement of DC voltage output
Test equipment ... digital voltmeter
Connect the output terminals of the TR6142 to the input terminals of the digital voltmeter (see Figure 3-2), and check that the voltage level is within the range shown in the following table.

Step	Range	Output voltage setting	Digital voltmeter indication range
1	10 V	+0.000V	-1 mV to + 1 mV
2	10 V	+11.999 V	+11.994 V to +12.004 V
3	1 V	+.0000 V	-200 µV to +200 µV
4	1 V	+1.1999 V	+1.1993 V to +1.2005 V
5	100 mV	+119.99 mV	+119.93 mV to +120.05 mV
6	10 mV	+11.999 mV	+11.990 mV to +12.008 mV

(2) Measurement of DC current output

Test equipment ... DC ammeter or a combination of a digital voltmeter and shunt resistors

Connect the output terminals of the TR6142 to the input terminals of the DC ammeter or to the input terminals of the digital voltmeter through a shunt (see Figure 3-3). Check that the current level is within the range shown in the following table.

Step	Range	Output voltage setting	DC ammeter indication range
1	100 mA	+119.99 mA	+119.92 mA to +120.06 mA
2	10 mA	+11.999 mA	+11.992 mA to +12.006 mA
3	1 mA	+1.1999 mA	+1.1992 mA to +1.2006 mA

3-6. CALIBRATION PROCEDURE

NOTE

The digital voltmeter and DC ammeter used for calibration must have already undergone zero and full-scale calibrations.

WARNING

1. Do not drop screws or the like into the instrument since the power must be kept on during calibration.
2. Do not remove the internal shielding cover.

Before the calibration, take the TR6142 out of the case according to the following procedure, referring to Figure 3-1.

① Remove the four screws on the rear panel which fix the instrument to the case.

② Remove the rear panel from the case and draw the instrument out of the case by the front panel.

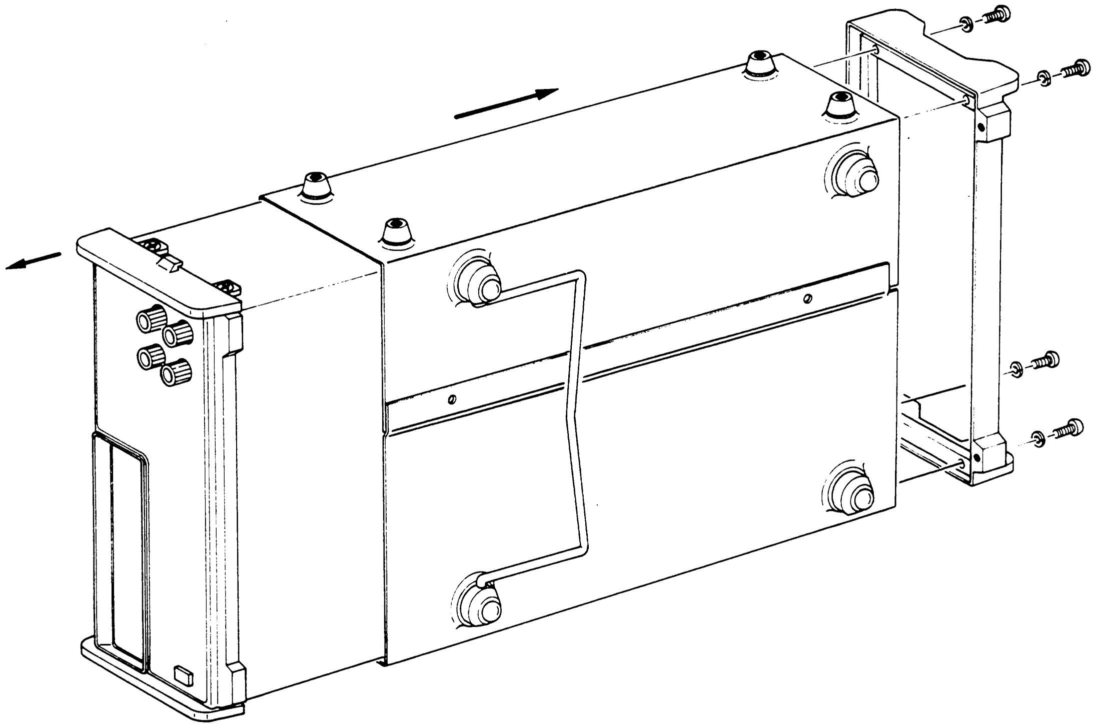


Fig. 3-1 Taking the TR6142 out of the case

The shielding cover shown in Figure 3-4 will appear when the TR6142 is taken out of the case. Perform calibration first in the voltage mode and then in the current mode according to the procedures described below.

WARNING

Do not touch the LINEAR, I LIMIT, V LIMIT, and +18 V control knobs when calibration.

(1) Calibration in the voltage mode

Connect a digital voltmeter to the instrument as shown in Figure 3-2.

First perform zero calibration and then full-scale calibration.

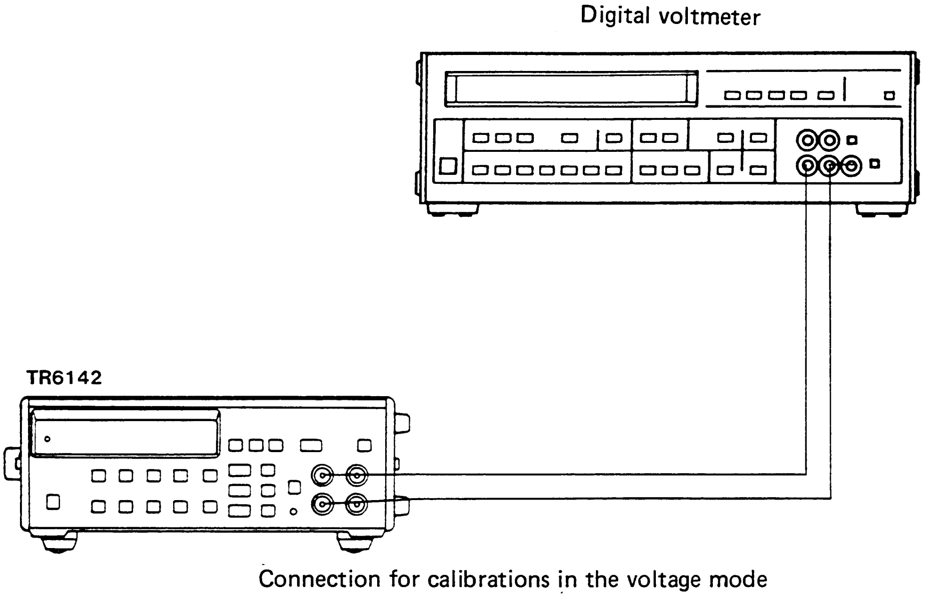


Fig. 3-2 Calibration in the voltage mode

ⓐ Zero calibration

Step	TR6142			Digital voltmeter (TR6877)	
	Range	Setting	Calibration point	Range	Indication range
1	10 V	0.000	10 V ZERO ①	1 V	0.000999 V max.
2	1 V	.000	1 V ZERO ②	1 V	0.000100 V max.

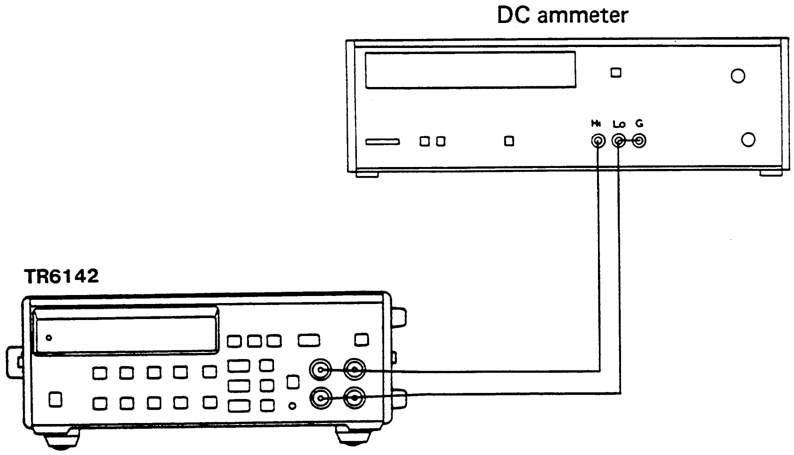
Repeat these calibration steps two or three times and make sure that the voltmeter indication always falls within the voltage indication range specified for each setting.

ⓑ Full-scale calibration

Step	TR6142			Digital voltmeter (TR6877)	
	Range	Setting	Calibration point	Range	Indication range
1	1 V	1.0000	1 V F.S. ③	1 V	Within 1.000000 ±500 counts
2	10 V	10.000	10 V F.S. ④	10 V	Within 10.00000 ±300 counts
3	100 mV	100.00	100 mV F.S. ⑤	1 V	Within 0.100000 ±40 counts
4	10 mV	10.00	Check	1 V	within 0.010000 ±50 counts

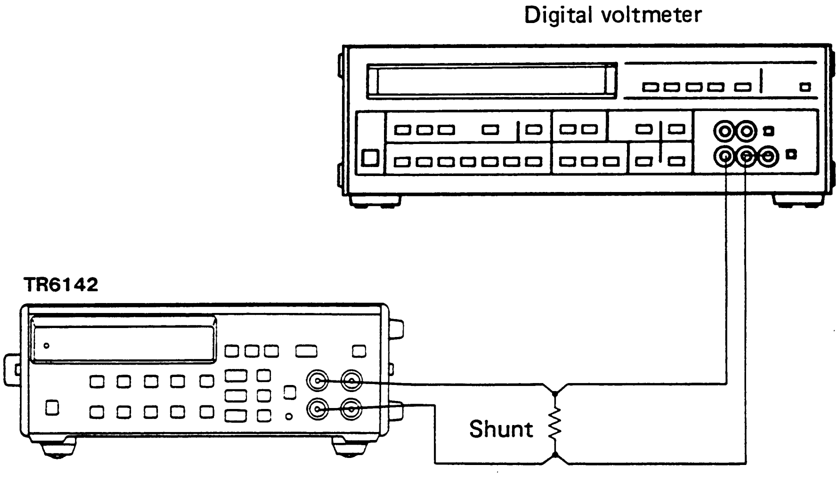
(2) Calibration in the current mode

There are two methods of calibration in the current mode, one using a DC ammeter and the other using a combination of a digital voltmeter and shunts. Connections for these methods are shown in (a) and (b) in Figure 3-3, respectively.



(a) Connection to a DC ammeter

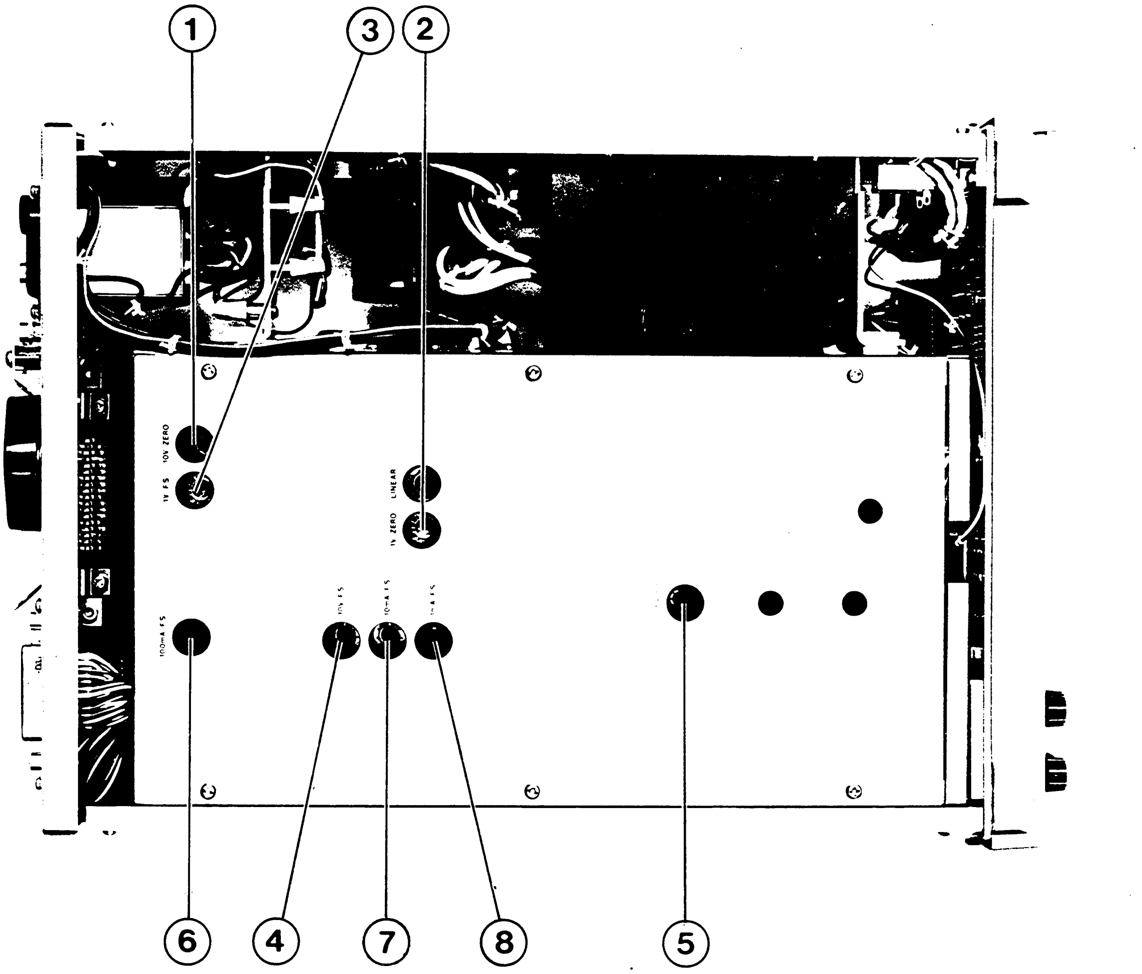
Fig. 3-3 Calibration in the current mode



(b) Using a digital voltmeter and a shunt

Fig. 3-3 Calibration in the current mode (Cont'd)

Step	TR6142			Calibrator			
				DC ammeter	Digital voltmeter and shunt		Indication range
	Range	Setting	Calibration point	Range	Shunt	Range	
1	100 mA	100.00	100 mA F.S. ⑥	100 mA	100 Ω	10 V	Within 10.00000 ±500 counts
2	10 mA	10.000	10 mA F.S. ⑦	10 mA	1 kΩ	10 V	Within 10.00000 ±500 counts
3	1 mA	1.0000	1 mA F.S. ⑧	1 mA	10 kΩ	10 V	Within 10.00000 ±500 counts



Number	Function	Number	Function
①	10V ZERO	⑤	100mA 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. 3-4 Calibration points

MEMO

SECTION 4
PRINCIPLES OF OPERATION

4-1. INTRODUCTION

The TR6142 is a DC voltage generator employing a pulse width modulation (PWM) technique which is well-known in the communication and magnetic recording fields, for voltage division based on the time division methods.

Figure 4-1 shows a simplified block diagram of the TR6142. The TR6142 consists of three basic blocks: the panel/control section, the reference voltage generator section, and the output amplification section.

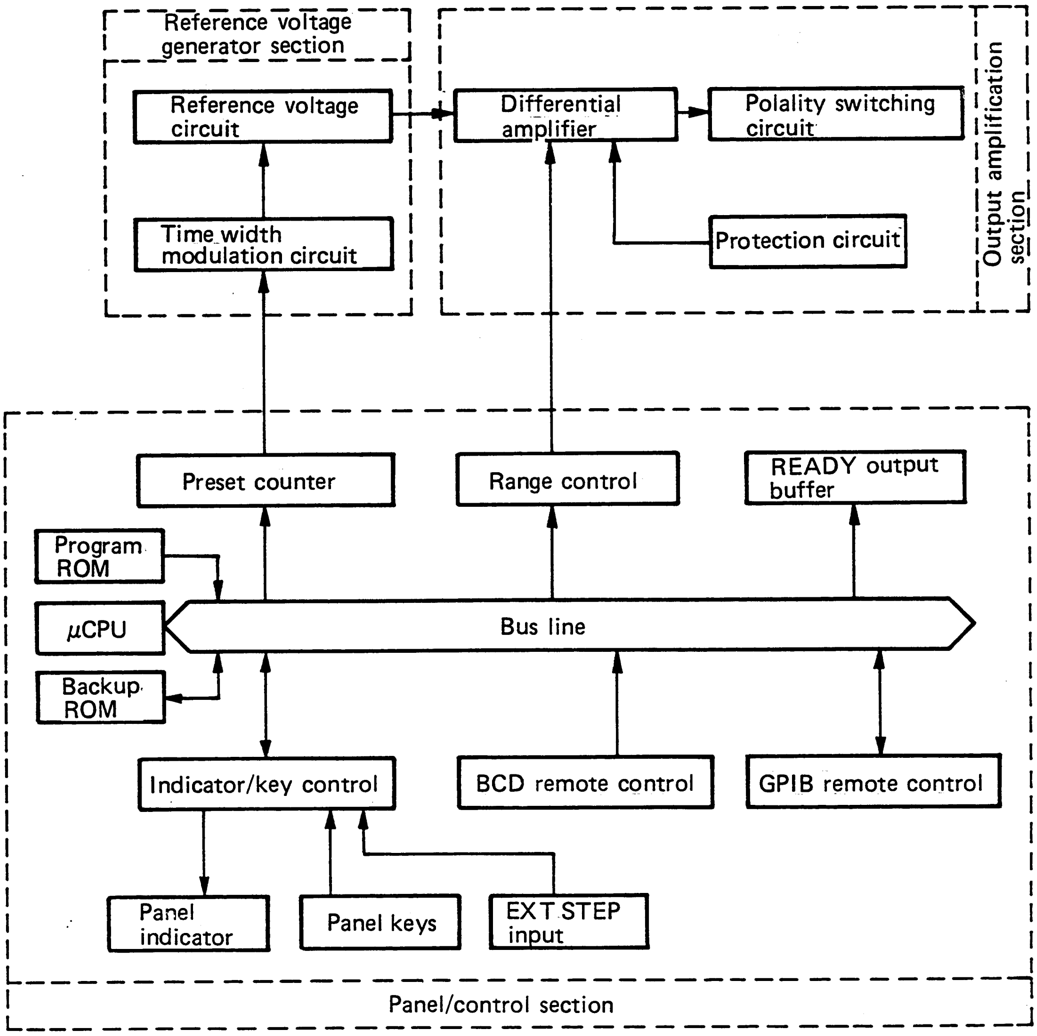


Fig. 4-1 TR6142 block diagram

Outline of the three basic blocks are described below:

(1) Panel/control section

The panel key inputs and panel indicator outputs are controlled by the μCPU through the indicator/key control circuit. The μCPU also controls the data settings from the BCD and GPIB remote control circuits and controls the output of these settings to the panel indicators. Input data is processed by the μCPU, converted to PWM (pulse-width modulated) pulses at the preset counter, and is then applied to the reference voltage generator section.

(2) Reference voltage generator section

The reference voltage generator section consists of a time width modulation circuit and a reference voltage circuit. This section divides the voltage using the time division method. Figure 4-2 illustrates this voltage division by the time division method as performed in the TR6142.

The theory of voltage division by the time division method is as follows: The input reference voltage Ez is converted to an intermittent signal and averaged with an R-C low-pass filter. The ratio of the averaged output voltage Es to the input reference voltage Ez, that is, the voltage division ratio, is determined by the intermitting time ratio. If the reference voltage Ez is made intermittent at switch SW, the resultant intermittent signal is a rectangular wave having a ratio represented by the time duration T1 of the reference voltage Ez and the zero-voltage time duration T2. The average value Es of this rectangular wave shown in Figure 4-2 (c) is given by the following expression:

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

This expression is equivalent to the following expression for general resistance type voltage division shown in Figure 4-2 (a):

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

If T1 + T2 is constant, the desired output can be obtained by adjusting T1.

The time width modulation circuit consists of two decimal counters, which are set and reset counters independent of each other. The two counters count the same clock pulses after an externally set value is preset in the set counter, so that a phase difference equal to the preset value is always kept between them. Using this phase difference, a pulse train having a duty ratio corresponding to the externally set value can be generated. This pulse train is used to switch the reference voltage generated at the reference voltage circuit. The resultant signal is averaged with the low-pass filter and is made the output voltage.

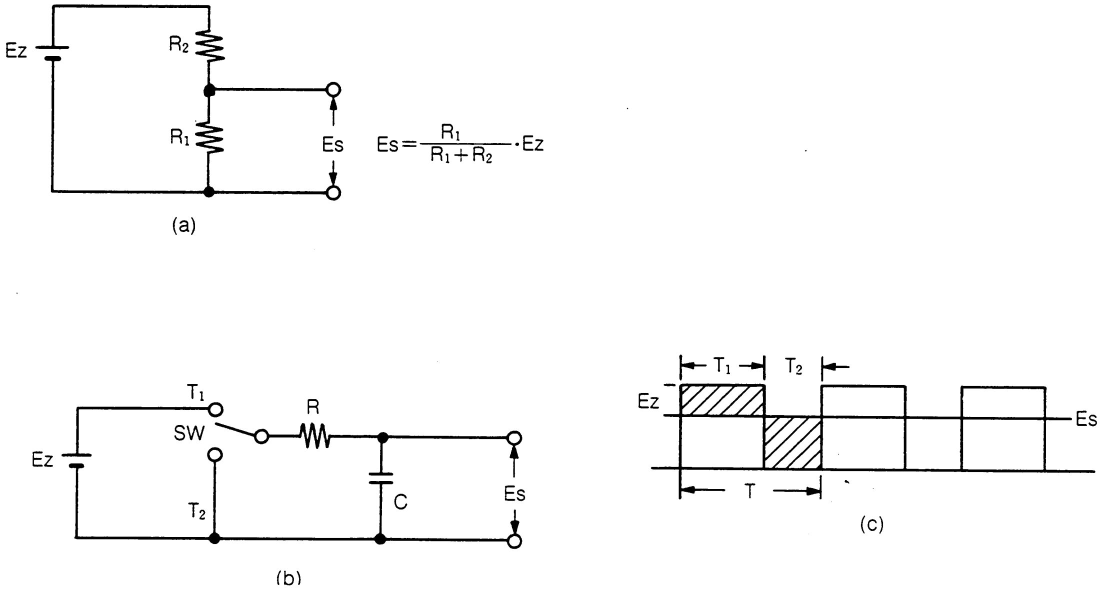


Fig. 4-2 Time division method

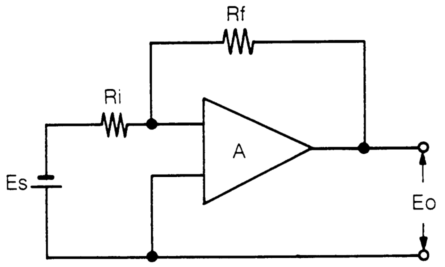
(3) Output amplification section

The output amplification section consists of a differential amplifier, a polarity switching circuit, and a protection circuit. Figure 4-3 illustrates the principles of operations of the output amplification section.

For voltage output, the output voltage of the reference voltage generator section is amplified by feeding the current back to the differential amplifier before it is finally output.

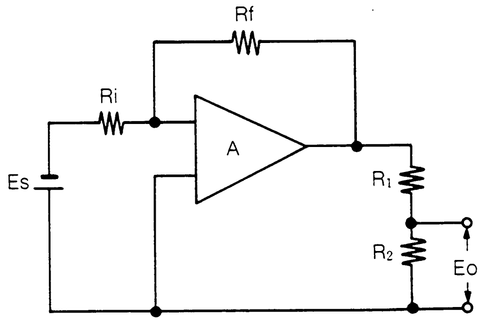
The range switching is performed by changing Ri and Rf.

(a) 1 V and 10 V ranges



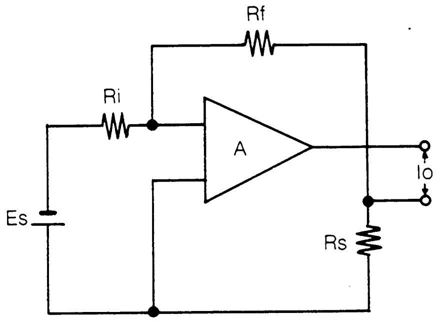
$$Eo = -\frac{Rf}{Ri}\cdot Es$$

(b) 10 mV and 100 mV ranges



$$Eo = -\frac{Rf}{Ri}\cdot\frac{R_2}{R_1+R_2}\cdot Es$$

(c) 1 mA, 10 mA, and 100 mA ranges



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

Fig. 4-3 Output amplification section

4-2. INDICATOR/KEY CONTROL CIRCUIT

The indicator/key control circuit mainly consists of a segment register, a select signal register, and a key buffer. This circuit handles keyboard inputs, EXT.STEP inputs, and indicator outputs under the control of the µCPU.

The indication is controlled at the timing of the timer clock (2 ms) generated at the µCPU. The µCPU converts the data for indication into a seven-segment display pattern at the time that the select signal register outputs SEL 0 thru SEL 7. EAch display is sequentially turned on one at a time. The resultant display pattern is then latched at the segment register to light the LED indicators in the 2 ms cycle.

The keyboard receives the select signal register outputs at the time that the display pattern is output for indication, and transfers data to the key buffer.

The µCPU performs calculations between the select signals currently output and the data read from the key buffer so as to recognize the key currently pressed.

Figure 4-4 shows a block diagram of the indicator/key control circuit.

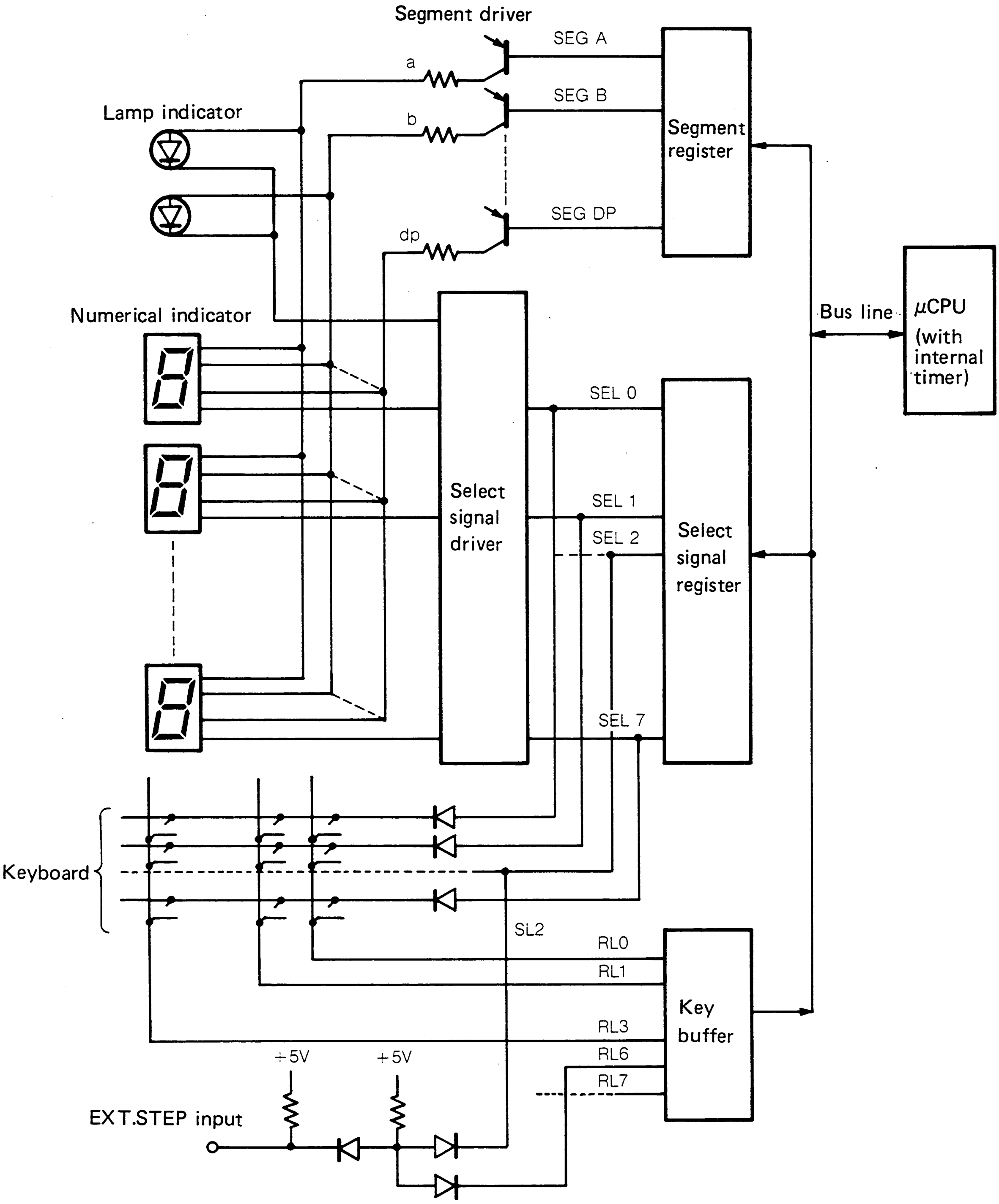


Fig. 4-4 Indicator/key control circuit block diagram

4-3. BCD/GPIB REMOTE CONTROL CIRCUIT

The μCPU controls all the BCD and GPIB remote control signals through the BCD data register and the GPIB interface.

An LSI is exclusively used for the GPIB interface and buffer. It performs status monitoring and data input/output under control of the μCPU.

The data signals of the BCD remote control signals are latched at the BCD data register by the LOAD signal. The BCD remote control operation is performed when the LOAD signal is detected by the μCPU. For this purpose, the LOAD signal must have a pulse width of 50 ms or more.

The range and OPERATE/standby signals are cyclically detected in the BCD remote control mode.

The state of switching between the BCD and GPIB remote control modes is cyclically detected.

Figure 4-5 shows a block diagram of the BCD/GPIB remote control circuit.

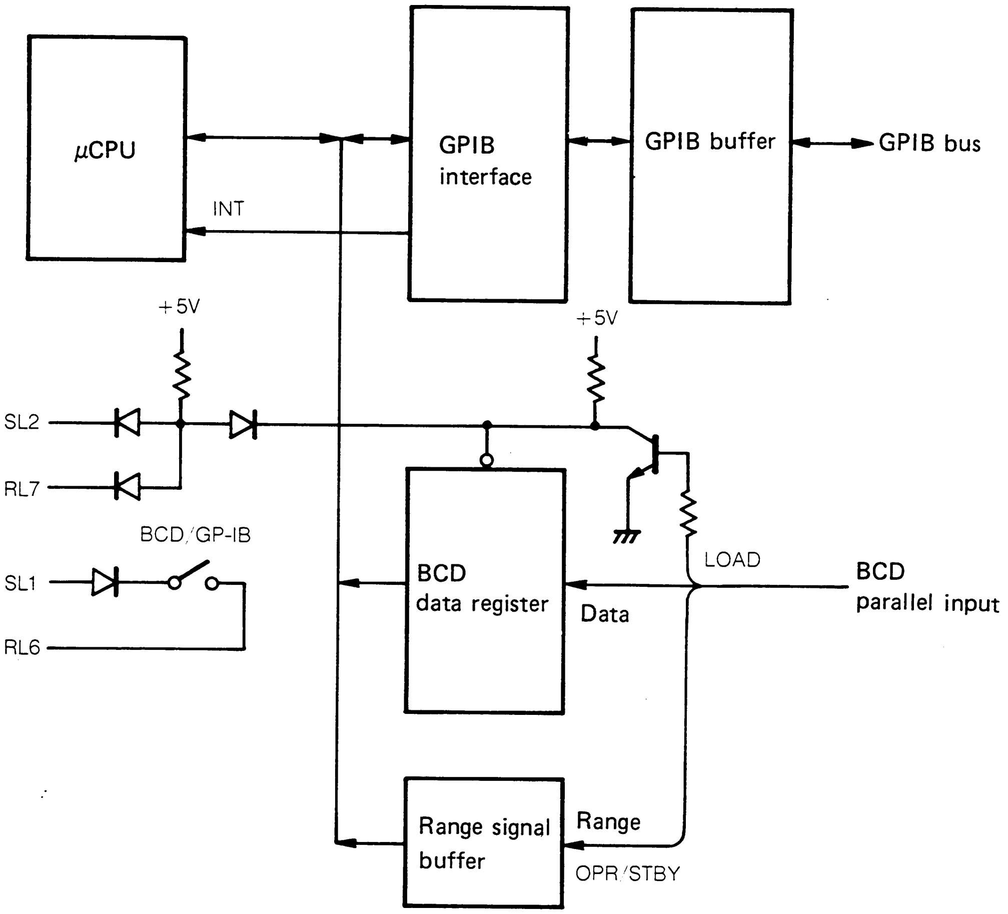


Fig. 4-5 BCD/GPIB remote control circuit block diagram

4-4. TIME WIDTH MODULATION CIRCUIT

The time width modulation circuit consists of a 5 MHz oscillator, a free-running counter, a data register, and so forth. This circuit generates a pulse train having a duty ratio proportional to the output level setting.

Figure 4-6 shows a block diagram of the time width modulation circuit. The free-running counter counts the pulses of the 5 MHz signal output from the 5 MHz oscillator. When the count reaches 12008, a 12008 detection signal is generated. This signal serves as a CLEAR signal to clear the contents of the free-running counter and, on the other hand, enters the K input of the output flip-flop.

The μCPU adds 5 to the set output level and latches the result at the data register. The comparator compares the latched value with the contents of the free-running counter, and when detecting the matching values, sends a signal to the J input of the output flip-flop.

Thus, there is a phase difference of the number of 5 MHz clock pulses proportional to the set output level between the 12008 detection signal (CLEAR signal) output from the free-running counter, which has a certain period of repetition, and the matching signal from the data register.

The output flip-flop is operated with this phase difference so that it outputs a pulse train (PWM signal) having a duty ratio proportional to the set output level.

Figure 4-7 shows a simple example f the operation timing described above. This example assumes that the free-running counter outputs a periodic signal every 10 counts and that the level set in the data register is 4.

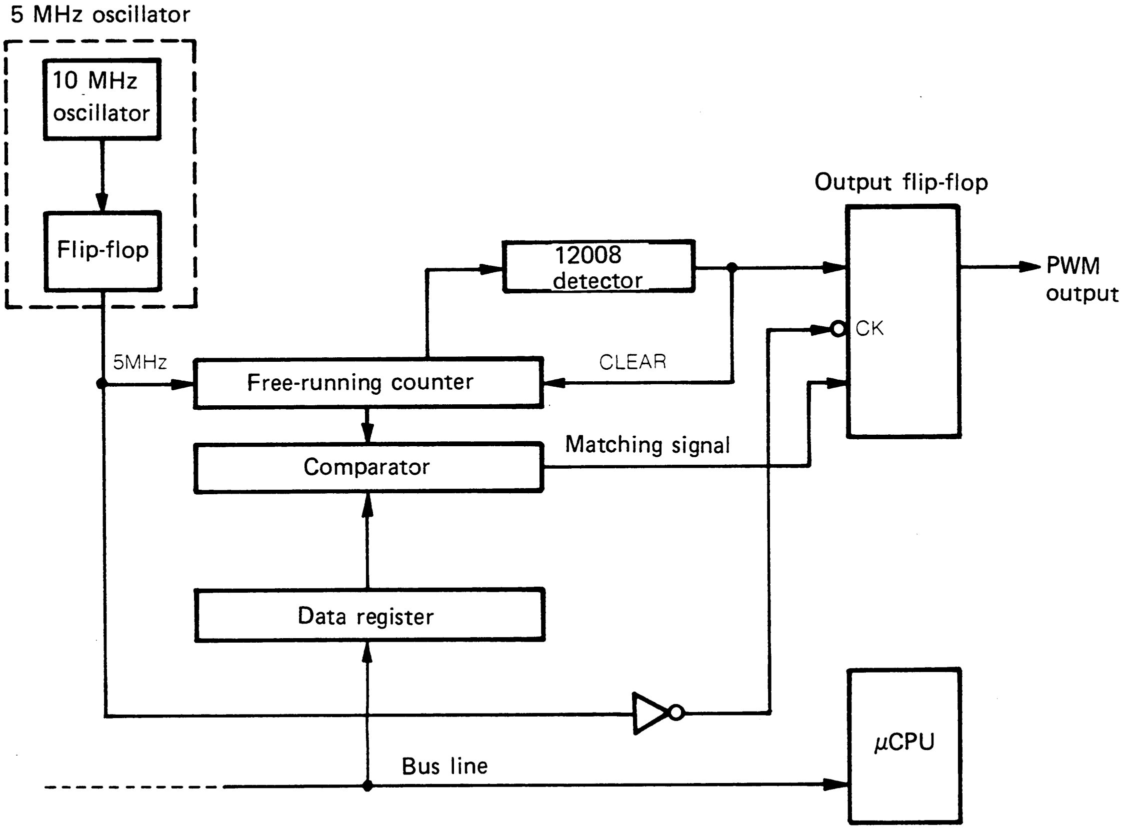


Fig. 4-6 Time width modulation circuit block diagram

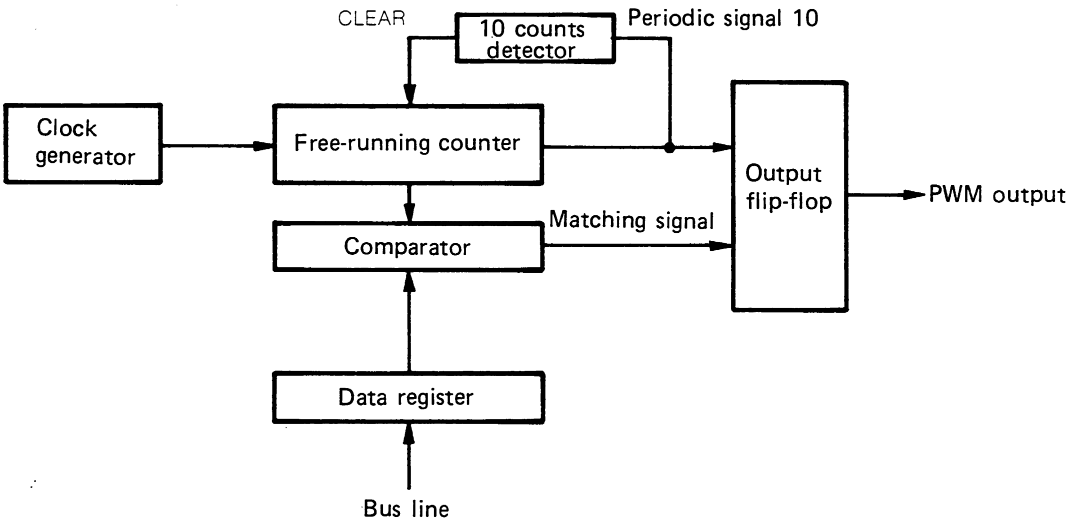


Fig. 4-7 PWM signal timing chart

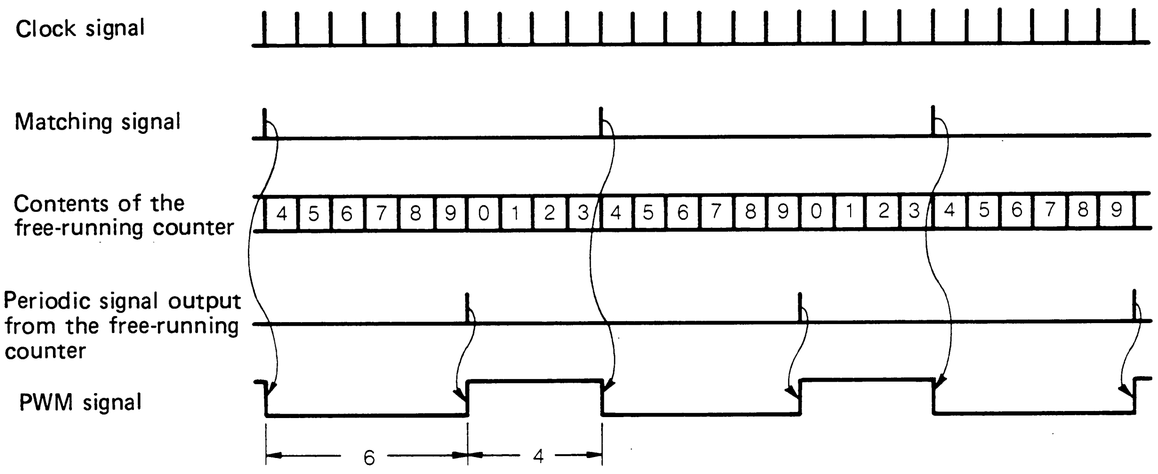


Fig. 4-7 PWM signal timing chart (cont'd)

4-5. REFERENCE VOLTAGE GENERATION CIRCUIT

The reference voltage generation circuit consists of a reference voltage circuit, a switching circuit, a low-pass filter, and an impedance converter. This circuit divides the time width of a stable Zener voltage with the PWM signal received from the time width modulation circuit. Figure 4-8 shows a block diagram of the reference voltage generation circuit.

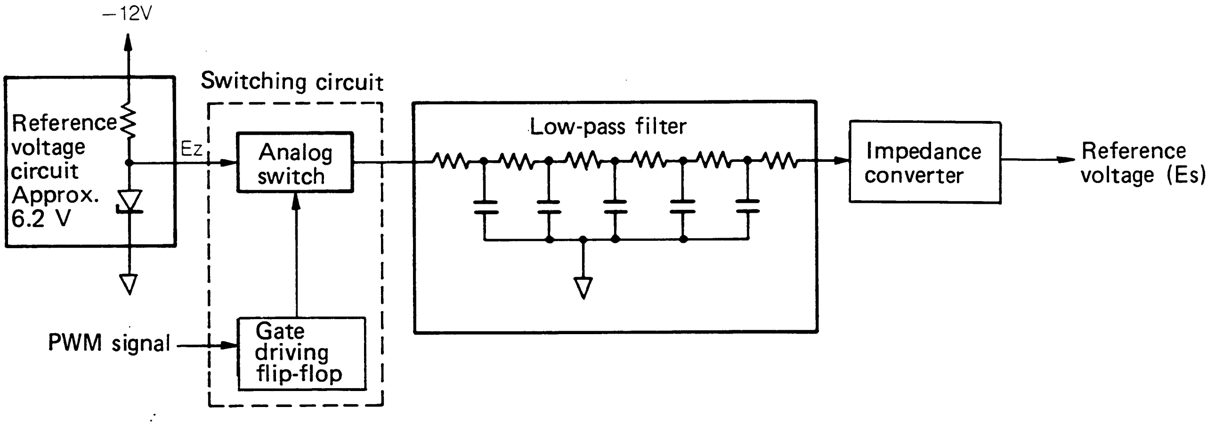


Fig. 4-8 Reference voltage generator circuit block diagram

4-6. REFERENCE VOLTAGE CIRCUIT

The analog circuit has two power lines for +18 V and -12 V. Since the +18 V and -12 V power supplies directly affect the output stability, an operational amplifier and metal film resistors are used for the +18 V and -12 V power voltage generators so that they supply stable power voltages against voltage fluctuations, temperature variations, and aging, keeping the output impedance low.

The reference voltage Ez, which is generated at a zener diode, is the most significant factor in determining the operational stability of the TR6142.

The reference voltage Ez is sent to the switching circuit where it is converted to a pulse train having a duty ratio proportional to the set output level according to the PWM signal.

4-7. SWITCHING CIRCUIT

The switching circuit consists of a gate driving flip-flop and an analog circuit. The switching circuit switches the Zener voltage of approximately 6.2 V generated at the Zener diode using the PWM signal received through a pulse transformer, sending the resultant signal to the following low-pass filter, where a DC voltage proportional to the set output level is generated. Figure 4-9 shows the switching circuit.

The pulse transformer insulates the analog circuit from the logic circuit in terms of direct current. The output of the pulse transformer triggers the gate driving flip-flop so that the gate driving flip-flop outputs signals to the analog switch.

FETs Q10 and Q11 are analog switches. Q12 and Q13 are flip-flop outputs to turn on/off the Q10 and Q11, respectively.

When Q13 goes off, Q11 goes on. At the same time, Q12 goes on to turn Q10 off. Es equals 0 in this case.

When Q13 goes on and Q12 off, Q11 and Q10 go off and on, respectively. Es equals Ez in this case.

Potentiometer R80 enhances the linearity by correcting the time constant errors caused by the turn-on and turn-off resistances of Q10 and Q11.

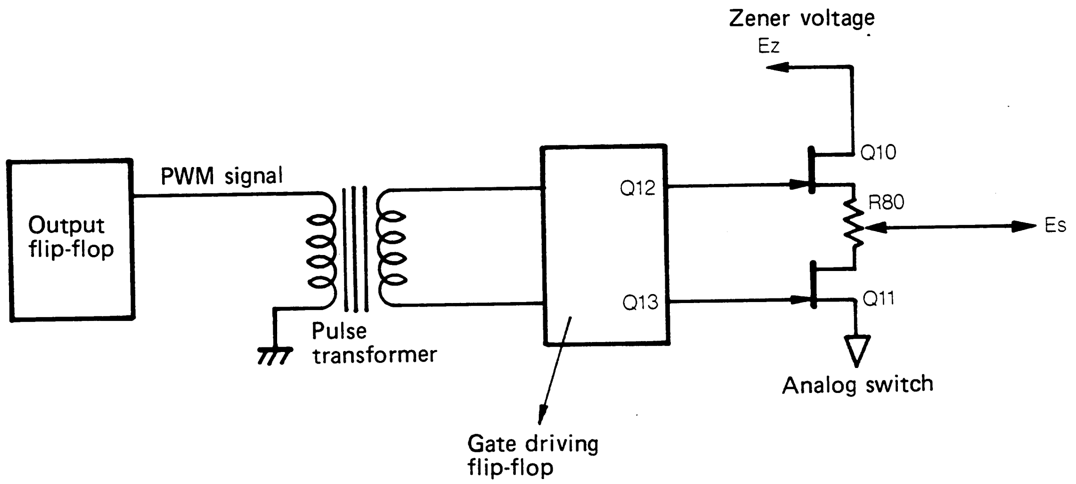


Fig. 4-9 Switching circuit

4-8. LOW-PASS FILTER

The signal generated by dividing time width of the Zener voltage, that is the reference voltage, is sent to a five-stage R-C ladder filter. This filter is a low-pass filter which passes signals with frequencies from DC to the cut-off frequency and suppresses signals with higher frequencies.

4-9. IMPEDANCE CONVERTER

The output impedance of the low-pass filter is very high because it consists of resistors and capacitors, which are passive elements. It is therefore necessary to convert the output impedance of the low-pass filter by connecting an impedance converter to its output. The impedance converter is an operational amplifier (with a gain of 1) having an FET as its input. The input impedance is high and the output impedance is low.
Figure 4-10 shows the impedance converter.

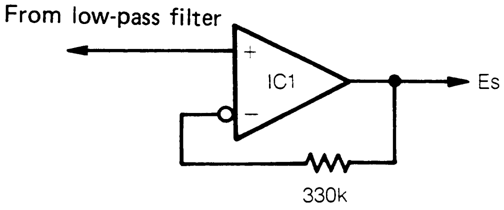


Fig. 4-10 Impedance converter

4-10. OUTPUT AMPLIFICATION CIRCUIT

The output amplification circuit consists of a differential amplifier having an FET as its input, feedback resistors and relays for range switching, and protection circuits to protect the circuit from overvoltage and overcurrent.
Figure 4-11 shows the output amplification circuit.
The input impedance of the differential amplifier is high since it uses an FET as its input.
If the impedance of the load connected to the output terminals becomes extremely low during voltage output, ICV is driven by the current flowing through RS1 and detects an overcurrent. If an overvoltage occurs during current output, ICI detects it using RS2 and RS3.
Both ICV and ICI apply negative feedback voltages to the base of Q17 through Q22 in order to lower the output. At the same time, ICL is driven to light the OVERLOAD lamp to indicate an overload.
Figure 4-11 shows the output amplification circuit.

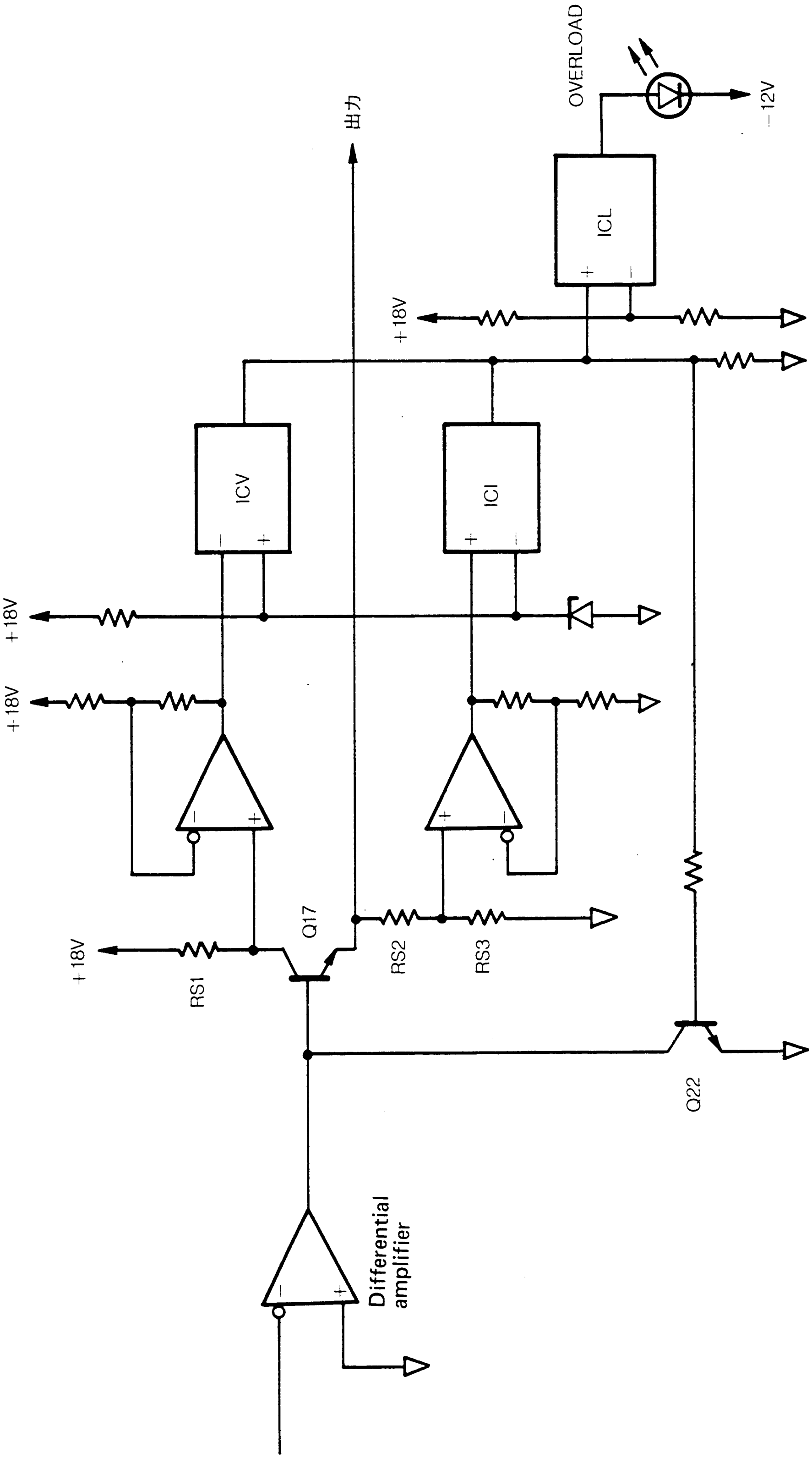
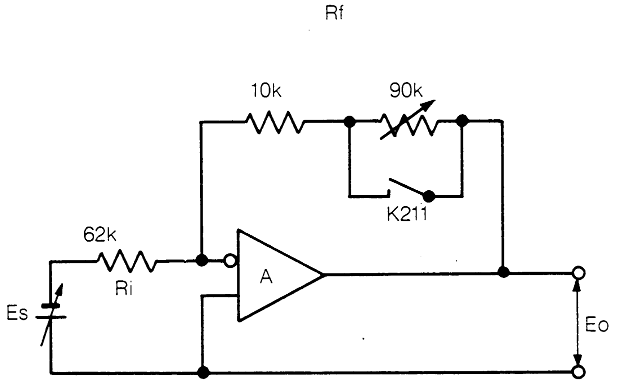


Fig. 4-11 Output amplification circuit

4-11. ATTENUATOR CIRCUIT

For each range, the feedback resistors are arranged as follows:

(1) 1 V and 10 V ranges

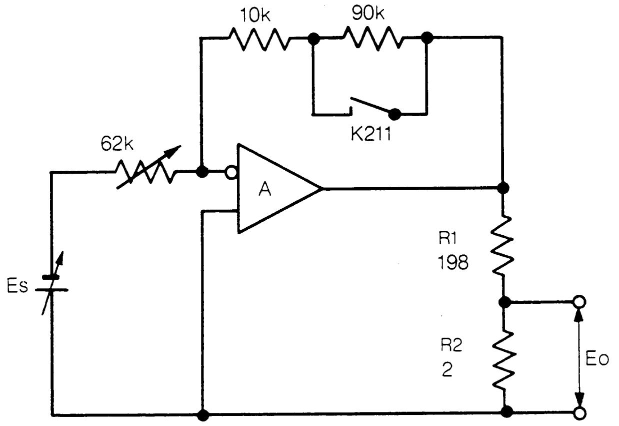


Range \ Relay	K211
1V	ON
10V	OFF

Fig. 4-12 1 V and 10 V ranges

(2) 10 mV and 100 mV ranges

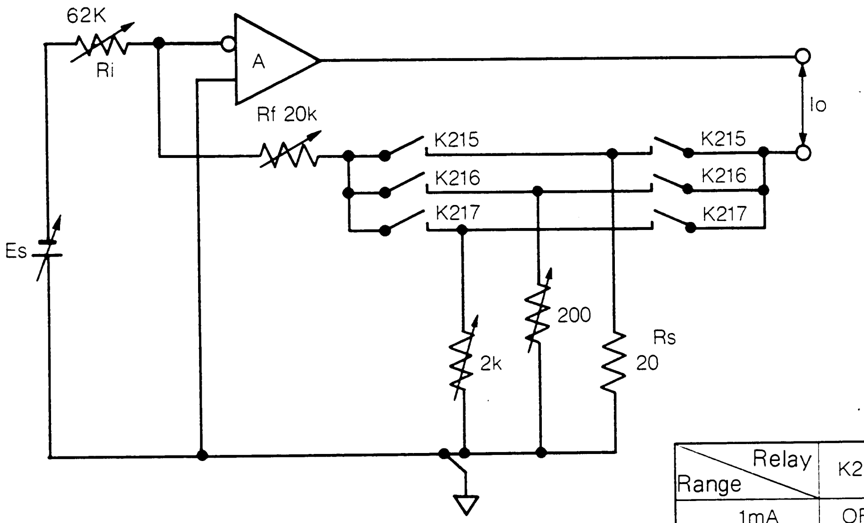
For these ranges, the outputs for the 1 V and 10 V ranges are divided by 100 by resistors R1 and R2.



Range \ Relay	K211
10mV	ON
100mV	OFF

Fig. 4-13 10 mV and 100 mV ranges

(3) 1 mA, 10 mA, and 100 mA ranges



Relay Range	K215	K216	K217
1mA	OFF	OFF	ON
10mA	OFF	ON	OFF
100mA	ON	OFF	OFF

Fig. 4-14 1 mA, 10 mA, and 100 mA ranges

(4) Voltage output

When the reference voltage Es output from the reference voltage generation circuit is applied to the inverse input of the differential amplifier through input resistor Ri, the output of the differential amplifier is fed back to the inverse input, through feedback resistor Rf, to control the voltage at the inverse input, through transistor Q17, and make it 0 V.

Accordingly, the output voltage Eo is give by the following expression:

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

Ri and Rf are fixed in each range. So, an output voltage Eo proportional to the reference voltage Es can be obtained when the reference voltage Es is varied within a range between approximately -6.3 V and 0 V.

This voltage can be used as a standard voltage supply since the output impedance of the differential amplifier is extremely low because of the large amount of negative feedback.

(5) Current output

Like Eo for the voltage output, eo can be given by the following expression:

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

Since the potential at the differential amplifier input is 0 V, the output current value is obtained by dividing eo by the combined resistance of Rf and Rs connected in parallel. This is a constant current not affected by the load resistance RL.

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

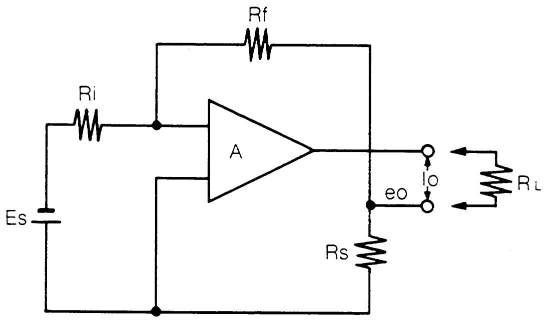


Fig. 4-15 Current output

MEMO

SECTION 5
GPIB INTERFACE

5-1. INTRODUCTION

The adoption of the GPIB* interface permits the TR6142 Programmable DC Voltage/Current Generator to receive controller commands to set DC voltage and current values for generation, to store them in the internal memory, to specify the first channel No., last channel No., scanning mode, and step time, to switch between the OPERATE and STANDBY state, to perform step scanning, to start automatic scanning, and to clear the set values. Furthermore, the TR6142 can issue a service request (SRQ) to the controller when a limit value is exceeded, a syntax error occurs during setting, setting is completed, or when automatic scanning is completed.

* GPIB: General Purpose Interface Bus

5-2. OUTLINE OF THE GPIB

The GPIB is an interface system that connects a measuring instrument to a controller and peripheral equipment with a simple cable (bus lines). The GPIB is superior to conventional interface systems in expandability and handliness. It has electrical, mechanical, and functional compatibility with products of other manufacturers. Only one bus cable is required to configure a variety of systems from simple ones to automated measuring systems having high functional capabilities.

To use the GPIB system, an address must be assigned to each device connected to the bus lines.

Each device participating in the GPIB system can have one or more of three roles: controller, talker, and listener.

Only one talker can send data to bus lines and multiple listeners can receive that data at any time during system operation.

The controller specifies addresses of the talker and listeners, transferring data from the talker to the listeners or setting instrumentation conditions, from the controller itself (which functions as a talker in this case) to the listeners.

Asynchronous, bidirectional data transfer is performed between the devices using eight data lines in bit-parallel, byte-serial form. These data lines permit the free combination of high speed and low speed devices to be connected because an asynchronous system is used to operate them.

Data (messages) exchanged between the devices include measuring data, instrumentation conditions (programs), and various commands. The ASCII code is used for data representation.

In addition to the eight data lines described above, the GPIB system has three handshake lines to control asynchronous data transfer between the devices, and five control lines to control the information flow in the bus.

- The handshake lines carry the following signals:

  DAV (Data Valid): Indicates the validity of data in the data line.

  NRFD (Not Ready For Data): Indicates that listening devices are not ready to receive further data.

  NDAC (Not Data Accepted): Indicates that data reception is not completed.

- The control lines carry the following signals:

  ATN (Attention): Enables a device to identify the signal on the data lines as an address, a command, or other information.

  IFC (Interface Clear): Used to initialize the interface system.

  EOI (End or Identify): Indicates the end of information transfer.

  SRQ (Service Request): Enables any device to request a service to the controller.

  REN (Remote Enable): Places remote controllable devices under remote program control.

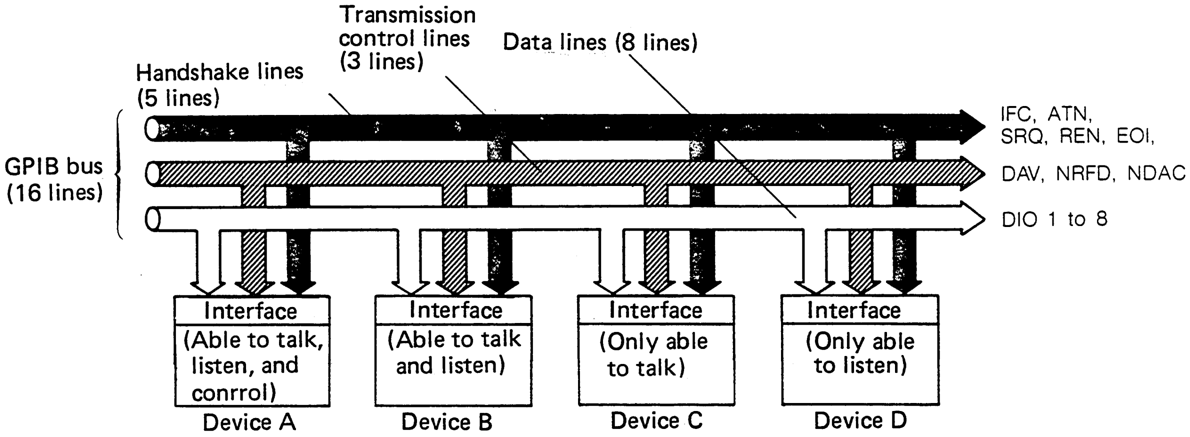
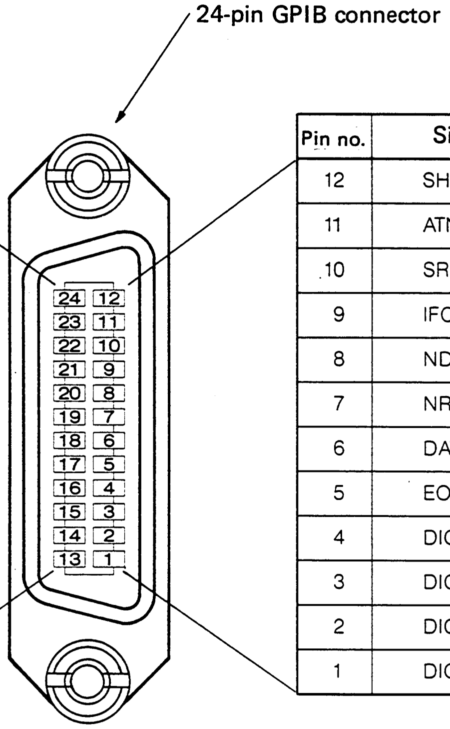


Fig. 5-1 GPIB bus structure

Signal name	Pin no.
GND LOGIC	24
GND (ATN)	23
GND (SRQ)	22
GND(IFC)	21
GND (NDAC)	20
GND (NRFD)	19
GND (DAV)	18
REN	17
DIO 8	16
DIO 7	15
DIO 6	14
DIO 5	13



Pin no.	Signal name
12	SHIELD
11	ATN
10	SRQ
9	IFC
8	NDAC
7	NRFD
6	DAV
5	EOI
4	DIO 4
3	DIO 3
2	DIO 2
1	DIO 1

Fig. 5-2 GPIB connector pin assignment

5-3. SPECIFICATIONS

5-3-1. GPIB Specifications

Standard: IEEE standard 488-1978

Code system: ASCII code

Logical levels: Logical 0 (high) ... +2.4 V min.
Logical 1 (low) ... +0.4 V max.

Bus line termination: Each of the 16 bus lines is terminated as shown in Figure 5-3.

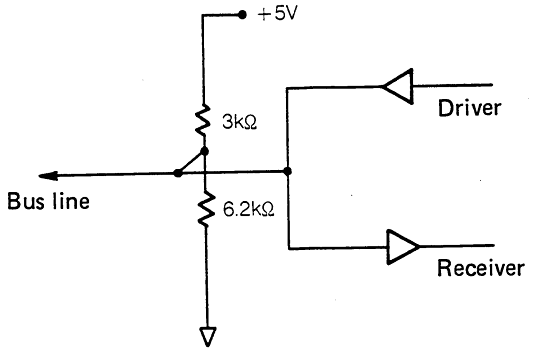


Fig. 5-3 Signal line termination

Driver : Open collector type
Output low voltage ... +0.4 V max., 48 mA
Output high voltage ... +2.4 V min., -5.2 mA

Receiver : Low for a voltage of +0.6 V max.
High for a voltage of +2.0 V min.

Bus cable length:
The total bus cable length must be (the number of devices connected to the bus) x 2 (m) or less, and must not exceed 20 m.

Address assignment:
A talker/listener address selected from 31 addresses can be set with the address switch on the rear panel.

Connector : 24-pin GPIB connector
57-20240-D35A (Amphenol) or equivalent

5-3-2. Interface Functions

Table 5-1 lists the interface functions.

Table 5-1 Interface functions

Code	Function
SH1	Source handshake capability
AH1	Acceptor handshake capability
T6	Basic talker; serial poll, unaddressed to talk if addressed to listen
L3	Basic listener; listen only mode, unaddressed to listen if addressed to talk
SR1	Service request capability
RL2	Remote/local switching capability
PP0	No parallel poll capability
DC1	Device clear (SDC and DCL commands are available) capability
DT1	Device trigger (GET command is available) capability
C0	No controller capability
E2	Open collector bus driver

5-4. HANDLING PROCEDURES

5-4-1. Connection to Component Devices

Since the GPIB system is configured with may devices, pay special attention to the following points when preparing to operate the entire system:

(1) Check the states (preparations) and operations of the TR6142, controller, and peripheral equipment referring to the instruction manuals of the respective devices before connecting them to the bus.

(2) The connection cable for connecting to a measuring instrument and the bus cable for connecting to the controller must not be unnecessarily long. The total bus cable length must be (the number of devices connected to the bus) x 2 (m) or less, and must not exceed 20 m.
ADVANTEST provides the standard bus cables listed in Table 5-3.

Table 5-2 Standard bus cables (Optionally available)

Length	Name
0.5 m	408JE-1P5
1 m	408JE-101
2 m	408JE-102
4 m	408JE-104

(3) Do not stack more than two bus cable connectors, and fasten the connectors securely with the connector set screws.
The bus cable connectors are of piggyback type, which has both male and female connectors on opposite sides to permit stacked connections.

(4) Check the power requirements, grounding, and setting conditions, as required, of each component device before turning its power on.
Turn on the power for all the devices connected to the bus; otherwise, normal system operation is not guaranteed.

(5) Disconnect the power cable from the AC power receptacle before connecting or disconnecting the bus cable.

5-4-2. Address Setting

a. Setting method of ADDRESS

① Press the STEP and LOCAL switches in this order to produce the A-◯◯ condition on the display.

② Set the number (0-30) to the address by the numerical key.

③ Press the STEP switch to terminate the setting.

Setting example for ADDRESS 17 is shown in Table 5-3.

b. Setting method of LISTEN ONLY

① Press the STEP and LOCAL switches in this order to produce the A-◯◯ condition on the display.

② Set a number larger than the one available for the GPIB address (31 or more) by the numerical key.

③ "LonL" will appear on the display about 700 ms after the number setting.

④ Press the STEP switch to terminate the setting.

The system is placed in the LISTEN ONLY mode independently from the preset address, and is then dedicated to a listener function.

NOTE

Press the STEP and LOCAL switches in order. When they are set to bcd, they are separated from the GPIB system. Repress the LOCAL switch, and reset it to A -◯◯.

Table 5-3 ADDRESS setting

Switch operation	Display
STEP → LOCAL	Continuous mode → Step time → A-00 Present condition
1	A-01
7	A-07
STEP	Continuous mode

Table 5-4 LISTEN ONLY setting

Switch operation	Display
STEP → LOCAL ☐	Continuous mode → Step time → A- 17 Present condition
☐ 3	A-73 → LonL Approx. 700 ms
STEP	Continuous mode

Table 5-5 Address codes

ASCII code character	Decimal code
LISTEN	
SP	00
!	01
"	02
#	03
$	04
%	05
&	06
	07
(	08
)	09
*	10
+	11
'	12
-	13
o	14
/	15
0	16
1	17
2	18
3	19
4	20
5	21
6	22
7	23
8	24
9	25
:	26
;	27
	28
=	29
	30

5-4-3. General Operating Precautions

(1) Only mode

To use this instrument in the only mode, press the STEP and LOCAL switches in this order. "LonL" will appear on the display. Also place the mate device on the bus in the only mode. When the instrument is used in the only mode, the controller must be left inactive. Otherwise, normal system operation is not guaranteed.

(2) Power intermission during operation

Normal system operation is not guaranteed after a power intermission (including instantaneous intermission) occurs during the operation of the GPIB system including this instrument. After the power is restored, this instrument is normally initialized to the values stored in the backup memory. Consideration should also be given to the states of the other devices in the GPIB system after a power intermission.

(3) Controller interrupts during data transfer between devices

The GPIB system permits data transfer between devices other than the controller.

If the controller issues an interrupt request to enter the serial polling mode or to add a new listener to the system during data transfer (during handshaking) between devices, the data transfer between the devices stops to give priority to the controller interrupt operation. The data transfer continues after the interrupt operation is terminated.

In general, a GPIB system which permits data transfer between interconnected devices should be programmed so that the controller can recognize the state of data transfer between devices.

(4) Changing the address settings during operation

If the address of this instrument is changed during operation, the system recognizes and uses the new address immediately after the change. The switching of "LonL" and "bcd" can be performed in the same way as address changing.

(5) This instrument assumes the states listed in Table 5-6 when the POWER switch is set to ON and when receiving various commands.

5-5. STATE OF TR6142 TO COMMANDS

Table 5-6 lists the state of TR6142 to commands.

Table 5-6 TR6142 setting status according to commands

Command	Talker (no lamp)	Listner (lamp)	SRQ (lamp)	Status byte	Panel key setting
POWER ON	Cleared	Cleared	Cleared	Cleared	Initialized to the backup data.
IFC	Cleared	Cleared	/	/	/
DCL, SDC, or C			Cleared	Cleared	Initialized
GET or E	/	/	Cleared	The setting completion bit is cleared.	OPERATE state
TR6142 addressed to talk	Set	Cleared	/	/	/
Talker addressing to other devices	Cleared	/	/	/	/
Talker unaddressing	Cleared	/	/	/	/
TR6142 addressed to listen	Cleared	Set	/	/	/
Listner unaddressing	/	Cleared	/	/	/
Serial polling	/	/	Cleared	/	/

Note: Each slash (/) indicates that the previous state remains unchanged.

DCL: Device Clear

SDC: Selected Device Clear

GET: Group Execute Trigger

5-6. LISTENER FORMAT (PROGRAM CODES)

This instrument can receive setting data from the controller and issue service requests to the controller as follows if a number is set in an address as A-○○ (○○ includes a number within 0 to 30) by remote function switching and it is addressed to listen. (The single-line bus signal REN must be set to true (logical 1).

5-6-1. List of Program Code

Item	Code	Contents	initialization
Operation	E	Sets in the operate mode.	
	H	Sets in the standby mode.	o
	C or C0	Clears the setting value, and sets in the standby mode.	
Function & range	V2	10mV	
	V3	100mV	
	V4	1V	o
	V5	10V	
	I1	1mA	
	I2	10mA	
	I3	100mA	
Continuous operation function *	K0	Increments the 10^0 digit continuously.	
	K1	Increments the 10^1 digit continuously.	
	K2	Increments the 10^2 digit continuously.	
	K3	Increments the 10^3 digit continuously.	
Continuous operation function *	K4	Decrements the 10^0 digit continuously.	
	K5	Decrements the 10^1 digit continuously.	
	K6	Decrements the 10^2 digit continuously.	
	K7	Decrements the 10^3 digit continuously.	
Buffer function for setting data	B	Stores the following data and the range setting code to the buffer, and outputs them by using the operation code E.	
Service request	S0	Issues the service request (SRQ).	
	S1	Does not issue the service request (SRQ).	o

* Applying the control signal to the EXT. STEP input terminal stops the operation.

(cont'd)

Item		Code	Contents	initialization
Automatic scan	Scanning start /stop	T1	Starts the random/step scanning	
		T2	Starts the single scanning.	
		T3	Starts the repeat scanning.	
		C1	Stops the scanning. The channel is initialized to the first channel.	
		C2	Suspends the scanning temporarily. The channel is held and restarted by either of T1, T2, or T3.	
		C3	Ends the memory setting mode.	
	First/ last channel specification	SC	SC n n n , n n n Last channel First channel (nnn ranges from 0 to 159.) SC n n n Last channel (The first channel in this case is 0.)	
	Step time setting	SI	SI t t t Scan time The unit is 100ms. (ttt ranges from 2 to 100.)	

5-6-2. OPERATE/STANDBY Switching

The controller can place this instrument in the OPERATE or STANDBY state.

Program code	Contents	Remarks
E	Places the TR6142 in the OPERATE state. The OPERATE lamp comes on.	Addressing command GET is also available.
H	Places the TR6142 in the STANDBY state. The STANDBY lamp comes on.	
C or C0	Places the TR6142 in the STANDBY state, clearing the set values.	The SDC and DCL commands are also available.

5-6-3. Function and Range Setting

The controller can set the output range of the DC voltage or current to be generated.

① Voltage generation

Program code	Range
V2	10mV
V3	100mV
V4	1V
V5	10V

② Current generation

Program code	Range
I1	1mA
I2	10mA
I3	100mA

5-6-4. Output Voltage/Current Value Setting (Fixed Range)

The general data format for the controller to set the output voltage or current value is shown below:

D-XX·XXXCR LF

Block delimiter:
CR LF
CR
LF
EOI

Data to be set: five digits max. If the data exceeds five digits in length, the excess digits are ignored.

Polarity: - or + The default value is +.

Header: D Indicates that this is data.

5-6-5. Output Voltage/Current Value Setting (Automatic Range Setting)

The general data format for the controller to set the output voltage or current value is shown below:

D-XX·XXXVCR LF

Block delimiter:
CR LF
CR
LF
EOI

Unit: V
MV
MA

Data to be set: decimal fraction digits on the right of the lowest allowable decimal place are ignored.

Polarity: - or + The default value is +.

Header: D Indicates that this is data.

Table 5-7 lists automatic range setting according to data setting.

Table 5-7 Automatic Range Setting

	Data setting	Indication	Range
Unit: mV	0 MV to 11.999 MV	0.000 mV to 11.999 mV	10 mV
	12 MV to 119.99 MV	12.00 mV to 119.99 mV	100 mV
	120 MV to 1199.9 MV	.1200 V to 1.1999 V	1 V
	1200 MV to 11999 MV	1.200 V to 11.999 V	10 V
Unit: V	0 V to 0.011999 V	0.000 mV to 11.999 mV	10 mV
	0.012 V to 0.11999 V	12.00 mV to 119.99 mV	100 mV
	0.12 V to 1.1999 V	.1200 V to 1.1999 V	1 V
	1.2 V to 11.999 V	1.200 V to 11.999 V	10 V
Unit: mA	0 MA to 1.1999 MA	.0000 mA to 1.1999 mA	1 mA
	1.2 MA to 11.999 MA	1.200 mA to 11.999 mA	10 mA
	12 MA to 119.99 MA	12.00 mA to 119.99 mA	100 mA

5-6-6. Data Format for Storing the Output Voltage and Current Values in Memory

$\underbrace{\text{CH}}_{①}, \underbrace{\text{data}}_{②}, \underbrace{\text{range}}_{③}, \underbrace{\text{CH}}_{④}, \text{data, range} \ldots \underbrace{\text{CR LF}}_{⑤} \ldots \underbrace{\text{C3}}_{⑥}$

① Channel

Nnnn N: header When an N is detected, the TR6142 enters the memory setting mode.

nnn: channel number (0 to 159)

② Data

```
D-XX.XXX    (Fixed range)
D-XX.XXXV    (Automatic range setting)
└┘└┘└────┘└┘
│ │  │     └ Unit: V, MV, MA (automatic range setting)
│ │  │             For a fixed range, select a range code from
│ │  │             the table given in item ③ below.
│ │  │
│ │  └────── Data to be set: decimal fraction digits on the right
│ │                          of the lowest allowable decimal
│ │                          place are ignored.
│ │
│ └───────── Polarity: - or +  The default value is +.
│
└─────────── Header: D  Indicates that this is data.
```

③ Range

Range code	Range
V2	10mV range
V3	100mV range
V4	1V range
V5	10mA range
I1	1mA range
I2	10mA range
I3	100mA range

The range code may be omitted when the data is set in the automatic range setting mode.

④ Channel

Channel numbers other than the first one (indicated by ① in the format) may be omitted. In this case, the channel number is automatically incremented by one for inputting the next data.

⑤ Block delimiter

Any one of the following codes may be used:

CR LF, LF, CR, EOI

⑥ Memory setting end code

Inputting program code C3 terminates the memory setting mode.

5-6-7. Memory Data Recall Format

$$\underbrace{\text{CH}}_{\textcircled{1}},\ \underbrace{\text{T1}}_{\textcircled{2}},\ \underbrace{\text{T1}}_{\textcircled{2}},\ \ldots\ \underbrace{\text{CR LF}}_{\textcircled{4}}\ \underbrace{\text{C3}}_{\textcircled{4}}$$

① Channel

Nnnn N: header

nnn: channel number (0 to 159)

② Program code

T1: Specifies that step scanning should be performed. This code is effective even if it follows a block delimiter.

③ Block delimiter

Any one of the following codes may be used:

CR LF, CR, LF, EOI

④ Memory setting end code

Inputting program code C3 terminates the memory setting mode.

5-6-8. Program Codes for Automatic Scanning

Parameter	Code	Contents
Scanning start/ stop, etc.	T1	Step scanning
	T2	Single scanning start
	T3	Repeat scanning
	C1	Scanning stop. Initializes the channel count to the first channel.
	C2	Scanning halt. Holds the current channel so that scanning starts with that channel when T1, T2, or T3 is received.
	C3	End of memory setting mode
Channel specification	N	$\mathrm{N}\underbrace{\mathrm{nnn}}$ Channel number (nnn is a number from 0 to 159)
First/last channel specification	SC	$\mathrm{SC}\ \underbrace{\mathrm{nnn}}_{\text{First channel}},\underbrace{\mathrm{nnn}}_{\text{Last channel}}$ (nnn is a number from 0 to 159) $\mathrm{SC}\ \underbrace{\mathrm{nnn}}$ Last channel (in this case, the first channel is assumed to be channel 0)
Step time setting	SI	$\mathrm{SI}\ \underbrace{\mathrm{ttt}}$ Scan time. The single unit is 100 ms.(ttt is a number from 2 to 100)

Notes: 1) Scanning is started from the xx channel if a channel set as "Nxx".

2) Scanning is started from the currently-set channel, if required, through the program code "T○".

5-6-9. Continuous Function

Program mode	Content
K0	continuous increment in the 10^0 digit
K1	continuous increment in the 10^1 digit
K2	continuous increment in the 10^2 digit
K3	continuous increment in the 10^3 digit
K4	continuous increment in the 10^0 digit
K5	continuous increment in the 10^1 digit
K6	continuous increment in the 10^2 digit
K7	continuous increment in the 10^3 digit

This function enables the set value to be continuously varied in the digits 10^0 through 10^3 using the corresponded program codes. The system begins setting when it receives the continuous setting code, and terminates setting when it receives the signal at the EXT.STEP input terminal on the rear panel. The status byte D6 is set to 1 and SRQ is sent out (in case of the S0 mode only).

NOTE

1. When other program code is received during the continuous variable setting, the operation according to this program code is performed. Status byte is not set when the continuous variable setting is terminated.
   In case of reception of another continuous variable setting code, however, the new setting is started.
2. The status byte D6 is cleared when the continuous variable setting code is received.

5-6-10. Buffer Function of Set Data

Program code	Content
B	The successive data and range setting codes are stored in a buffer and are output by the request for the operate code (E).

If "B" has been received before the setting code, no changes in the display will appear while the setting code is temporarily stored in a buffer. The setting code stored in the buffer can be output to the display by the reception of operate code (even during operation).

NOTE

1. The operate code is available for the normal operations.
2. The setting code and range code are updated to the most recent codes after the reception of "B".
3. If a program code other is than the data setting code, range setting code and operate code, the operation is performed according to this code and the previous buffer code is made invalid.

5-6-11. Initial Values

The TR6142 initializes the instrumentation conditions to the values listed in the following table when it receives a universal command DCL, an addressing command SDC, or a program code C from the controller.

Parameter	Initial value
OPERATE/STANDBY state	STANDBY
Range	V4 (1 V range)
Output data	V+0 (voltage output, 0 V)
Step time	---
Channel	First channel
Memory storing data (all data)	---
First channel	---
Last channel	---
Automatic scanning mode	---
Service request	S1 (service request disabled)

Note: --- indicates the value set before the power was turned off.

5-6-12. Service Request (SRQ) Issuing Mode Setting

The SRQ issuing mode can be specified using program codes S0 and S1.

S0 mode: This is a mode in which the TR6142 issues SRQs (service requests).

The TR6142 issues an SRQ when the limiter in the TR6142 operates, when a syntax error occurs, when setting with panel keys or from the controller is completed in the OPERATE state, or when automatic scanning is completed.

S1 mode: This is a mode in which thew TR6142 does not issue SRQs.

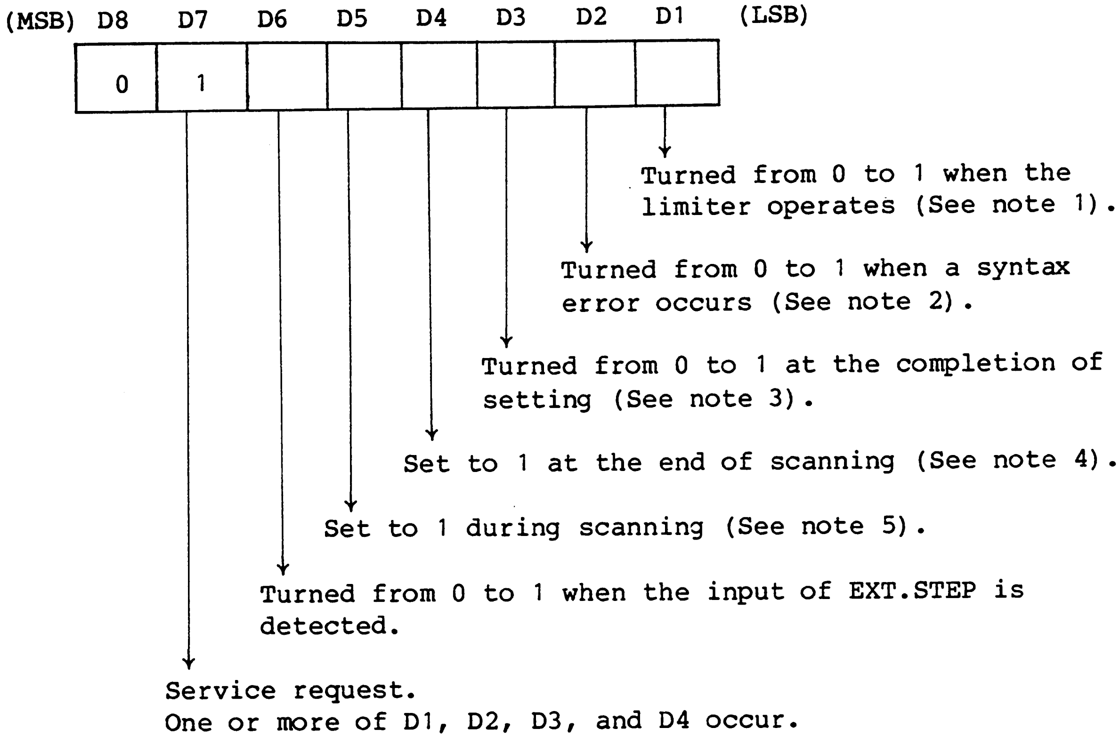
5-6-13. Service Request

Service requesting causes:

The limiter in the TR6142 operates, a syntax error occurs, setting with panel keys or from the controller is completed in the OPERATE state, or automatic scanning is completed.

Status byte:

When issuing a service request (SRQ), the TR6142 sends the following status byte to the controller in response to serial polling from the controller.



D1: Turned from 0 to 1 when the limiter operates (See note 1).

D2: Turned from 0 to 1 when a syntax error occurs (See note 2).

D3: Turned from 0 to 1 at the completion of setting (See note 3).

D4: Set to 1 at the end of scanning (See note 4).

D5: Set to 1 during scanning (See note 5).

D6: Turned from 0 to 1 when the input of EXT.STEP is detected.

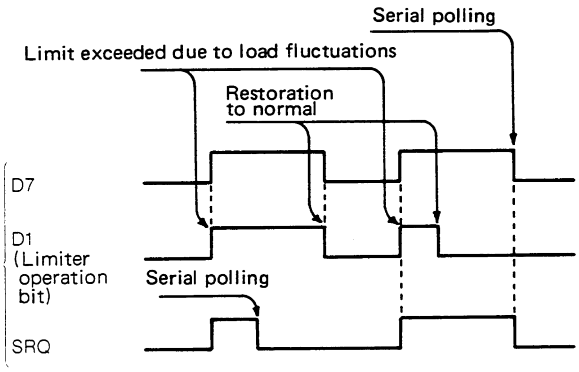
D7: Service request.
One or more of D1, D2, D3, and D4 occur.

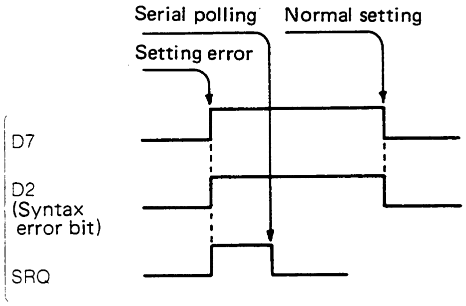
Notes: 1) The limiter operates when the load current exceeds the limit value during voltage generation or when the output voltage exceeds the limit value during current generation due to fluctuations in the load in the OPERATE state.
Bit D1 is reset to 0 when the TR6142 is restored to normal after the limiter has operated. It the TR6142 is restored to normal before it is interrogated in serial polling, bit D7 is held on until the interrogation.

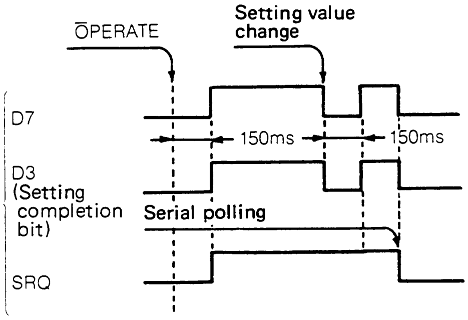
2) A syntax error occurs when the TR6142 detects an undefined code, a data value is set over the allowable range, or no range code is specified during memory setting in the fixed range format.
Bit D2 is reset to 0 when a block delimiter and then the next setting code is received after the syntax error has occurred.

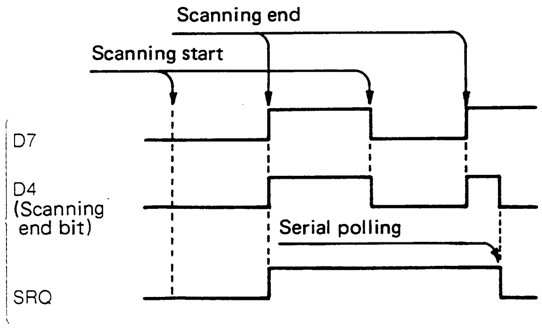
3) The completion of setting occurs when the TR6142 is switched from STANDBY to OPERATE state or about 150 ms after output voltage or current value is set in the OPERATE state. Bit D3 is reset to 0 when the set value is next changed, the TR6142 is switched from OPERATE to STANDBY state or it is interrogated in serial polling.

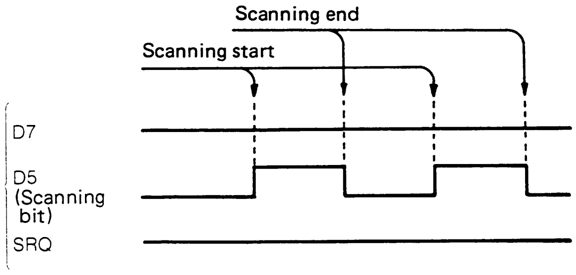
4) The end of scanning occurs when single scanning reaches the last channel. Bit D4 is reset to 0 when the next scanning starts or the TR6142 is interrogated in serial polling.
5) The scanning state is held during single or repeat scanning.
6) The operation of each bit of the status byte is illustrated below:


Serial polling
Limit exceeded due to load fluctuations
Restoration to normal
D7
D1 (Limiter operation bit)
Serial polling
SRQ


Serial polling
Normal setting
Setting error
D7
D2 (Syntax error bit)
SRQ


OPERATE
Setting value change
D7
150ms
150ms
D3 (Setting completion bit)
Serial polling
SRQ


Scanning end
Scanning start
D7
D4 (Scanning end bit)
Serial polling
SRQ


Scanning end
Scanning start
D7
D5 (Scanning bit)
SRQ

5-7. TALKER DESIGNATION FUNCTION

If the system is designated as a talker when it is placed in the GPIB mode, the following items can be set through the controller.

Basic format

$$\underbrace{\text{D ○}}_{①}\quad\underbrace{\pm\text{x.xxxx}}_{②}\quad\underbrace{\text{E }\pm\text{x}}_{③}\quad\underbrace{\text{CR LF}}_{④}$$

① Header

Code	Content
DV	Voltage setting
DI	Current setting

② Mantissa part ..... Polarity, five-digit number with a decimal point

③ Exponent part ..... "E", polarity, one-digit number

Setting range	Header	Mantissa part	Exponent part	Unit
10 mV	DV	±x.xxxx	E - 2	V
100 mV			E - 1	
1 V			E + 0	
10 V			E + 1	
1 mA	DI		E - 3	A
10 mA			E - 2	
100 mA			E - 1	

④ Block delimiter

Setting mode	Block delimiter
DL0	CR LF is output or EOI is simultaneously output with LF
DL1	Only LF is output
DL2	EOI is simultaneously output with the last byte

* When the system is designated as a talker, the panel set value is output to the controller according to the above format.

5-8. NOTES ON PROGRAMMING

5-8-1. Setting Programming Information

The range and output data value sent from the controller are set sequentially on the TR6142.

This means that, if more than one range code is consecutively sent from the controller, for example, the last code is set on the TR6142 (see Example 2).

A syntax error occurs when the TR6142 detects an undefined header code, an undefined code for an output range or limit value, or a setting outside the allowable range. Then, the TR6142 issues an SRQ signal to the controller.

Some examples of TR6142 setting using the HP-85 controller are shown below:

<Example 1>

```
OUTPUT  704;  "HV4  D1.1234 E"
  (1)  (2)(3) (4)(5)  (6)   (7)
```

(1) Specifies the HP-85 to the talker and TR6143 to the listener.

(2) Interface selector No.7 and TR6142 address (when it is set to 04).

(3) Places the TR6142 in the STANDBY state.

(4) Sets the output range to 1 V for DC voltage.

(5) Sets the output level to +1.1234 V.

(6) Switches the TR6142 to the OPERATE state.

- Code V4 sets the output range to 1 V, data D1.1234 sets the output level to +1.1234 V, and finally code E switches the TR6142 in the OPERATE state.
- The space codes and commas in the code string are ignored.

<Example 2>

```
OUTPUT 704; "HV4V5D+1.1234E"
             └┘└─┘└─┘└──────┘
             (1)(2)(3)  (4)
```

(1) Places the TR6142 in the STANDBY state.

(2) Sets the output range to 1 V.

(3) Sets the output range to 10 V.

(4) Sets the output level to +1.123 V.

- The output range is set to 5 V (10 V range), and a voltage of +1.123 V is output. The last digit 4 is ignored.

<Example 3>

```
OUTPUT 704: "HI8E"
              └┘
              (1)
```

(1) Undefined

- A syntax error occurs and the TR6142 issues a service request (SRQ) to the controller since code I8 is undefined.
- Data is set when a terminator is detected or program code other than this follows the value to be set.

5-8-2. Relationship Between Output Range and Data Setting

Pay attention to the relationship between the output range and data setting when setting the voltage or current output value in the fixed range mode.

A syntax error occurs if the data setting exceeds 119.99% of the specified output range.

<Example>

Range code	Range	Data setting	Output value	Remarks
V5	10 V	D+11.999	+11.999 V	Valid
		D+1.23456	+1.234 V	Valid
		D-0.0123	-0.0123 V	Valid
		D-13.0	Syntax error	The indicator holds the previous value.

5-8-3. Detection of Load Fluctuations or a Fault

The TR6142 may detect an overload for some load conditions in the OPERATE state.

The TR6142 issues a service request concerning an overload only once when detecting an overload due to load fluctuations or a fault.

<Example> Programming with the HP-85

```
OUTPUT 704; "V5 D+9.876E"
```

- The TR6142 applies the set voltage of +9.876 V to the load when it is placed in the OPERATE state. When a load current exceeding the current limit flows, the TR6142 detects an overload.

5-8-4. Others

(1) Note that all the set values are cleared and the initial values are set on the TR6142 when program code C is received.
This is also applied when the SDC or DCL command is received.
Use the H command to place the TR6142 in the STANDBY state without initializing the settings.

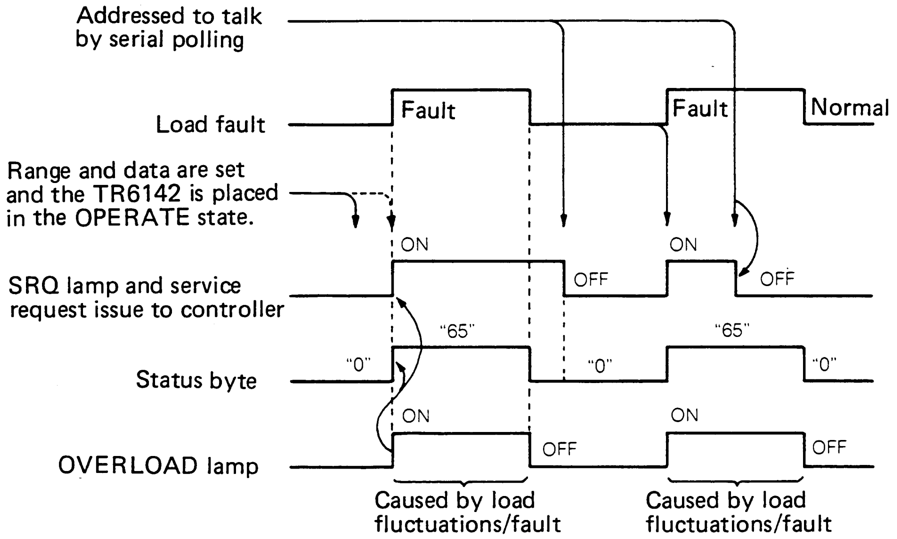
(2) When a syntax error occurs, the relevant information (the parameter in which the error is detected) is not set. This parameter retains the information which it had before the error occurred.

(3) Programs must be coded so that the TR6142 is placed in the STANDBY state before each range switching.

5-8-5. Service Request Operation

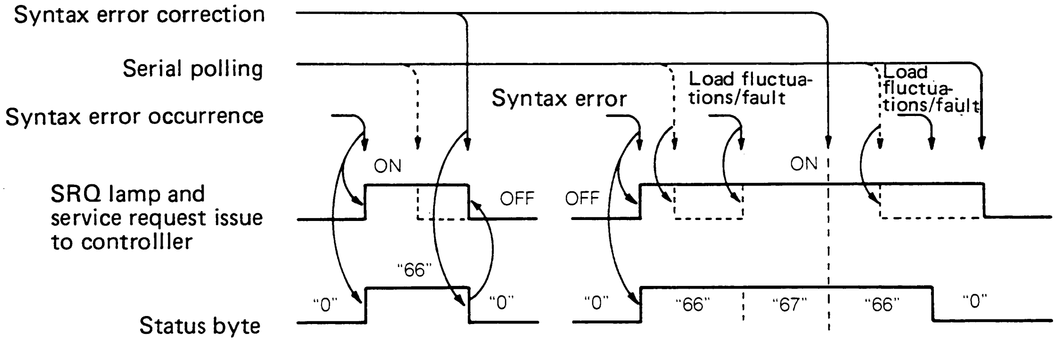
(1) The TR6142 operates as shown in Figure 5-4 (a) when issuing a service request as a result of an overload being detected. Take special care regarding operation when coding a program.

(2) The TR6142 operates as shown in Figure 5-4 (b) when a syntax error occurs or an overload and a syntax error occur simultaneously.



Note : An SRQ resulting from load fluctuations or a fault is cleared by serial polling only.

(a)



Note : After a syntax error occurs, the SRQ and status byte are cleared by correcting the syntax error.
A syntax error is corrected by inputting the corrected program statement.

(b)

Note: After a syntax error occurrs, the SRQ and status byte are cleared by correcting the syntax error.
A syntax error is corrected by inputting the corrected program statement.

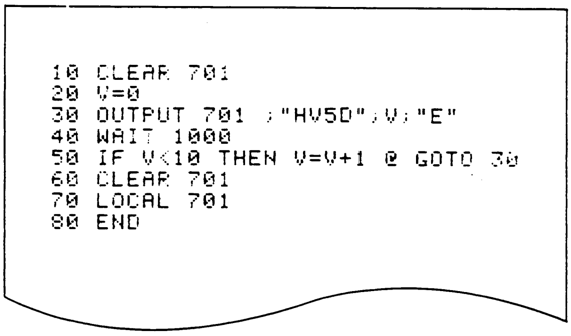
Fig. 5-4 Service Request Operation

5-9. PROGRAM EXAMPLES

(1) The controller makes the TR6142 to generate voltages between 0 V and 10 V in 1 V increments.

The HP-85 is used (device code = 1).

<Program>



```
10 CLEAR 701
20 V=0
30 OUTPUT 701 ;"HV5D";V;"E"
40 WAIT 1000
50 IF V<10 THEN V=V+1 @ GOTO 30
60 CLEAR 701
70 LOCAL 701
80 END
```

<Program description>

10 Clear the TR6142.

20 Set the first voltage value to be generated (0 V).

30 Place the TR6142 in the STANDBY state, specify a voltage range, set a voltage value to be generated (output), then switch the TR6142 in the OPERATE state.

40 Wait one second after the voltage is generated.

50 If the generated voltage does not exceed 10 V, increment the voltage value by 1 V.

60 Clear the TR6142.

70 Place the TR6142 in the local control mode.

(2) The controller makes the TR6142 to generate voltages between +10 V and -12 V in 2 V decrements. When the limiter operates, the controller recognizes that operation and prints the voltage generated that caused the limiter to operate. The controller detects SRQs issued from other devices, if any. Finally, a voltage of -12 V is set and a syntax error is detected.

The HP-85 is used (device code = 1).

Program

```
 10   CLEAR 7
 20   V=0 @ OUTPUT 701 ;"S0HV5D0E"
 30   ON INTR 7 GOSUB 120
 40   OUTPUT 701 ;"D"; 10-V
 50   WAIT 1000
 60   ENABLE INTR 7;8
 70   IF V<20 THEN V=V+2 @ GOTO 40
 80   CLEAR 701
 90   LOCAL 701
100   BEEP
110   END
120   ! SERVICE FOR DEVICE 1
130   S=SPOLL(701)
140   IF S<64 THEN CLEAR 7 @ PRINT
      "OTHER DEVICE" @ RETURN
150   IF BIT(S,0)=1 THEN PRINT "LI
      MIT OVER" @ PRINT 10-V
160   IF BIT(S,1)=1 THEN PRINT "SY
      NTAX ERROR" @ PRINT 10-V
170   RETURN
```

Program description

10 Clear the TR6142.

20 Initialize the TR6142 and place it in the SRQ issuing mode. Place the TR6142 in the STANDBY state, specify a voltage range, set a voltage value to be generated (output) to 0 V, then switch the TR6142 in the OPERATE state.

30 Declare the interrupt condition and processing routine statement number.

40 Set voltage value to be generated (output).

50 Wait one second after the voltage is generated.

60 Enable interrupts.

70 If V 22, increment the voltage value by 2 V, then return to line number 40.

80 Clear the TR6142.

90 Place the TR6142 in the local mode.

100 Make a beep.

110 End.

120 If an SRQ is issued, start with this line.

130 Interrogate device code 701 (TR6142) by serial polling, and place the contents of the status byte from device code 701 into S.

140 If S 64 (the TR6142 did not issue an SRQ), clear all devices and print "other device."

150 Detect a limit being exceeded and print the set voltage.

160 Detect a syntax error and print the set voltage.

170 Return to the previous routine.

(3) Different data are simultaneously output to two TR6142's (using HP9816 controller).

<Program>

```
 10   CLEAR 7
 20   OUTPUT 702;"D1. 111VE"
 30   OUTPUT 703;"D0. 012VE"
 40   !
 50   OUTPUT 702;"BD0V"
 60   OUTPUT 703;"BD-1. 111V"
 70   !
 80   SEND 7;MTA LISTEN 2 LISTEN 3
 90   SEND 7;DATA "E"
100   SEND 7;UNL
110   END
```

<Program description>

10 Clear the system.
20 Apply 0.111 V to the TR6142 with address 02.
30 Apply 0.012 V to the TR6142 with address 03.
40 Comment
50 Store 0 V in the buffer of the TR6142 with address 02. (Output is maintained at 1.111 V)
60 Store -1.111 V in the buffer of the TR6142 with address 03. (Output is maintained at 0.012 V)
70 Comment
80 Designate the TR6142's with address 02 and 03 as listeners simultaneously.
90 Output the different voltage values in the TR6142's with address 02 and 03 simultaneously according to operate code "E".
    The TR6142 with address 02   0V
    The TR6142 with address 03   -1.111V
100 Release the listener designations.
110 End.

(4) A voltage value is scanned in the continuous variable mode, terminated by the EXT.STEP input and then the value is displayed on the controller (using HP9816 controller).

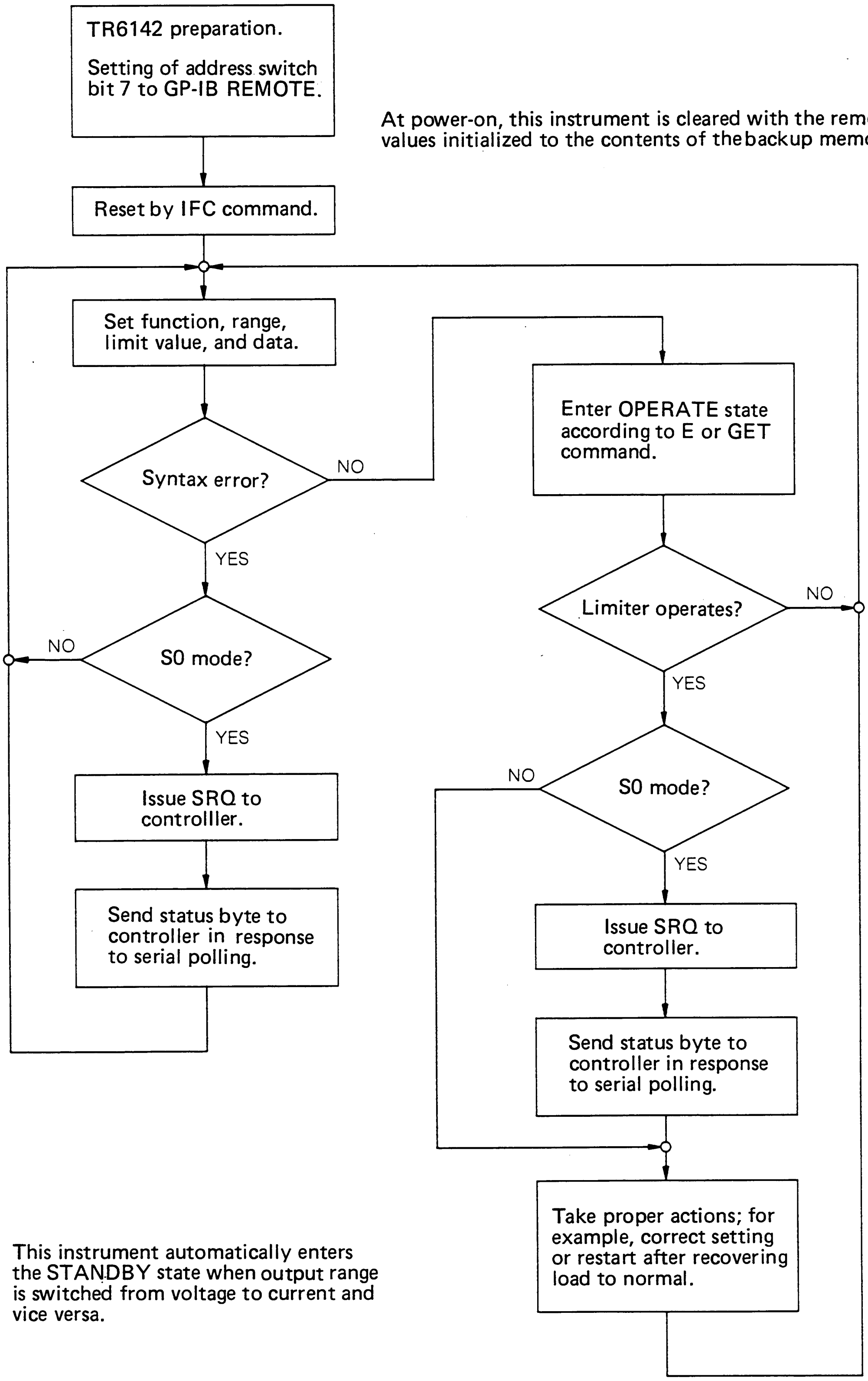
<Program>

```
 10   DIM Data$[24]
 20   ON INTR 7 GOSUB Serv_rtn
 30   Mask=2
 40   CLEAR 7
 50   OUTPUT 702;"S0"
 60   OUTPUT 702;"E"
 70   OUTPUT 702;"K0"
 80   ENABLE INTR 7;Mask
 90   GOTO 90
100   !
110   !
120   Serv_rtn: !
130             S=SPOLL (702)
140             IF BIT (S, 5)=0 THEN 180
150             ENTER 702;Data$
160             PRINT "DATA=;Data$
170             GOTO 200
180             ENABLE INTR 7;Mask
190             RETURN
200             END
```

<Program description>

10 Secure the data area.
20 Specify a processing routine in case of an occurrence of an SRQ interrupt.
30 Specify an SRQ enable.
40 Clear the system.
50 Place the TR6142 with address 02 in the SRQ sending mode.
60 Switch the TR6142 in the OPERATE state.
70 Continuously increment the 10^0 digit in TR6142.
80 Enable the SRQ interrupt.
90 Wait for the SRQ interrupt.
100 Comment
110 Comment
120 The following is the processing routine for the SRQ interrupt. (This processing routine is executed when an SRQ interrupt occurs due to the EXT.STEP input.)
130 Read the status byte in the TR6142 with address 02.
140 Branch to line number 180 if the status byte D5 is 0.
150 Read the panel set value of the TR6142 with address 02.
160 Display the read value.
170 Branch to line number 200 and end.
180 Enable the SRQ interrupt.
190 Return to the original routine.
200 End

5-10. GENERAL OPERATION FLOWCHART



At power-on, this instrument is cleared with the remote setting values initialized to the contents of thebackup memory.

This instrument automatically enters the STANDBY state when output range is switched from voltage to current and vice versa.

SECTION 6
TROUBLESHOOTING

6-1. INTRODUCTION

If the TR6142 malfunctions or if the stipulated accuracies of the TR6142 cannot be attained by calibration, locate the fault by referring to the troubleshooting procedure described in this section.

See Figure 6-1 for the test points, and parts locations in Section 8 for the parts to be checked.

6-2. PRELIMINARY INSPECTION BEFORE REPAIR

(1) First, it is necessary to determine whether the fault has been caused internally or externally.
Possible external causes of faults include AC line voltage drops, noise, induction, and poor connections.

(2) Check if the power fuse has blown and if the power cable is damaged.

(3) Before inspecting the inside of the TR6142, operate it according to the operating procedure described in SECTION 3 and guess which circuit block is in trouble based on the abnormal condition observed.

(4) Remove the case, and visually check for dislocated wiring, broken parts, printed circuit failures, and any abnormalities.

6-3. HOW TO REPLACE PARTS

After completing the preliminary inspection before repair as depicted in 6-2, check the suspected location of the fault with proper testing instruments, such as a digital multimeter and oscilloscopes, while referring to the troubleshooting examples mentioned in 6-4 and relevant circuit diagrams.

(1) Types of replacement parts

If any defective part is found, replace it with a good one. The replacement part must satisfy the performance specifications required for the circuit. As a rule, therefore, the replacement part must be the same as the one being replaced. If the same part is not available as a replacement, a substitute having the same specifications may be used except for semiconductors. When replacing a defective semiconductor, always use the same semiconductor.

(2) Replacing semiconductors

When replacing semiconductors, it must be remembered that semiconductors can easily be damaged by heat. Hold the defective semiconductor to be replaced with a pair of tweezers with a high thermal conductivity and quickly remove it using a soldering iron (of 30 W or less). If, when removing or inserting a semiconductor, the soldering iron is held in contact with the printed circuit board for longer than allowable, not only the copper plating on the circuit board but also the semiconductor itself may be damaged by heat.

(3) Replacing resistors and capacitors

When replacing defective passive elements such as resistors and capacitors, use good replacements having the same specifications as those of the parts to be replaced.

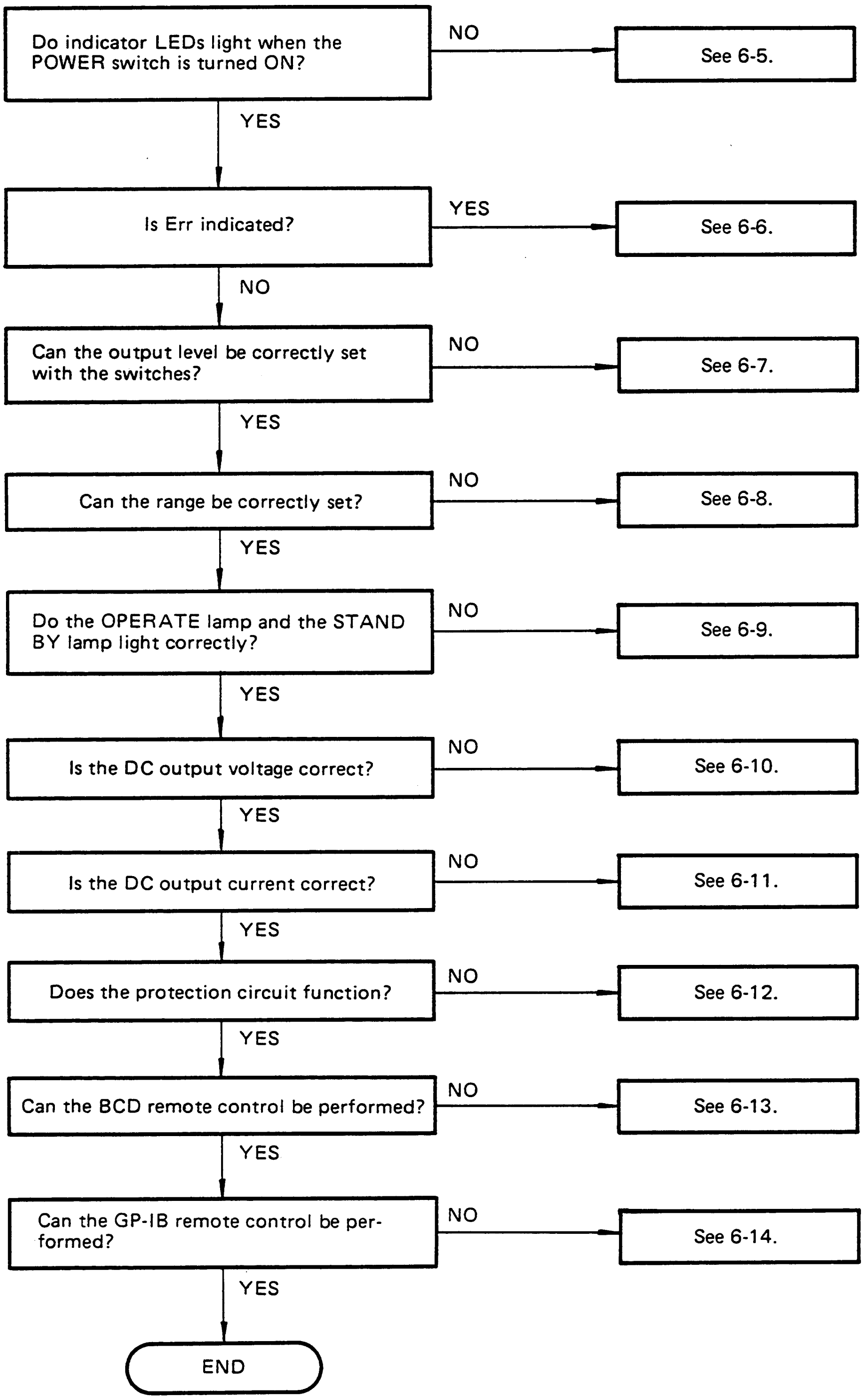
(4) Lead wire connections

When connecting lead wires, take care of the possible effect of induction at signal and AC power lines. To connect a lead wire, wind one or two turns around the appropriate point and quickly solder the connection, taking care not to damage the coating on the wire.

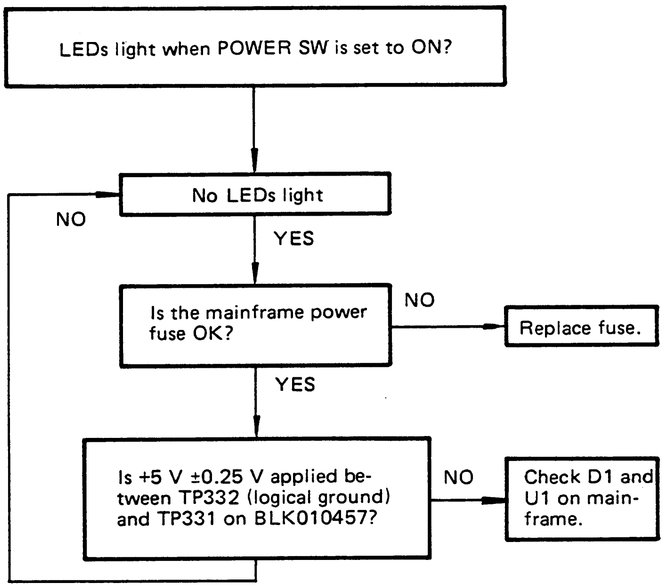
(5) Removing printed circuit boards

A printed circuit board can be removed by disconnecting the connectors from it and removing the screws fixing it in place.

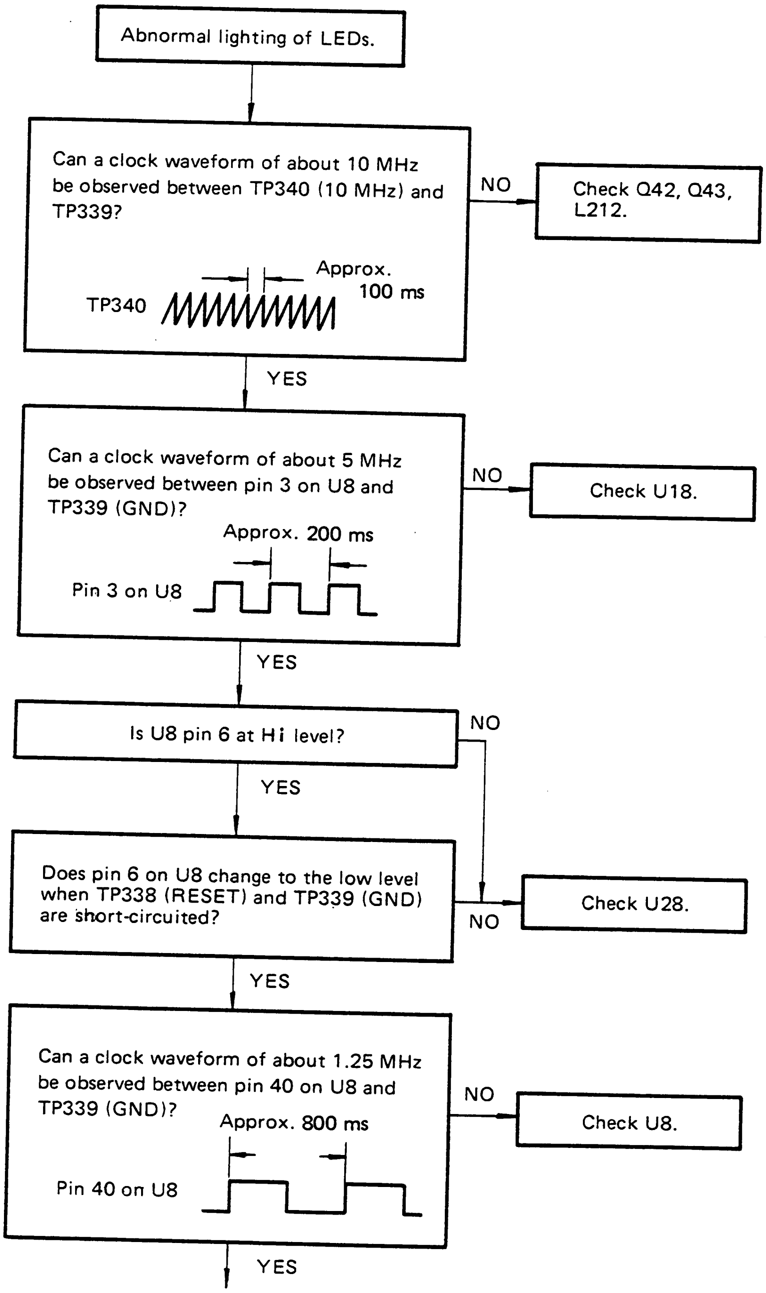
6-4. TROUBLESHOOTING EXAMPLES

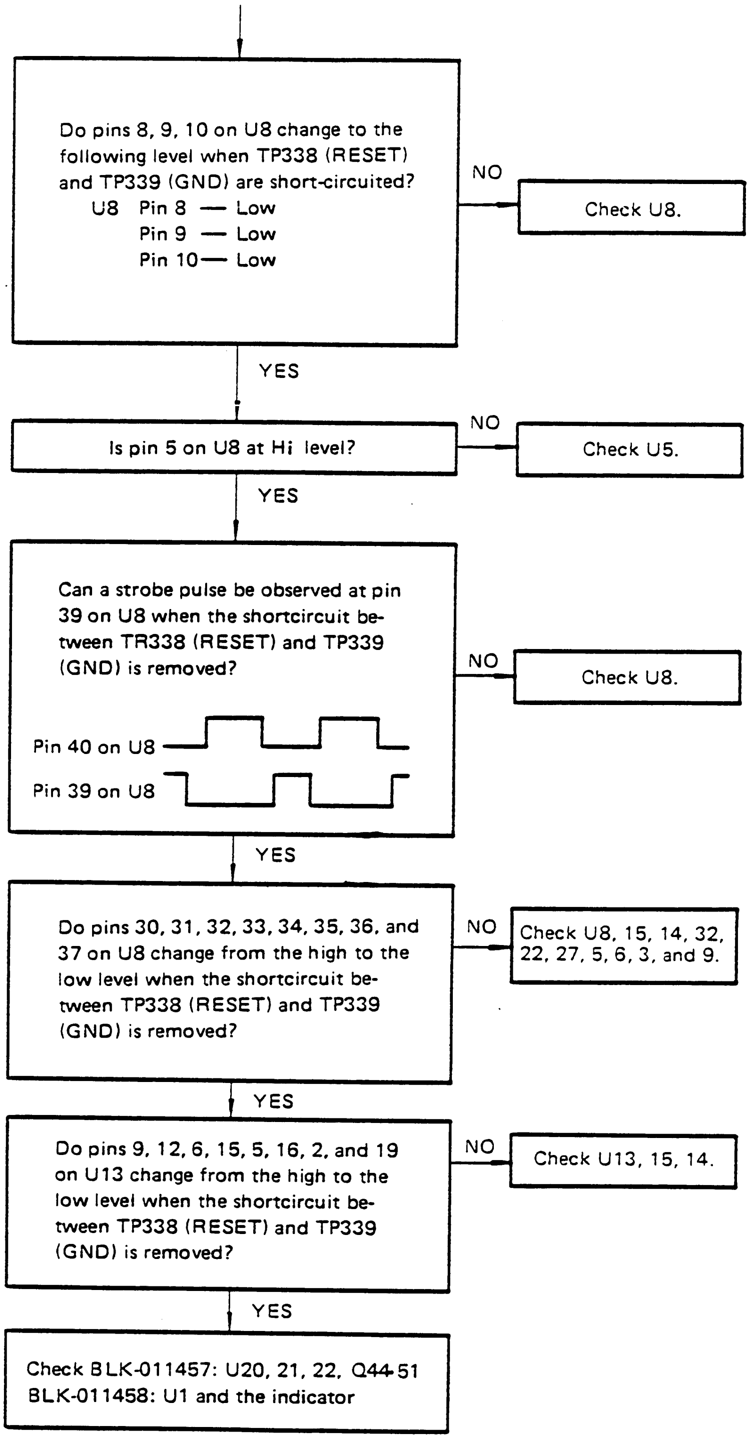


6-5. INDICATOR LEDs DO NOT LIGHT

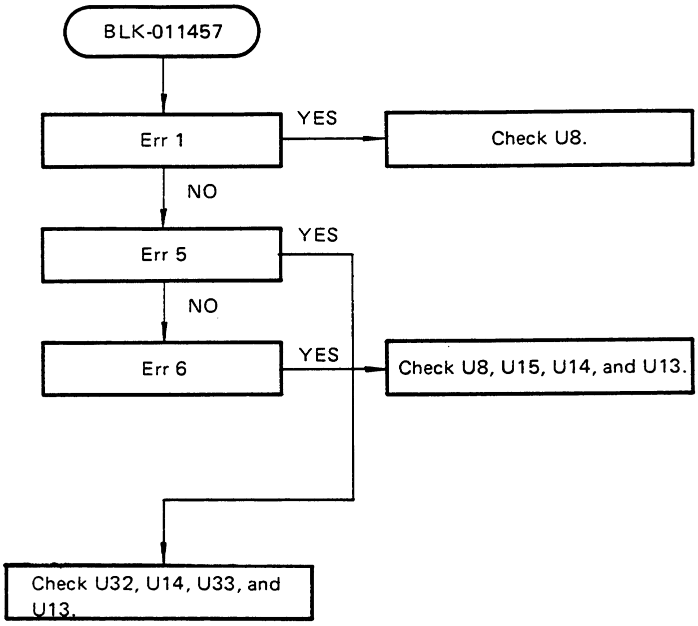


(Continued on the next page)

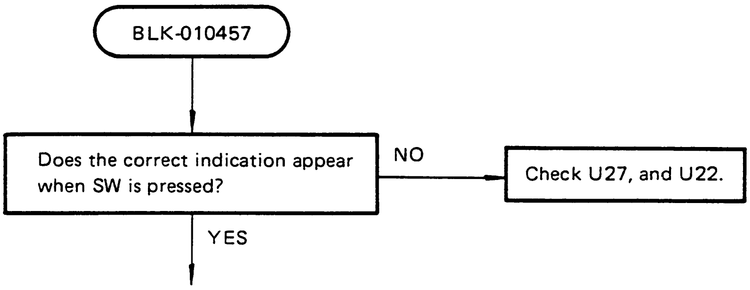

Abnormal lighting of LEDs.
Can a clock waveform of about 10 MHz be observed between TP340 (10 MHz) and TP339?
Approx. 100 ms
TP340
NO
Check Q42, Q43, L212.
YES
Can a clock waveform of about 5 MHz be observed between pin 3 on U8 and TP339 (GND)?
Approx. 200 ms
Pin 3 on U8
NO
Check U18.
YES
Is U8 pin 6 at Hi level?
NO
YES
Does pin 6 on U8 change to the low level when TP338 (RESET) and TP339 (GND) are short-circuited?
NO
Check U28.
YES
Can a clock waveform of about 1.25 MHz be observed between pin 40 on U8 and TP339 (GND)?
Approx. 800 ms
Pin 40 on U8
NO
Check U8.
YES


Do pins 8, 9, 10 on U8 change to the following level when TP338 (RESET) and TP339 (GND) are short-circuited?
U8 Pin 8 — Low
Pin 9 — Low
Pin 10— Low
NO
Check U8.
YES
Is pin 5 on U8 at Hi level?
NO
Check U5.
YES
Can a strobe pulse be observed at pin 39 on U8 when the shortcircuit between TR338 (RESET) and TP339 (GND) is removed?
Pin 40 on U8
Pin 39 on U8
NO
Check U8.
YES
Do pins 30, 31, 32, 33, 34, 35, 36, and 37 on U8 change from the high to the low level when the shortcircuit between TP338 (RESET) and TP339 (GND) is removed?
NO
Check U8, 15, 14, 32, 22, 27, 5, 6, 3, and 9.
YES
Do pins 9, 12, 6, 15, 5, 16, 2, and 19 on U13 change from the high to the low level when the shortcircuit between TP338 (RESET) and TP339 (GND) is removed?
NO
Check U13, 15, 14.
YES
Check BLK-011457: U20, 21, 22, Q44-51
BLK-011458: U1 and the indicator

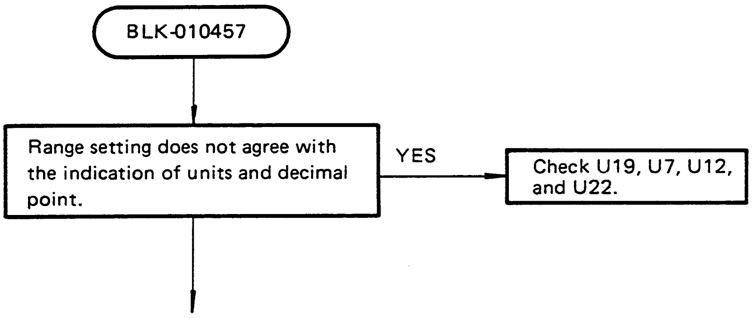
6-6. ERR IS INDICATED



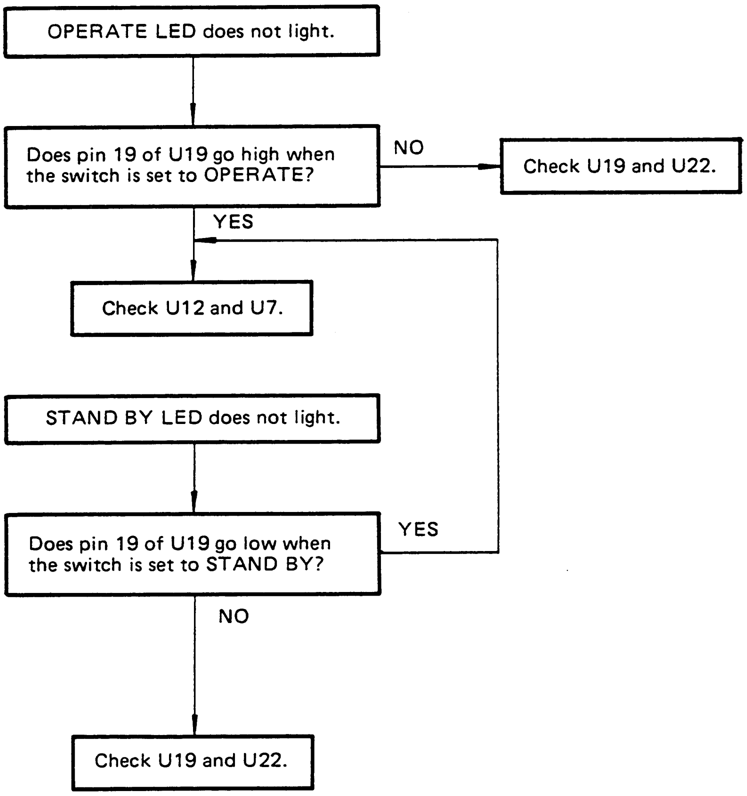
6-7. OUTPUT LEVEL CANNOT BE CORRECTLY SET WITH SWITCHES



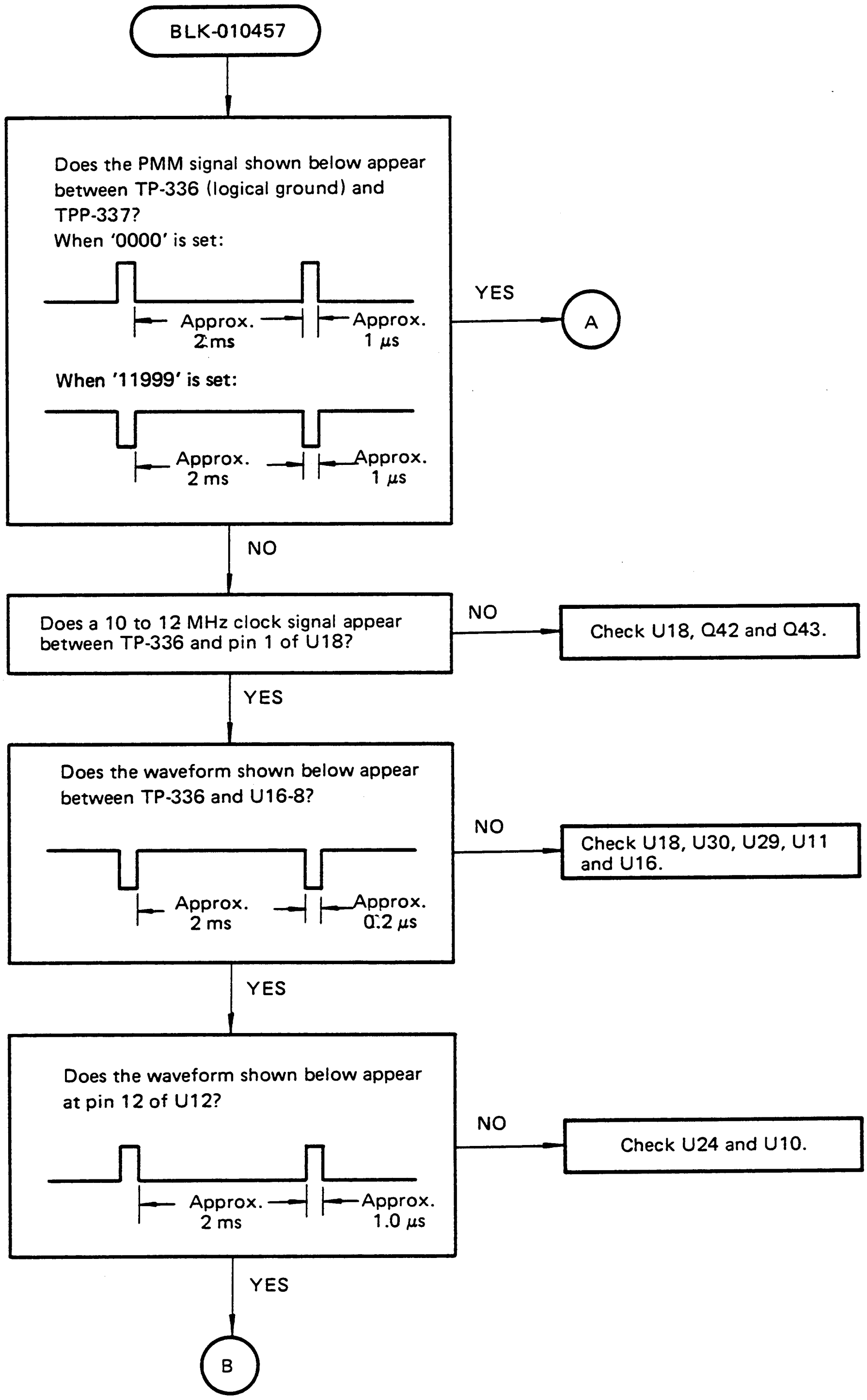
6-8. RANGE CANNOT BE CORRECTLY SET



6-9. OPERATE/STAND BY LED FAILURE



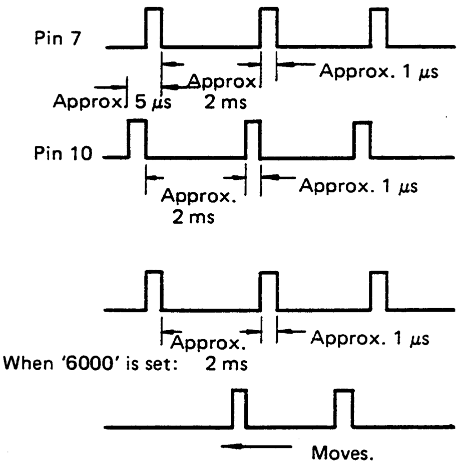
6-10. DC VOLTAGE OUTPUT IS INCORRECT



B

Do the waveforms appearing at pins 7 and 10 of U10 change as shown below according to the setting when observed using a two-channel oscilloscope?

When '0000' is set:



NO → Check U10.

YES ↓

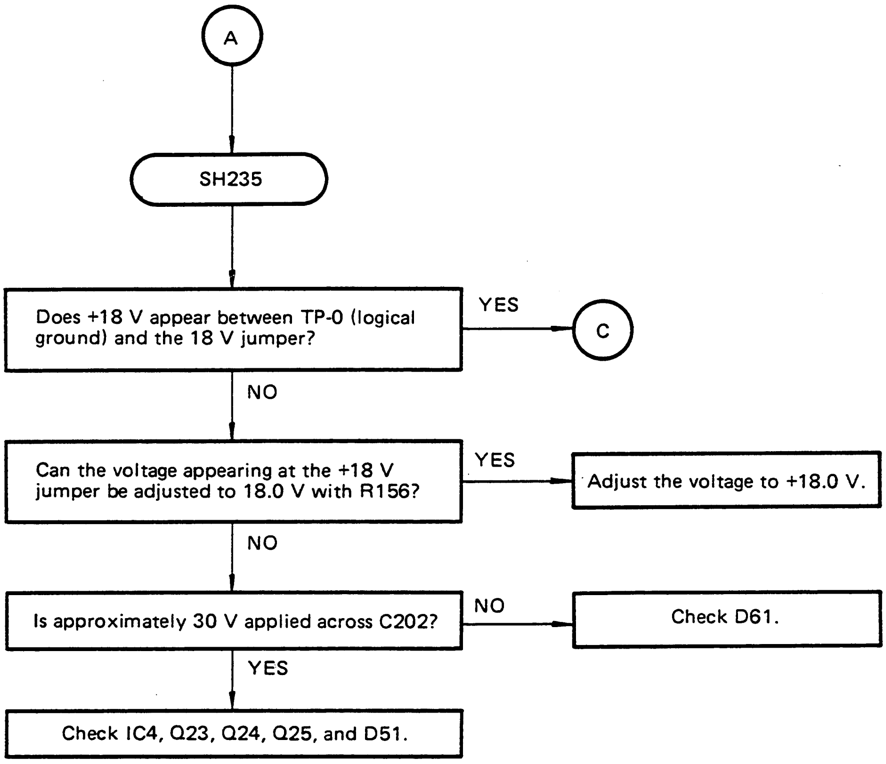
Is the output of U26 and U19 correct?

	U19						U26							
	5	16	6	15	9	12	2	19	5	16	6	15	9	12
When '0000' is set:	1	1	1	1	1	1	1	1	1	1	1	0	1	0
When '8181' is set:	1	0	0	0	0	0	0	0	0	0	0	1	0	1
When '8192' is set:	0	1	1	1	1	1	1	1	1	1	1	0	1	0

1; HI 0; LO

NO → Check U19 and U26.

YES → Check U17, U24, U25 and U31.



Does +18 V appear between TP-0 (logical ground) and the 18 V jumper?

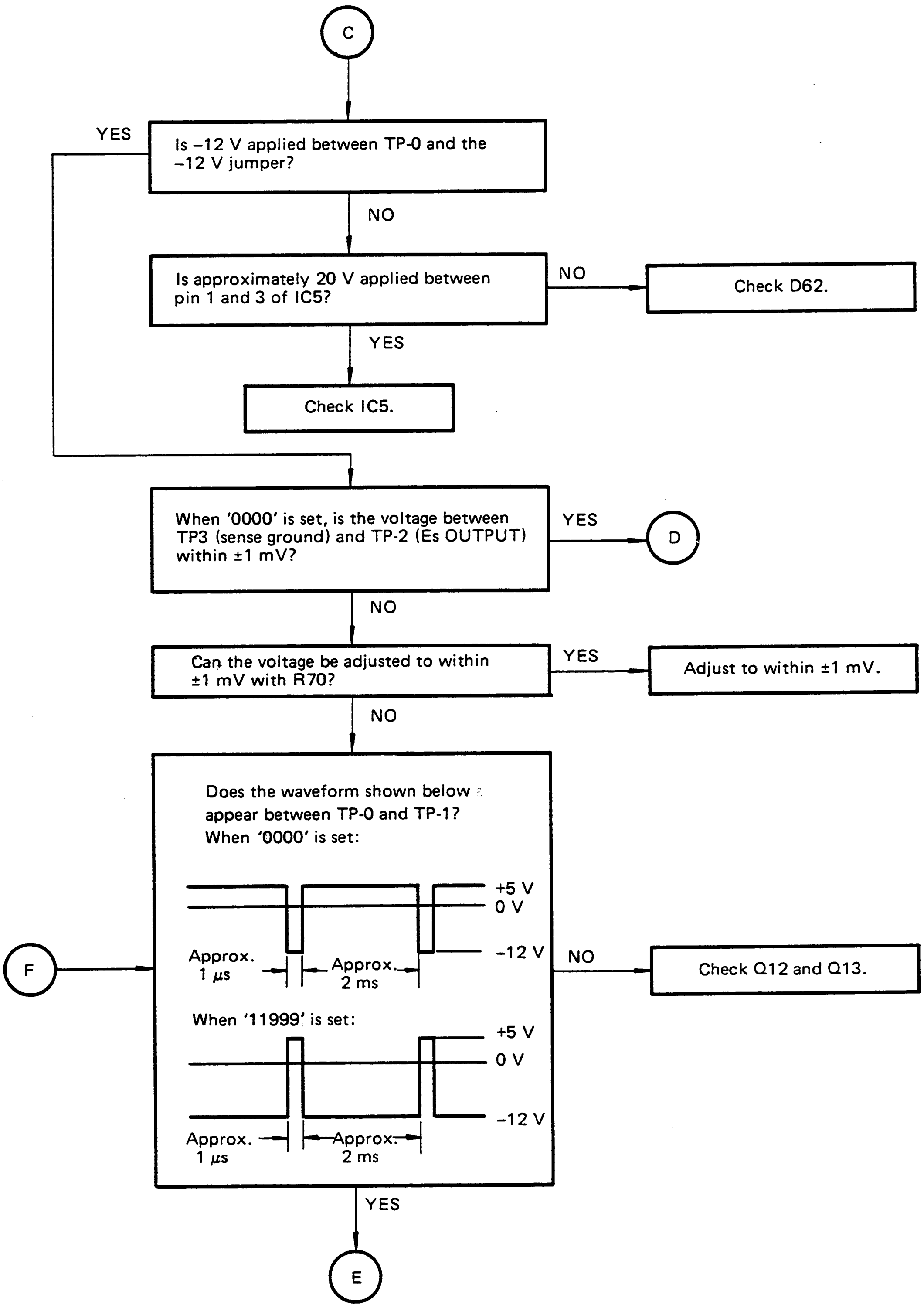
Can the voltage appearing at the +18 V jumper be adjusted to 18.0 V with R156?

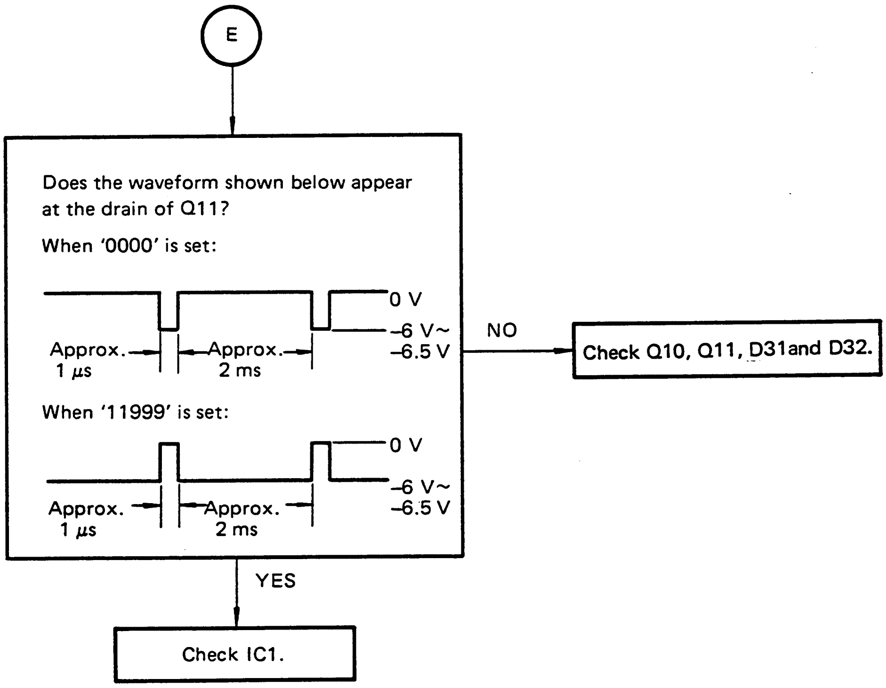
Adjust the voltage to +18.0 V.

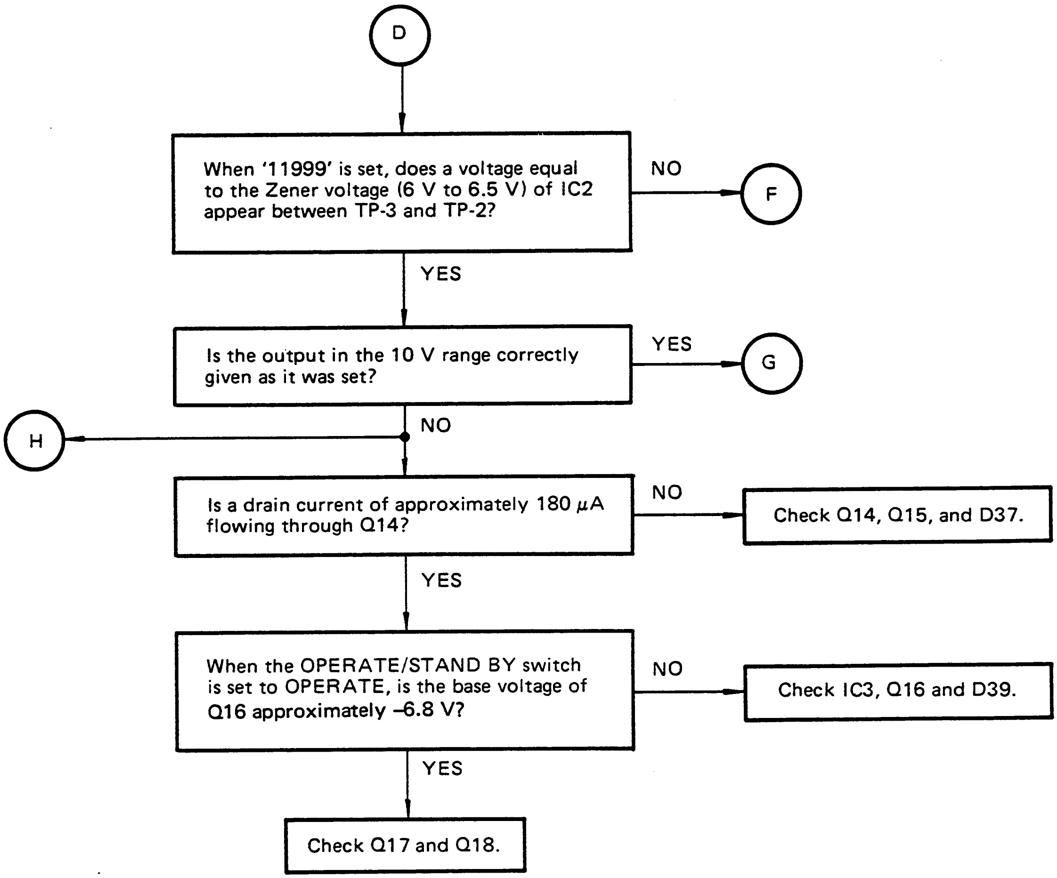
Is approximately 30 V applied across C202?

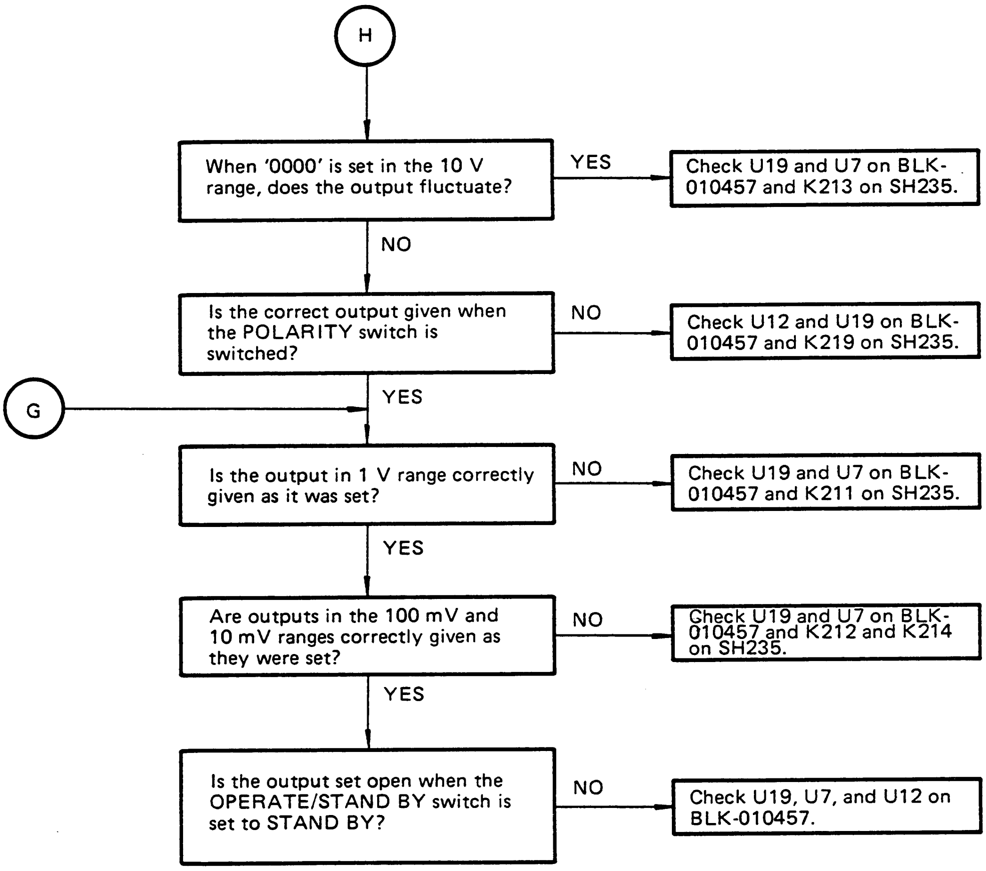
Check D61.

Check IC4, Q23, Q24, Q25, and D51.

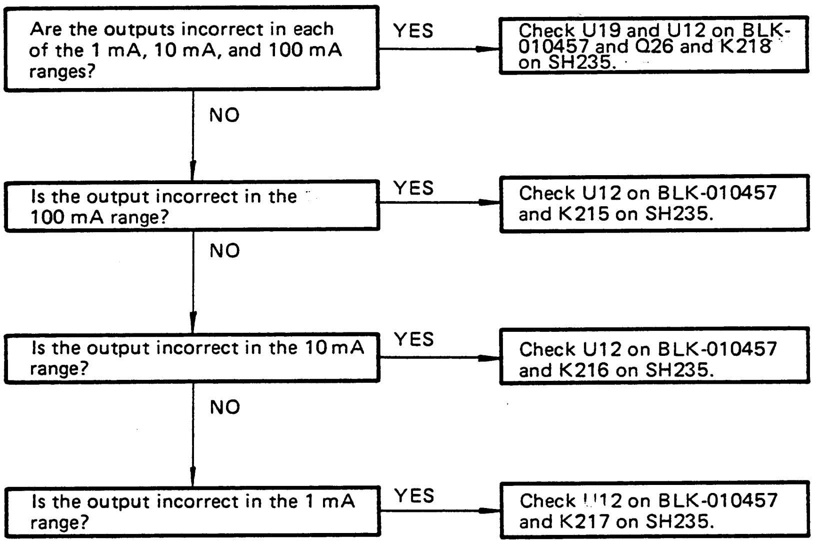

C
Is −12 V applied between TP-0 and the −12 V jumper?
YES
NO
Is approximately 20 V applied between pin 1 and 3 of IC5?
NO
Check D62.
YES
Check IC5.
When '0000' is set, is the voltage between TP3 (sense ground) and TP-2 (Es OUTPUT) within ±1 mV?
YES
D
NO
Can the voltage be adjusted to within ±1 mV with R70?
YES
Adjust to within ±1 mV.
NO
Does the waveform shown below appear between TP-0 and TP-1?
When '0000' is set:
+5 V
0 V
−12 V
Approx. 1 μs
Approx. 2 ms
When '11999' is set:
+5 V
0 V
−12 V
Approx. 1 μs
Approx. 2 ms
F
NO
Check Q12 and Q13.
YES
E


E
Does the waveform shown below appear at the drain of Q11?
When '0000' is set:
0 V
-6 V~
-6.5 V
Approx.
1 μs
Approx.
2 ms
When '11999' is set:
0 V
-6 V~
-6.5 V
Approx.
1 μs
Approx.
2 ms
NO
Check Q10, Q11, D31and D32.
YES
Check IC1.

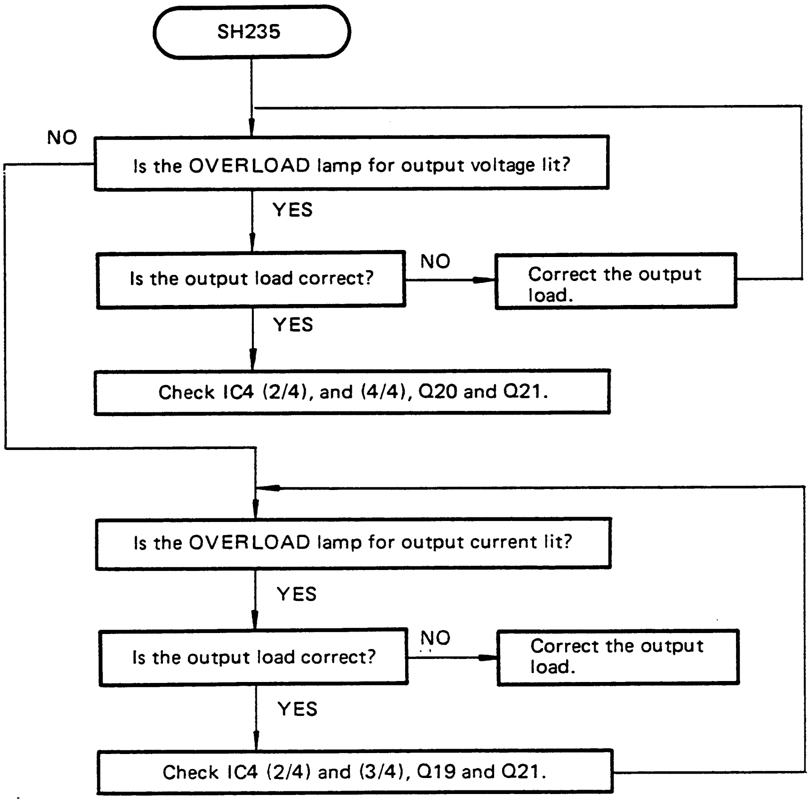

D
When '11999' is set, does a voltage equal to the Zener voltage (6 V to 6.5 V) of IC2 appear between TP-3 and TP-2?
NO
F
YES
Is the output in the 10 V range correctly given as it was set?
YES
G
NO
H
Is a drain current of approximately 180 μA flowing through Q14?
NO
Check Q14, Q15, and D37.
YES
When the OPERATE/STAND BY switch is set to OPERATE, is the base voltage of Q16 approximately -6.8 V?
NO
Check IC3, Q16 and D39.
YES
Check Q17 and Q18.


H
When '0000' is set in the 10 V range, does the output fluctuate?
YES
Check U19 and U7 on BLK-010457 and K213 on SH235.
NO
Is the correct output given when the POLARITY switch is switched?
NO
Check U12 and U19 on BLK-010457 and K219 on SH235.
G
YES
Is the output in 1 V range correctly given as it was set?
NO
Check U19 and U7 on BLK-010457 and K211 on SH235.
YES
Are outputs in the 100 mV and 10 mV ranges correctly given as they were set?
NO
Check U19 and U7 on BLK-010457 and K212 and K214 on SH235.
YES
Is the output set open when the OPERATE/STAND BY switch is set to STAND BY?
NO
Check U19, U7, and U12 on BLK-010457.

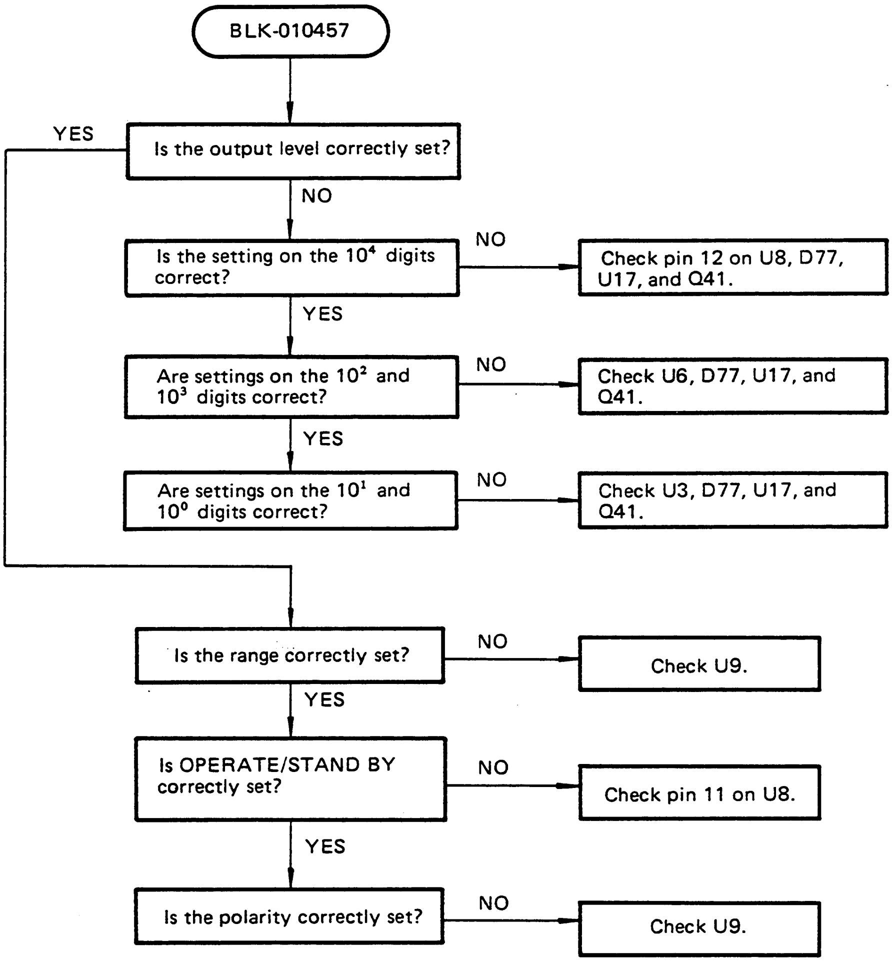
6-11. DC OUTPUT CURRENT IS INCORRECT



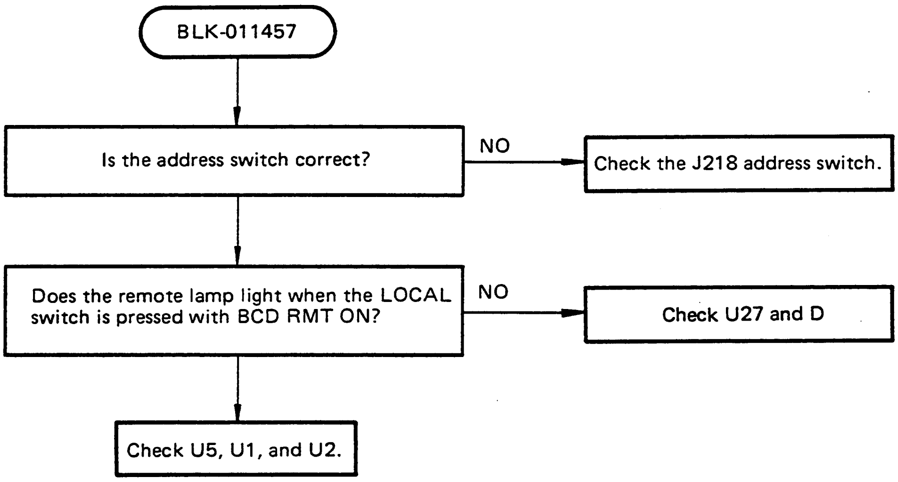
6-12. PROTECTION CIRCUIT FAILURE

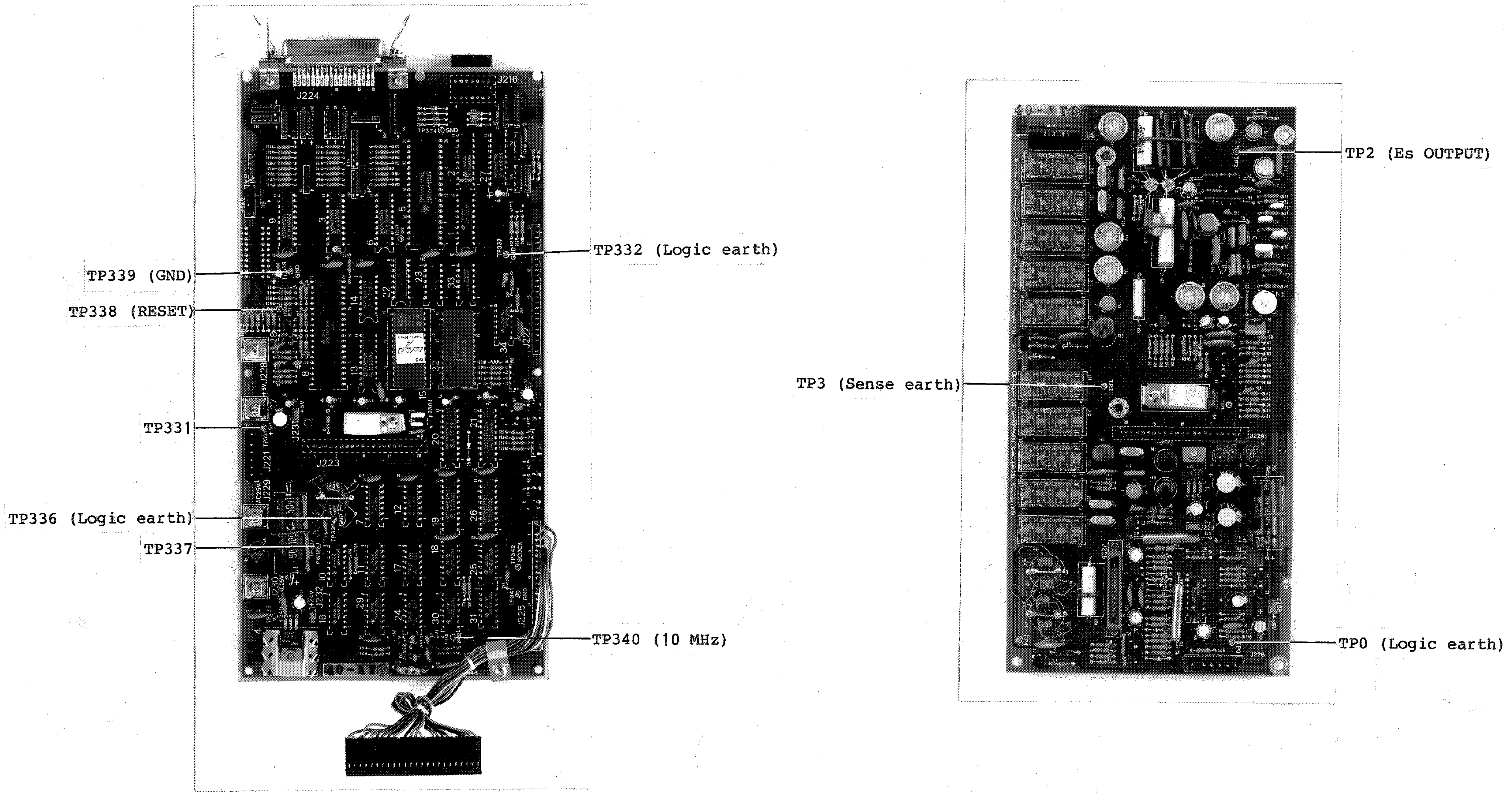


6-13. BCD REMOTE CONTROL IS INCORRECT



6-14. GP-IB REMOTE CONTROL IS INCORRECT





Test points on BLK-010457

Test points on SH235

Fig. 6-1 Test points used for troubleshooting

SECTION 7
PARTS LIST

7-1. INTRODUCTION

This section provides a list of electrical parts used in the TR6142 Programmable DC Voltage/Current Generator. For the replacement of an electrical part, check its specifications and ratings by referring to the description of the parts list before replacing the defective part. If replacement of mechanical or electrical parts marked with an asterisk (*) is required, contact your nearest ADVANTEST representative. When ordering electrical parts, write their part and stock numbers. For mechanical part ordering write their part names and stock numbers.

NOTE

Specifications of parts are subject to change without notice to meet the users' demands or the requirements of our quality control

7-2. SYMBOLS AND ABBREVIATIONS

The symbols and abbreviations used in the parts list, schematic diagrams and text are shown in the table below. In the schematic diagrams, active low signals are identified by a prefixed asterisk (*). For quick identification of the panel features of the product all references to them in the text are written in capital letters.

Table 7-1 Abbreviation

REFERENCE DESIGNATIONS

C	Capacitor
C_a	Cable
F	Fuse
FH	Fuse Holder
IC	Integrated Circuit
J	Electrical Connector, Jack
L	Coil, Inductor
Q	Transistor
R	Resistor
S	Switch (Slide, Lever, Push Button, Rotary)
T	Transformer
TP	Test Point (Check Point)
X	Crystal

MULTIPLIERS

Abbreviation	Prefix	Multiple
G	giga	10^9
M	mega	10^6
k	kilo	10^3
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}

Table 7-2 Abbreviations

ABBREVIATIONS	
A	ampere
AC	alternating current
ADJ.	adjustment
A/D	analog-to-digital
AMP.	amplifier
ATT.	attenuator
ASTIG.	astigmatism
ANT.	antenna
AUTO	automatic, -operation
A.Z.	auto zero
BATT.	battery
BCD	binary coded decimal
B.P.F.	band-pass filter
B.W.	band width
CAR	carbon
CAL.	calibrate
CER	ceramic
cm	centimeter
COM.	common
CRT	cathode-ray tube
COMP.	comparator
CONT.	control
CONV.	converter
D/A	digital-to-analog
dB	decibel
dBm	decibel referred to 1 mW
dBμ	decibel (0 dBμ = 1 μVrms.)
DC	direct current
DET.	detector
DIV. (div.)	division
DISP.	dispersion
ELECT	electolytic
EXT.	external
F	farad
FET.	field-effect transistor
FM	frequency modulation
FREQ.	frequency
FXD	fixed
FLM	film
f.s.	full scale
g	gram
GHz	gigahertz
GND	ground
H	henry
h	hour
HI	high
H.P.F.	high-pass filter
Hz	hertz
H.POSI.	horizontal position
H.GAIN	horizontal gain
IC	integrated circuit
IF	intermediate frequency
IN.	input
INT.	internal
kg	kilogram
kHz	kilohertz
kΩ	kiloohm
kV	kilovolt
LED	light-emitting diode
LEV.	level
LIN.	linear
LO	low, local oscillator
LOG.	logarithm
L.P.F.	low-pass filter
m	meter
mA	milliampere
MAX.	maximum
MΩ	megohm
mg	milligram
MHz	megahertz
MIN.	minimum
min.	minute (time)
mm	millimeter
MOD.	modulator
ms	millisecond
mV	millivolt
mVrms.	millivolt rms.
mW	milliwatt
μA	microampere
μF	microfarad
μH	microhenry
μs	microsecond
μV	microvolt
μVrms.	microvolt rms.
μW	microwatt
MANU.	manual
MIX.	mixer
NPN	negative-positive-negative
nA	nanoampere
NC	no connection
NORM.	normal
ns	nanosecond
nW	nanowatt
OPT.	option
OSC.	oscillator
Ω	ohm
OUT.	output
P	peak
pF	picofarad
PL	phase lock
PLO	phase lock oscillator
PM	phase modulation
p-p	peak-to-peak
PPM	pulse-position-modulation
PRF	pulse-repetition frequency
ps	picosecond
POSI.	position
PNP	positive-negative-positive
Q.P.	quasi peak value
REF.	reference
RF	radio frequency
rms.	root-mean-square
rdg.	reading
REG.	regulator
SI	silicon
s	second (time)
S.G.	single generator
SSB	single sideband
S.W.R.	standing-wave ratio
S	switch
T	timed (slow-blow fuse)
TTL	transistor-transistor logic
TV	television
TP	test point
VAR	variable
V	volt
VA	voltampere
VCO	voltage-controlled oscillator
VFO	variable-frequency oscillator
Vp-p	volts peak-to-peak
Vrms.	volts rms.
V.S.W.R.	voltage standing wave ratio
V.POSI.	vertical position
V.GAIN	vertical gain
W	watt
YIG	yttrium-iron-garnet
1st	the first
2nd	the second
3rd	the third

TR6142

MECHANICAL PARTS LIST

MAIN FRAME ASSEMBLY

Fig. & INDEX No.	Stock no.	Description	Qty
7-1 1	MCT-28197A	FRAME, front	1
2	MBJ-28969A	PANEL, front	1
3	MNS-28970A001A	PLATE, front panel	1
4	MBS-28974A001A	PANEL, rear	1
5	MBZ-28977A	FRAME, shield	1
6	MBS-28975A001A	COVER, shield	1
7	MBJ-28971A	FRAME, right	1
8	MBJ-28972A	FRAME, left	1
9	MBJ-28956A	SUPPORTER A	1
10	MBJ-28957A	SUPPORTER B	1
11	MBJ-28958A	BRACKET	1
12	MPS-28586A002A	FILTER	1
13	MKJ-28961A	SUPPORTER, switch	1
14	MKZ-28963A	SPACER	2
15	LTP-000211-1	TRANSFORMER	1
16	CCK-ADR01F16V	CAPACITOR	1
17	DFH-000844	HOLDER, fuse	1
18	JCF-AB001JX02	CONNECTOR, BNC	2
19	JTE-AG001EX01	TERMINAL, GND	1
20	JCD-AE003PX01	INLET, 3 pin	1
21	SIA-7805K-1	TRANSISTOR	1
22	YEE-000397	COVER, transistor	1
23	JCS-AC024JX02	CONNECTOR, GPIB	1
24	YEE-000292	CLAMP, nylon	2
25	YEE-000153	NUT, clamp	2
26	KSP-000035	SWITCH, power	1
27	KSP-000102	SWITCH, SENSE	1
28	RVR-AA20K	KNOB, current limit	1
29	MNS-28973A	PLATE, name	1

TR6142

MECHANICAL PARTS LIST

MAIN FRAME ASSEMBLY

Fig. & INDEX No.	Stock no.	Description	Qty
7-1 30	MMX-10486A	GROMMET	8
31	MMX-10487A	SPACER	8
32	YEE-00128	BUSHING A	1
33	YEE-00127	BUSHING B	1

TR6142

MECHANICAL PARTS LIST

CASE

Fig. & INDEX No.	Stock no.	Description	Qty
7-2 1	CASE	MBT-28976A	1
2	FRAME, rear	MCT-20573A	1
3	HANDLE	MMX-10271A	1
4	SPACER, handle	MBX-20547A	2
5	COVER, handle	MMX-20570A	2
6	STOPPER, handle	MKX-20548A	2
7	FOOT A	MMX-10498A	2
8	FOOT B	MMX-10499A	2
9	RUBBER	MMX-12291A	4
10	STAND	MBC-17074B	1
11	FOOT C	MMX-20594A	4

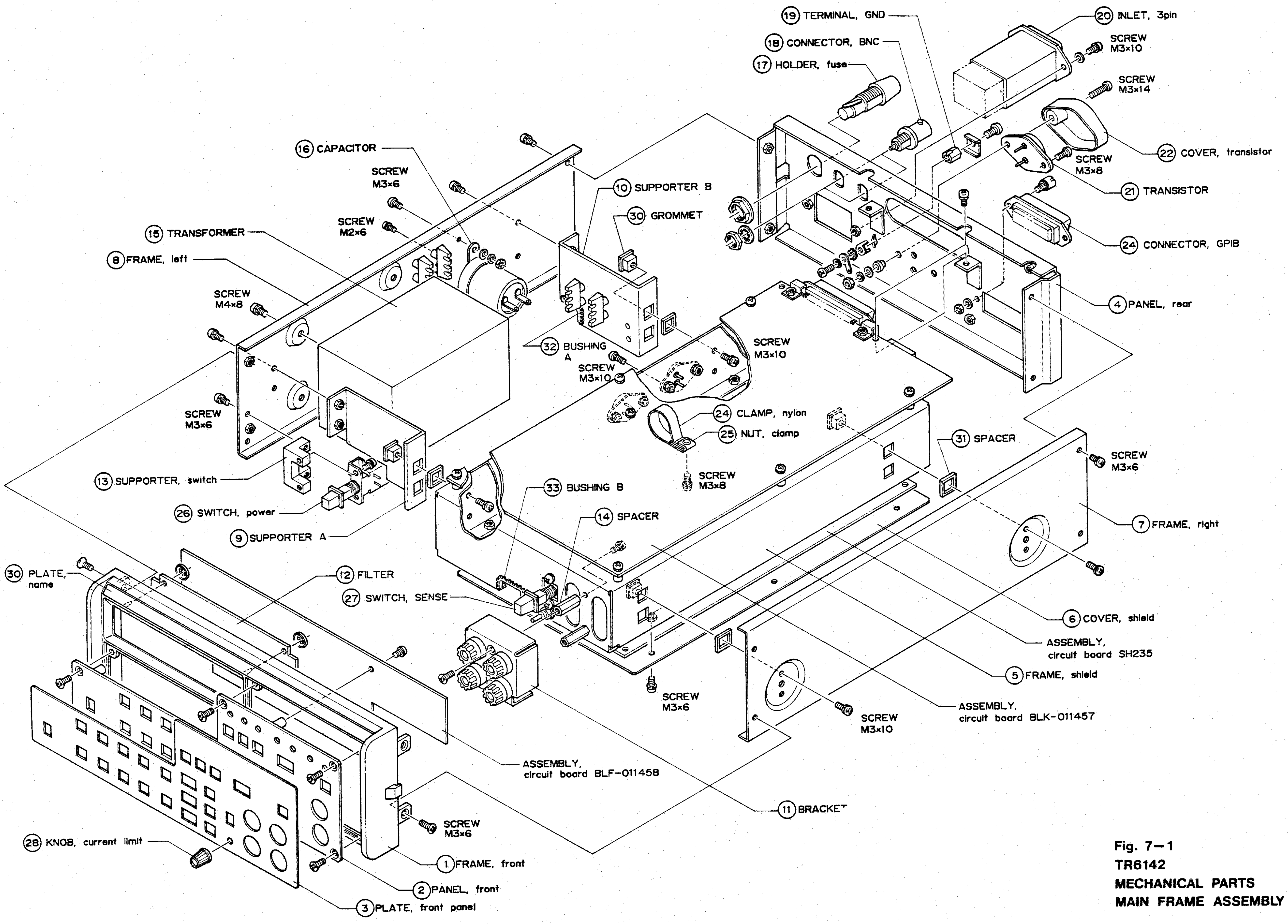


Fig. 7—1
TR6142
MECHANICAL PARTS
MAIN FRAME ASSEMBLY

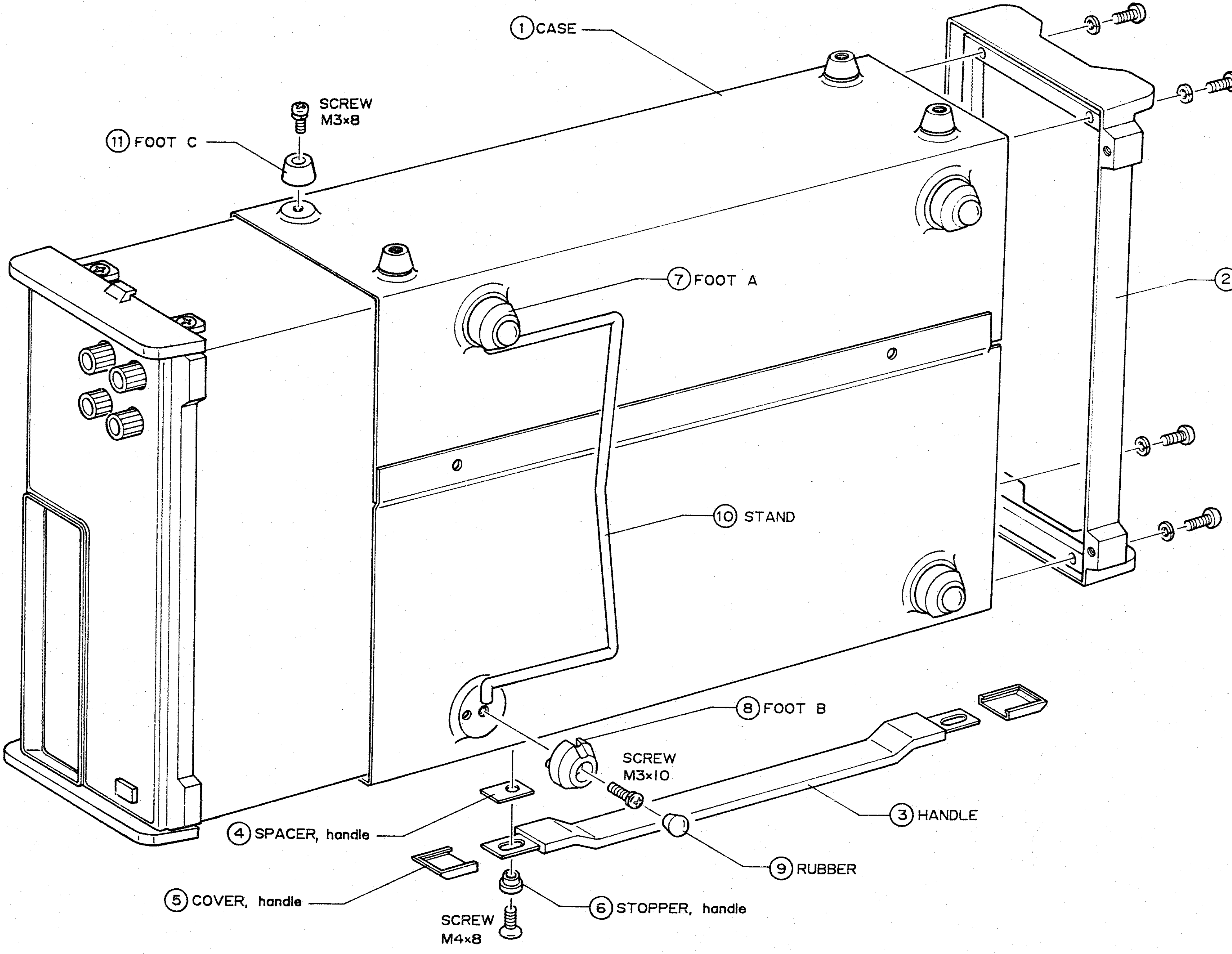


Fig. 7−2
TR6142
MECHANICAL PARTS
CASE

Parts No.	ADVANTEST Stock No.	Description
U1	SIA-7805K-1	IC: Voltage Regulator
Q1	STN-2SC1445	Transistor SI NPN
Q2	STN-2SC1445	Transistor SI NPN
D1	SDP-W02	Diode SI
VR1	RVR-AA20K	R:
C1	CCK-ADR01F16V	C: FXD ELECT 0.01µF 16V
C2	CSM-ACR01U50V	C: FXD CER 0.01µF +80, -20% 50V
C3	CFM-ACR1UR4K	C: FXD Polyester FLM 0.1µF ±10% 4kV
F1	DFT-AAR315A	Fuse
FH1	DFH-000844	Fuse Holder
J1	JCS-AD010JX01	Connector
J2	JCP-AS006JX01	Connector
J3	JCP-AS006JX01	Connector
J4	DCB-QS-0505	Connector
J5	JCS-AC024JX02	Connector
J6	JCD-AE003PX01	Socket
J7	JCF-AB001JX02	Connector
J8	YEE-000733	Connector
J9	JCF-AB001JX02	Connector
J10		Not assigned
J11	YEE-000733	Connector
P1	JTB-AA001JX02	Binding Post
P2	JTB-AA001JX01	Binding Post
P3	JTB-AA001JX02	Binding Post
P4	JTB-AA001JX01	Binding Post
P5 thru P8	JTT-AA003EX01	Terminal
P9	JTE-AG001EX01	Terminal
P10	JTT-AA003EX01	Terminal
P11 thru P14	JTM-AG001JX02	
S1	KSP-000035	Switch
S2	KSP-000102	Switch
T1	LTP-000211-1	Transformer

Parts No.	ADVANTEST Stock No.	Description
U1	SIA-356	IC: Junction FET Input Type Oprational Amplifier
U2	SDZ-6-1	
U3	SIA-301A	IC: Operational Amplifier
U4	SIA-324	IC: Quadruple Operational Amplifier
U5	SIA-7812U-5	IC: Series Voltage Regulator
Q10	SFN-2N4393-18	FET Junction N-Channel
Q11	SFN-2N4393-18	FET Junction N-Channel
Q12	STN-2SC944	Transistor SI
Q13	STN-2SC944	Transistor SI
Q14	SFT-840-28	Dual FET Junction N-Channel
Q15	STN-2SC1815-15	Transistor SI NPN
Q16	STN-2SC1815-15	Transistor SI NPN
Q17	STN-2SC1279	Transistor SI NPN
Q18		Not assigned
Q19 thru Q21	STP-2SA1015	Transistor SI PNP
Q22	STN-2SC1279	Transistor SI NPN
Q23		Not assigned
Q24	STN-2SC1815-15	Transistor SI NPN
Q25	STN-2SC1815-15	Transistor SI NPN
Q26	STP-2SA1015	Transistor SI PNP
D31 thru D34	SDS-1S953	Diode SI
D35	SDS-LD1	Diode SI
D36	SDS-LD1	Diode SI
D37	SDZ-W056	Zener Diode
D38	SDZ-W090	Zener Diode
D39	SDZ-H4-8	Zener Diode
D40	SDZ-W090	Zener Diode
D41	SDS-1S953	Diode SI
D42	SDS-1S953	Diode SI
D43	SDZ-W081-5	Zener Diode
D44	SDS-1S953	Diode SI
D45	SDS-1S953	Diode SI
D46	SDP-SM1-1	Diode SI
D47	SDS-1S953	Diode SI
D48	SDS-1S953	Diode SI
D49	SDP-SM1	Diode SI
D50	SDS-1S953	Diode SI
D51	SDZ-W090	Zener Diode
D52 thru D60	SDS-1S953	Diode SI
D61	SDP-W02	Diode SI
D62	SDP-W02	Diode SI
D63	SDZ-W050	Zener Diode
D64 thru D67	SDS-1S953	Diode SI

Parts No.	ADVANTEST Stock No.	Description
R70	RVR-CB20K	R: VAR CERMET 20kΩ
R71	RCB-AH330K	R: FXD CAR 330kΩ ±5% 1/4W
R72	RCB-AH5R6K	R: FXD CAR 5.6kΩ ±5% 1/4W
R73 thru R77	RCB-AH47K	R: FXD CAR 47kΩ ±5% 1/4W
R78	RMF-AR47KFK	R: FXD Metal FLM 47kΩ ±1% 1/4W
R79	RMF-AB5R1KFJ	R: FXD Metal FLM 5.1kΩ ±1% 1/4W
R80	RVR-BC100	R: VAR WW 100Ω
R81	RCB-AH2R7K	R: FXD CAR 2.7kΩ ±5% 1/4W
R82	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
R83	RCB-AH10K	R: FXD CAR 10kΩ ±5% 1/4W
R84	RCB-AH10K	R: FXD CAR 10kΩ ±5% 1/4W
R85	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
R86	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R87	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R88	RCB-AH2R7K	R: FXD CAR 2.7kΩ ±5% 1/4W
R89	RCB-AH2R7K	R: FXD CAR 2.7kΩ ±5% 1/4W
R90	RCB-AH120	R: FXD CAR 120Ω ±5% 1/4W
R91	RVR-BC200	R: VAR WW 200Ω
R92	DGP-DR0013-1	R: FXD WW
R93	RWT-AQ43KF	R: FXD WW 43kΩ
R94	RWT-AQ43KF	R: FXD WW 43kΩ
R95	RMF-AB39QFJ	R: FXD Metal FLM 39Ω ±1% 1/4W
R96	RMF-AB39QFJ	R: FXD Metal FLM 39Ω ±1% 1/4W
R97	RMF-AB18QFJ	R: FXD Metal FLM 18Ω ±1% 1/4W
R98	RMF-AB18QFJ	R: FXD Metal FLM 18Ω ±1% 1/4W
R99	RVR-BC20	R: VAR WW 20Ω
R100	RMF-AR820QFJ	R: FXD Metal FLM 820Ω ±1% 1/4W
R101	RMF-AR15KFK	R: FXD Metal FLM 15kΩ ±1% 1/4W
R102	RCB-AH10K	R: FXD CAR 10kΩ ±5% 1/4W
R103	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
R104	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R105	RCB-AH1R8K	R: FXD CAR 1.8kΩ ±5% 1/4W
R106	RCB-AH1K	R: FXD CAR 1kΩ ±5% 1/4W
R107	RCB-AH6R8K	R: FXD CAR 6.8kΩ ±5% 1/4W
R108	RCB-AK10	R: FXD CAR 10Ω ±5% 1/4W
R109	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
R110	RCB-AH15	R: FXD CAR 15Ω ±5% 1/4W
R111	RCB-AH15	R: FXD CAR 15Ω ±5% 1/4W
R112	RCB-AH10K	R: FXD CAR 10kΩ ±5% 1/4W
R113	RCB-AH560	R: FXD CAR 560Ω ±5% 1/4W
R114	RCB-AH100	R: FXD CAR 100Ω ±5% 1/4W
R115	RVR-AK200	R: VAR CERMET 200Ω
R116	RCB-AH560	R: FXD CAR 560Ω ±5% 1/4W
R117	RCB-AH47K	R: FXD CAR 47kΩ ±5% 1/4W
R118	RMF-AR1R5KFK	R: FXD Metal FLM 1.5kΩ ±1% 1/4W
R119	RCB-AH22K	R: FXD CAR 22kΩ ±5% 1/4W
R120	RVR-AK10K	R: VAR CERMET 10kΩ

Parts No.	ADVANTEST Stock No.	Description
R121	RCB-AH2R2K	R: FXD CAR 2.2kΩ ±5% 1/4W
R122	RCB-AH1R2K	R: FXD CAR 1.2kΩ ±5% 1/4W
R123	RCB-AH10K	R: FXD CAR 10kΩ ±5% 1/4W
R124	RCB-AH3R3K	R: FXD CAR 3.3kΩ ±5% 1/4W
R125	RCB-AH15K	R: FXD CAR 15kΩ ±5% 1/4W
R126	RCB-AH680	R: FXD CAR 680Ω ±5% 1/4W
R127	RCB-AH27K	R: FXD CAR 27kΩ ±5% 1/4W
R128	RFL-AB10KQ	R: FXD WW 10kΩ
R129	RWT-AS89R95KQ	R: FXD WW 89.95kΩ
R130	RVR-BC100	R: VAR WW 100Ω
R131	RWT-AA19R93KA	R: FXD WW 19.93kΩ
R132	RVR-BC100	R: VAR WW 100Ω
R133	RVR-CB20K	R: VAR CERMET 20kΩ
R134	RMF-AB68KFJ	R: FXD Metal FLM 68kΩ ±1% 1/4W
R135	RFL-AB2R287KB	R: FXD WW 2.287kΩ
R136	RVR-BC10K	R: FXD WW 10kΩ
R137	RMF-AB15KFJ	R: FXD Metal FLM 15kΩ ±1% 1/4W
R138	RFL-AB204QB	R: FXD WW 204Ω
R139	RWT-AF20QB	R: FXD WW 20Ω
R140	RWT-AV1QF-1	R: FXD WW 1Ω
R141	RWT-AV2QF-1	R: FXD WW 2Ω
R142 thru R144	RFL-AB596R4QB	R: FXD WW 596.4Ω
R145	RVR-CB20K	R: VAR CERMET 20kΩ
R146	RMF-AB15KFJ	R: FXD Metal FLM 15kΩ ±1% 1/4W
R147	RWT-AW2QF-1	R: FXD WW 2Ω
R148	RMF-AR18KFK	R: FXD Metal FLM 18kΩ ±1% 1/4W
R149	RMF-AR1KFK	R: FXD Metal FLM 1kΩ ±1% 1/4W
R150	RCB-AH1R5K	R: FXD CAR 1.5kΩ ±5% 1/4W
R151	RCB-AH2R7K	R: FXD CAR 2.7kΩ ±5% 1/4W
R152	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
R153	RCB-AH2R7K	R: FXD CAR 2.7kΩ ±5% 1/4W
R154	RCB-AH2R2K	R: FXD CAR 2.2kΩ ±5% 1/4W
R155	RMF-AR10KFK	R: FXD Metal FLM 10kΩ ±1% 1/4W
R156	RVR-AK2K	R: VAR CERMET 2kΩ
R157	RMF-AR10KFK	R: FXD Metal FLM 10kΩ ±1% 1/4W
R158	RCB-AH680	R: FXD CAR 680Ω ±5% 1/4W
R159	RCB-AH18K	R: FXD CAR 18kΩ ±5% 1/4W
R160	RCB-AH1R8K	R: FXD CAR 1.8kΩ ±5% 1/4W
R161	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
R162	RMF-AR18KFK	R: FXD Metal FLM 18kΩ ±1% 1/4W
R163	RCB-AH10K	R: FXD CAR 10kΩ ±5% 1/4W
R164	RCB-AH56K	R: FXD CAR 56kΩ ±5% 1/4W
R165	RCB-AH56K	R: FXD CAR 56kΩ ±5% 1/4W
C170	CSM-ACR1U25V	C: FXD CER 0.1μF +80, -20% 25V
C171	CSM-ACR1U25V	C: FXD CER 0.1μF +80, -20% 25V
C172	CSM-ACR022U50V	C: FXD CER 0.022μF +80, -20% 25V

Parts No.	ADVANTEST Stock No.	Description
C173	CFM-ASR01U50V	C: FXD Polyester FLM 0.01µF ±10% 50V
C174	CFM-ASR022U50V	C: FXD Polyester FLM 0.022µF ±10% 50V
C175	CFM-ASR022U50V	C: FXD Polyester FLM 0.022µF ±10% 50V
C176	CFM-ASR047U50V	C: FXD Polyester FLM 0.047µF ±10% 50V
C177	CFM-ASR068U50V	C: FXD Polyester FLM 0.068µF ±10% 50V
C178	CSM-ACR1U25V	C: FXD CER 0.1µF +80, -20% 25V
C179	CSM-ACR1U25V	C: FXD CER 0.1µF +80, -20% 25V
C180	CSM-AC22P50V	C: FXD CER 22pF ±10% 50V
C181	CSM-AC22P50V	C: FXD CER 22pF ±10% 50V
C182	CSM-AC100P50V	C: FXD CER 100pF ±10% 50V
C183	CSM-AC100P50V	C: FXD CER 100pF ±10% 50V
C184	CMC-AC470PR3K	C: FXD DIPPED MICA 470pF ±5% 300V
C185	CSM-ACR1U50V	C: FXD CER 0.01µF +80, -20% 50V
C186	CSM-ACR1U25V	C: FXD CER 0.1µF +80, -20% 25V
C187	CSM-ACR1U25V	C: FXD CER 0.1µF +80, -20% 25V
C188	CSM-ACR01U50V	C: FXD CER 0.01µF +80, -20% 50V
C189	CSM-AC33P50V	C: FXD CER 33pF ±10% 50V
C190	CTA-AE2R2U35V	C: FXD ELECT TANTAL 2.2µF 35V
C191	CSM-ACR01U50V	C: FXD CER 0.01µF +80, -20% 50V
C192	CTA-AE2R2U35V	C: FXD ELECT TANTAL 2.2µF 35V
C193	CSM-ACR01U50V	C: FXD CER 0.01µF +80, -20% 50V
C194	CSM-ACR1U50V	C: FXD CER 0.1µF +80, -20% 50V
C195	CSM-ACR022U50V	C: FXD CER 0.022µF +80, -20% 50V
C196	CFM-ACR22UR2K	C: FXD Polyester FLM 0.22µF ±10% 2kV
C197	CFM-AC1UR2K	C: FXD Polyester FLM 1µF ±10% 2kV
C198	CFM-ACR1UR2K	C: FXD Polyester FLM 0.1µF ±10% 2kV
C199	CSM-ACR1U25V	C: FXD CER 0.1µF +80, -20% 25V
C200	CSM-ACR1U25V	C: FXD CER 0.1µF +80, -20% 25V
C201	CCK-AB100U50V	C: FXD ELECT 100µF 50V
C202	CCK-AA470U50V	C: FXD ELECT 470µF 50V
C203	CCK-AB10U50V	C: FXD ELECT 10µF 50V
C204	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C205	CCK-AB33U25V	C: FXD ELECT 33µF 25V
C206	CCK-AB220U35V	C: FXD ELECT 220µF 35V
C207	CCK-AB33U25V	C: FXD ELECT 33µF 25V
C208	CFM-ACR1UR4K	C: FXD Polyester FLM 0.1µF ±10% 4kV
K211	KRL-000675-1	Relay
K212	KRL-000674-1	Relay
K213 thru K217	KRL-000675-1	Relay
K218 thru K220	KRL-000673-1	Relay
J224	JCS-AD020PX02	Connector
J225	JCS-AD010PX03	Connector
J226	JCP-AS006PX01	Connector
J227 thru J229		Not assigned

Parts No.	ADVANTEST Stock No.	Description
D242	SDS-1S953	Diode SI
D243	SDS-1S953	Diode SI
L251	LTP-000265-1	Transformer
L252	LTP-000265-1	Transformer

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TR6142
CONTROLLER
BLK-011457

Parts No.	ADVANTEST Stock No.	Description
U1	SIT-75160	IC:
U2	SIT-75161	IC:
U3	SIM-74HC373	IC: Octal D-type Latch
U4	SIA-7824U	IC:
U5	SIM-9914	IC:
U6	SIM-74H373	IC: Octal D-type Latch
U7	SIT-7406	IC: Hex inverter Buffer/Driver with Open-Collector High-Voltage Output
U8	SIM-63A03	IC:
U9	SIM-74HC244	IC: Octal Buffer/Line Driver/Line Receiver
U10	SIT-7473	IC: Dual J-K Flip-Flop with Clear
U11	SIT-74LS93	IC: 4-Bit Binary Counter Low Power
U12	SIT-7406	IC: Hex Inverter Buffer/Driver with Open-Collector High-Voltage Output
U13	SIM-74HC373	IC: Octal D-type Latch
U14	SIM-74HC138	IC: 3-to-8 Line Decoder/Multiplexer
U15	SIS-001022A	IC:
U16	SIT-74LS30	IC: 8-Input Positive-NAND Gate Low Power
U17	SIT-74LS136	IC: Quad Exclusive-OR Gate Low Power
U18	SIT-74LS93	IC: 4-Bit Binary Counter Low Power
U19 thru U21	SIM-74HC374	IC: Octal D-Type Flip-Flop
U22	SIM-74HC138	IC: 3-to-8 Line Decoder/Multiplexer
U23	SIM-74HC00	IC: Quadruple 2 Input Positive-NAND Gate
U24	SIT-74LS136	IC: Quad Exclusive-OR Gate Low Power
U25	SIT-74LS136	IC: Quad Exclusive-OR Gate Low Power
U26	SIM-74HC374	IC: Octal D-Type Flip-Flop
U27	SIM-74HC244	IC: Octal Buffer/Line Driver/Line Receiver
U28	SIA-393	IC:
U29	SIT-74LS93	IC: 4-Bit Binary Counter Low Power
U30	SIT-74LS93	IC: 4-Bit Binary Counter Low Power
U31	SIT-74LS136	IC: Quad Exclusive-OR Gate Low Power
U32	SMM-2817-2	IC:
U33	SIT-74LS04	IC: Hex Inverter Low Power
U34	SIT-74LS30	IC: 8-Input Positve-NAND Gate Low Power
Q41		Not assigned
Q42	STN-2SC641	Transistor SI NPN
Q43	STN-2SC641	Transistor SI NPN
Q44 thru Q51	STP-2SA1015	Transistor SI PNP
Q52	STN-2SC1815	Transistor SI NPN
D61	SDP-W02	Diode SI
D62	SDS-AP401	Diode COM
D63	SDS-AN401	Diode COM
D64	SDS-AP401	Diode COM
D65	SDS-AN401	Diode COM
D66	SDS-AP401	Diode COM
D67	SDS-AN401	Diode COM

Parts No.	ADVANTEST Stock No.	Description
D68	SDS-A54	Diode COM
D69	SDS-A64	Diode COM
D70	SDS-AP401	Diode COM
D71	SDS-AN401	Diode COM
D72	SDS-AN401	Diode COM
D73	SDS-AP401	Diode COM
D74	SDZ-H2-5	Zener Diode
D75	SDZ-H2-5	Zener Diode
D76 thru D78	SDS-AP401	Diode COM
D79		Not assigned
R86	RAY-AA10K4	R: FXD COM 10kΩ
R87	RAY-AA10K4	R: FXD COM 10kΩ
R88 thru R96	RCB-AH12K	R: FXD CAR 12kΩ
R97	RCB-AH5R6K	R: FXD CAR 5.6kΩ ±5% 1/4W
R98 thru R100	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R101	RAY-AA10K4	R: FXD COM 10kΩ
R102	RCB-AH47K	R: FXD CAR 47kΩ ±5% 1/4W
R103 thru R110	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R111	RAY-AA10K6	R: FXD COM 10kΩ
R112	RCB-AH1K	R: FXD CAR 1kΩ ±5% 1/4W
R113	RAY-AA10K4	R: FXD COM 10kΩ
R114	RAY-AA10K4	R: FXD COM 10kΩ
R115	RCB-AH270	R: FXD CAR 270Ω ±5% 1/4W
R116		Not assigned
R117 thru R126	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R127		Not assigned
R128	RCB-AH5R6K	R: FXD CAR 5.6kΩ ±5% 1/4W
R129	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R130	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
R131	RCB-AH100K	R: FXD CAR 100kΩ ±5% 1/4W
R132	RCB-AH560	R: FXD CAR 560Ω ±5% 1/4W
R133	RCB-AH560	R: FXD CAR 560Ω ±5% 1/4W
R134	RCB-AH1R2K	R: FXD CAR 1.2kΩ ±5% 1/4W
R135 thru R142	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
R143	RCB-AH1K	R: FXD CAR 1kΩ ±5% 1/4W
R144	RCB-AH6R8K	R: FXD CAR 6.8kΩ ±5% 1/4W
R145	RCB-AH6R8K	R: FXD CAR 6.8kΩ ±5% 1/4W
R146	RCB-AH33K	R: FXD CAR 33kΩ ±5% 1/4W
R147	RCB-AH1R5K	R: FXD CAR 1.5kΩ ±5% 1/4W
R148	RCB-AH1R5K	R: FXD CAR 1.5kΩ ±5% 1/4W

Parts No.	ADVANTEST Stock No.	Description
R149	RAY-AA100K4	R: FXD COM 100kΩ
R150	RAY-AA100K4	R: FXD COM 100kΩ
R151	RAY-AA10K4	R: FXD COM 10kΩ
R152	RAY-AA10K4	R: FXD COM 10kΩ
R153	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R154	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R155	RCB-AH10K	R: FXD CAR 10kΩ ±5% 1/4W
R156	RCB-AH220	R: FXD CAR 220Ω ±5% 1/4W
R157	RCB-AH100K	R: FXD CAR 100kΩ ±5% 1/4W
R158	RCB-AH47K	R: FXD CAR 47kΩ ±5% 1/4W
R159	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R160	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
R161	RCB-AH12K	R: FXD CAR 12kΩ ±5% 1/4W
R162	RCB-AH4R7K	R: FXD CAR 4.7kΩ ±5% 1/4W
C166	CCK-AB330U10V	C: FXD ELECT 330µF 10V
C167	CCK-AB10U16V	C: FXD ELECT 10µF 16V
C168	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C169	CCK-AA1000U50V	C: FXD ELECT 1000µF 50V
C170	CSM-AC100P50V	C: FXD CER 100pF ±10% 50V
C171	CSM-ACR1U50V	C: FXD CER 0.1µF +80, -20% 50V
C172	CSM-ACR1U50V	C: FXD CER 0.1µF +80, -20% 50V
C173	CCK-AB10U16V	C: FXD ELECT 10µF 16V
C174	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C175	CSM-AC220P50V	C: FXD CER 220pF ±10% 50V
C176	CCK-AB10U50V	C: FXD ELECT 10µF 50V
C177	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C178	CCK-AB10U16V	C: FXD ELECT 10µF 16V
C179	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C180	CCK-AB10U16V	C: FXD ELECT 10µF 16V
C181	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C182	CSM-AC100P50V	C: FXD ELECT 100pF ±10% 50V
C183	CCK-AB10U16V	C: FXD ELECT 10µF 16V
C184 thru C186	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C187	CCK-AB10U16V	C: FXD ELECT 10µF 16V
C188	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C189	CCK-AB10U16V	C: FXD ELECT 10µF 16V
C190	CSM-AC220P50V	C: FXD ELECT 220pF ±10% 50V
C191	CSM-AC100P50V	C: FXD ELECT 100pF ±10% 50V
C192	CSM-AC100P50V	C: FXD ELECT 100pF ±10% 50V
C193	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C194	CCK-AB10U16V	C: FXD ELECT 10µF 16V
C195	CCK-AB100U10V	C: FXD ELECT 100µF 10V
C196	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V
C197	CSM-ACR01U50V	C: FXD CER 0.01µF +80, -20% 50V
C198	CSM-AC100P50V	C: FXD CER 100pF ±10% 50V
C199	CSM-ACR1U50V	C: FXD CER 0.1µF +80, -20% 50V
C200	CSM-ACR047U50V	C: FXD CER 0.047µF +80, -20% 50V

Parts No.	ADVANTEST Stock No.	Description
C201	CCK-AB10U16V	C: FXD ELECT 10µF 16V
C202	CSM-AC4700P50V	C: FXD CER 4700pF ±10% 50V
C203	CFM-AC3300P50V	C: FXD Mylar 3300pF ±10% 50V
C204	CFM-AC2200P50V	C: FXD Mylar 2200pF ±10% 50V
C205	CSM-AC100P50V	C: FXD CER 100pF ±10% 50V
C206	CSM-AC100P50V	C: FXD CER 100pF ±10% 50V
C207	CSM-AC470P50V	C: FXD CER 470pF ±10% 50V
L211	LTP-000265-1	L: FXD Coil
L212	LCL-B00051-1	L: FXD Coil
SW216	KSA-000267	Switch

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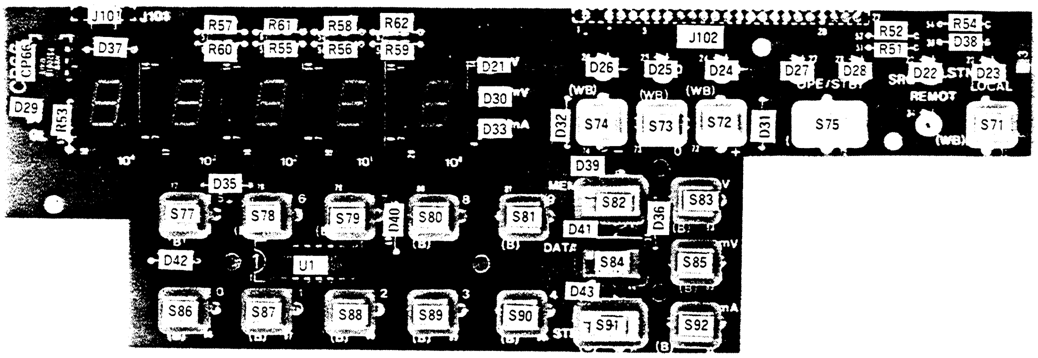
TR6142
DISPLAY
BLF-011458

Parts No.	ADVANTEST Stock No.	Description
U1	SIT-75468	IC:
D16 thru D20	NLD-000015	Light Emitting Diode
D21	NLD-000016	Light Emitting Diode
D22 thru D28	NLD-000003	Light Emitting Diode
D29	NLD-000016	Light Emitting Diode
D30	NLD-000016	Light Emitting Diode
D31	SDS-1S953	Diode SI
D32	SDS-1S953	Diode SI
D33	NLD-000016	Light Emitting Diode
D34	NLD-000003	Light Emitting Diode
D35 thru D38	SDS-1S953	Diode SI
D39	NLD-000003	Light Emitting Diode
D40	SDS-1S953	Diode SI
D41	NLD-000003	Light Emitting Diode
D42	SDS-1S953	Diode SI
D43	NLD-000003	Light Emitting Diode
R51	RCB-AH1K	R: FXD CAR 1kΩ ±5% 1/4W
R52	RCB-AH1K	R: FXD CAR 1kΩ ±5% 1/4W
R53	RCB-AH470K	R: FXD CAR 470kΩ ±5% 1/4W
R54	RCB-AH3R3K	R: FXD CAR 3.3kΩ ±5% 1/4W
R55 thru R62	RCB-AH330	R: FXD CAR 330Ω ±5% 1/4W
CP66	SEC-PS2001	Photo Conpler
SW71 thru SW75	KSP-000250	Switch
SW76 thru SW92	KSP-000250	Not assigned Switch
J101	JCP-BH003PX01	Connector
J102	JCP-AA024PX01	Connector

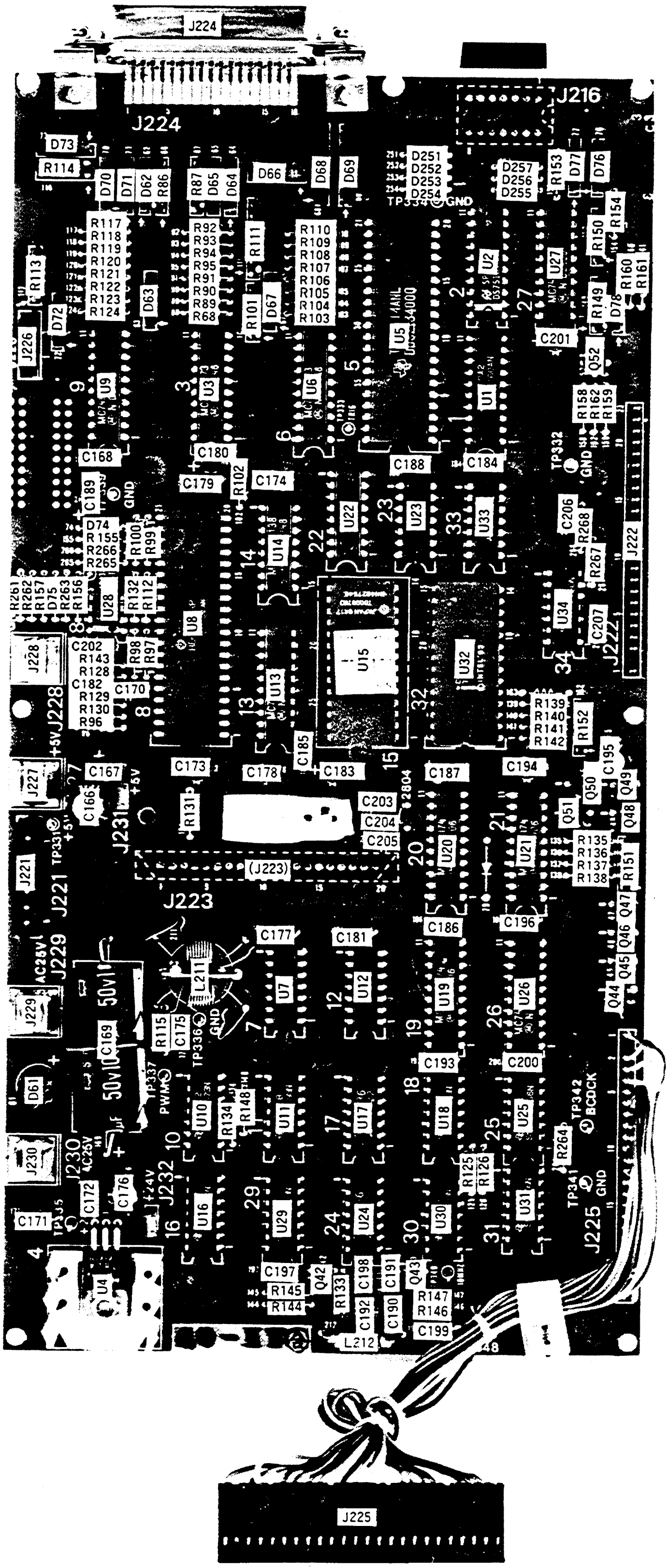
SECTION 8

LOCATIONS & DIAGRAMS

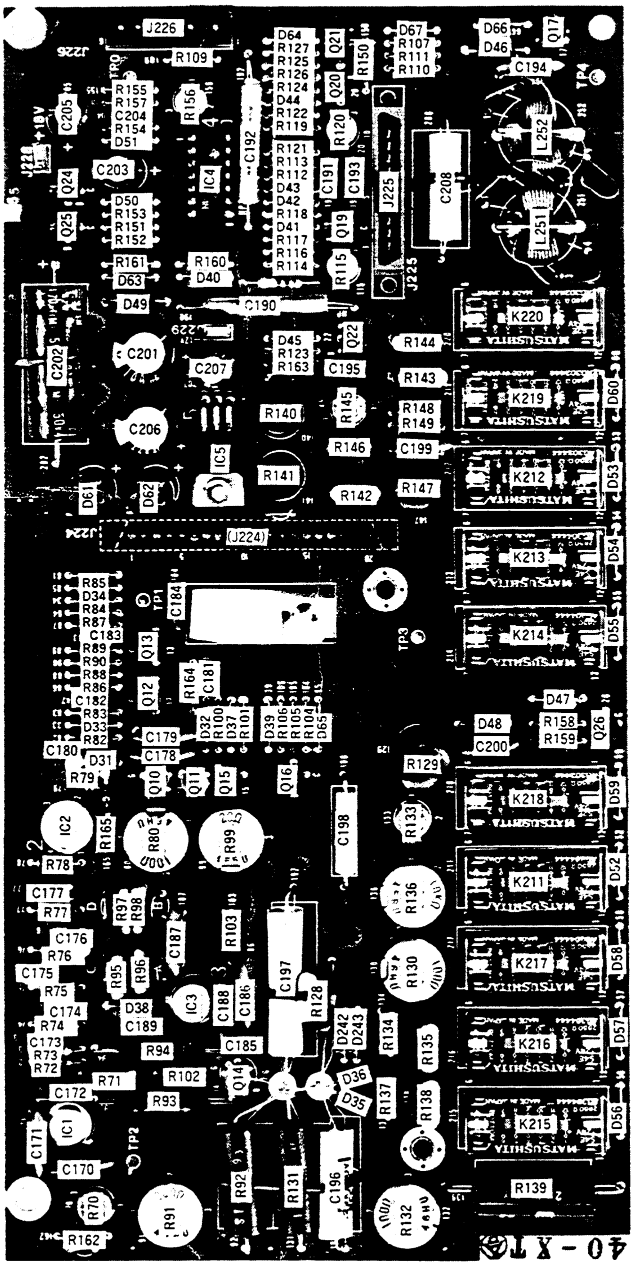
BLF-011458	DISPLAY board
BLK-011457	CONTROL board
BLK-0SH253x02	ANALOG board



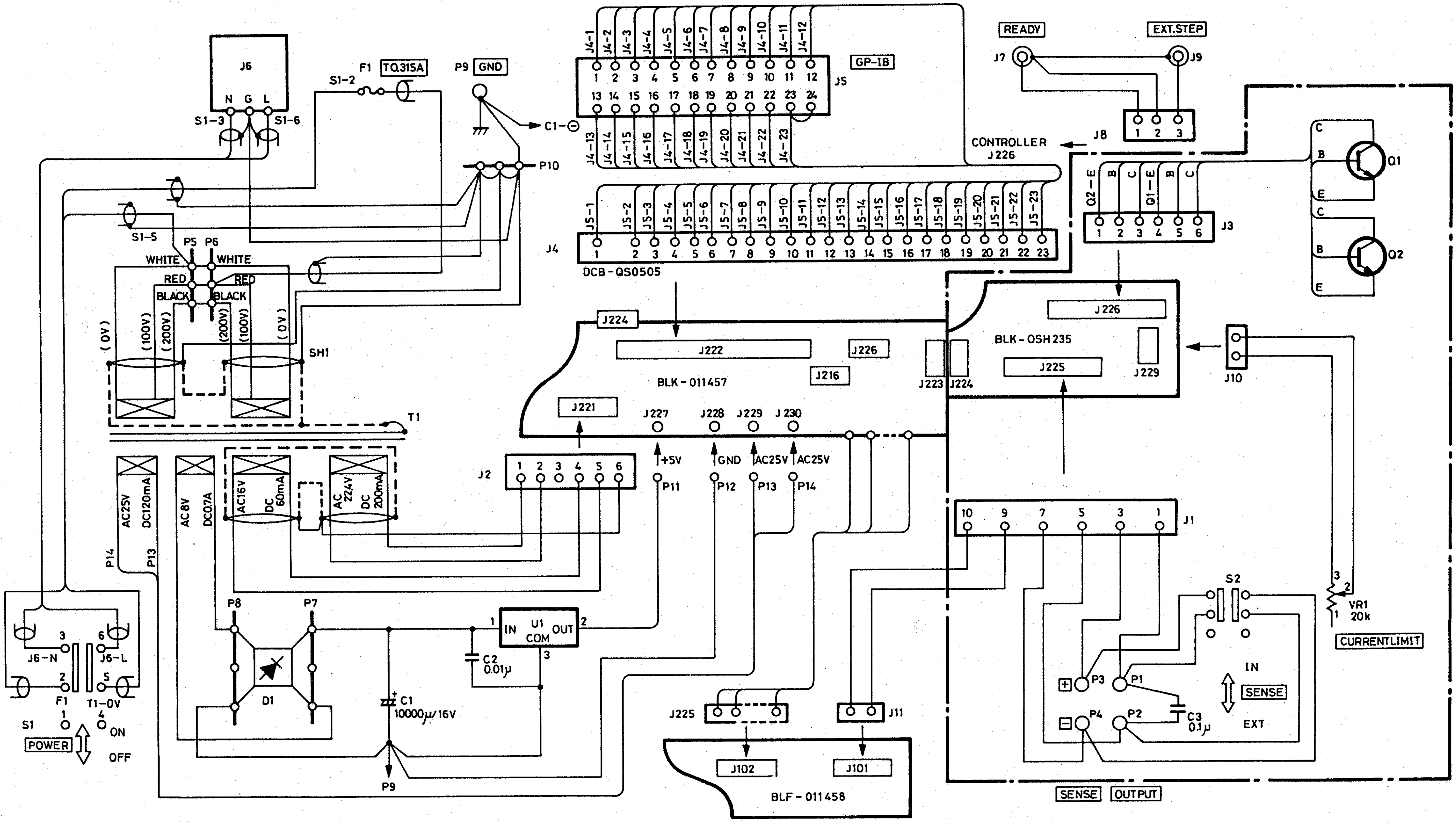
BLF-011458 locations



BLK-011457 locations

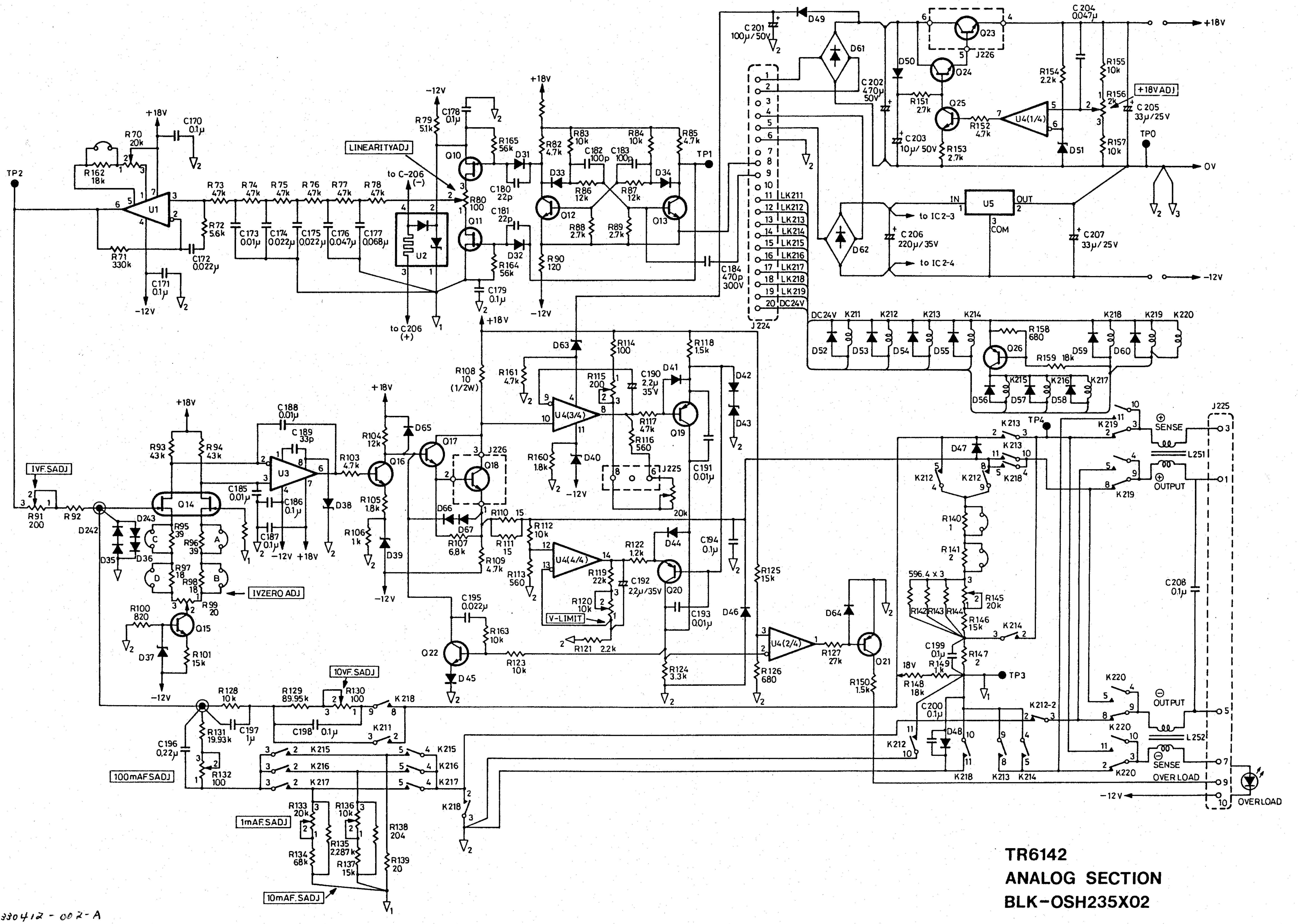


BLK-0SH253x02 locations



TR6142
SCHEMATIC SECTION

0330412-001-A



TR6142
ANALOG SECTION
BLK-OSH235X02

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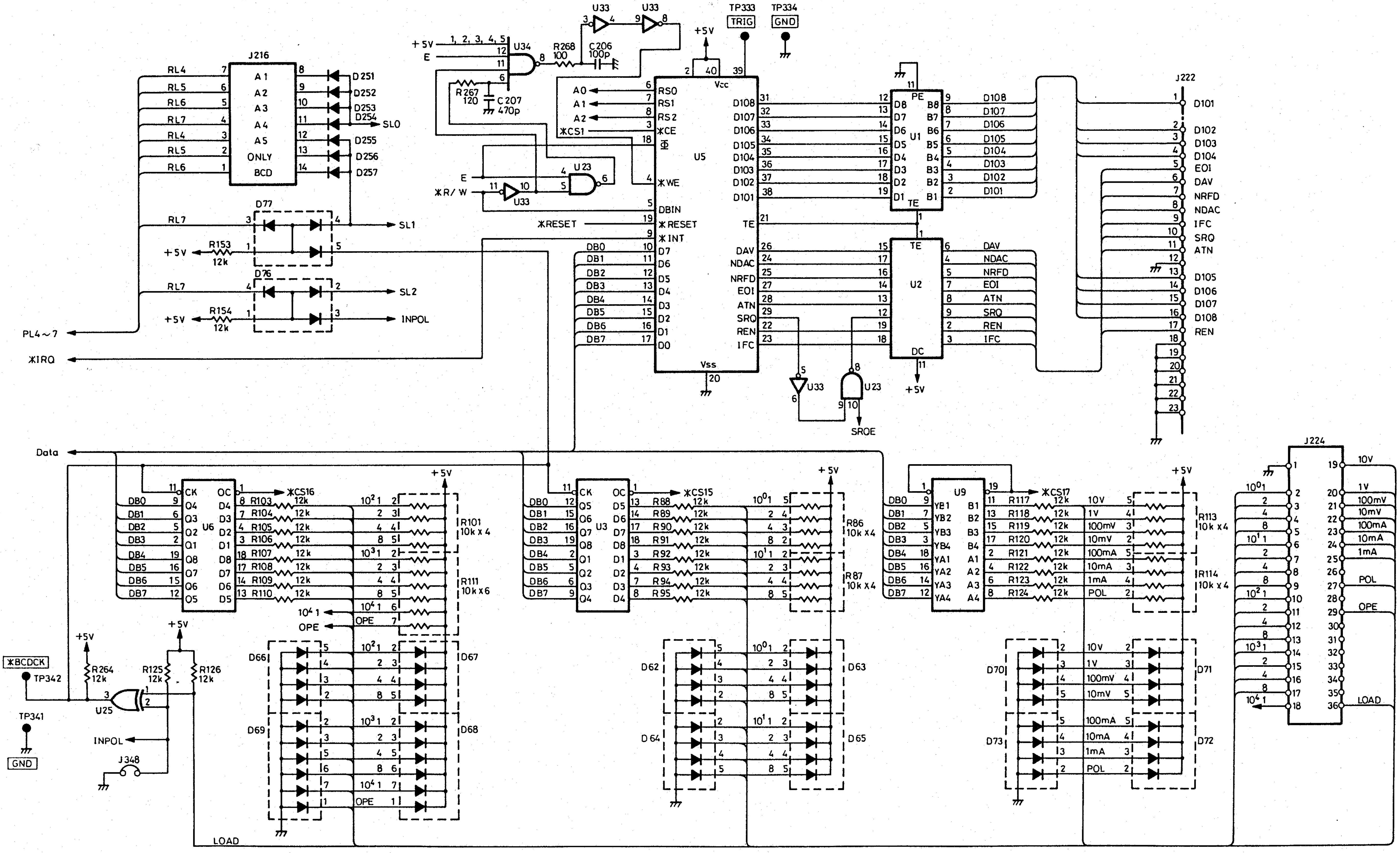

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CONTROLLER
BLK-011457 1/3

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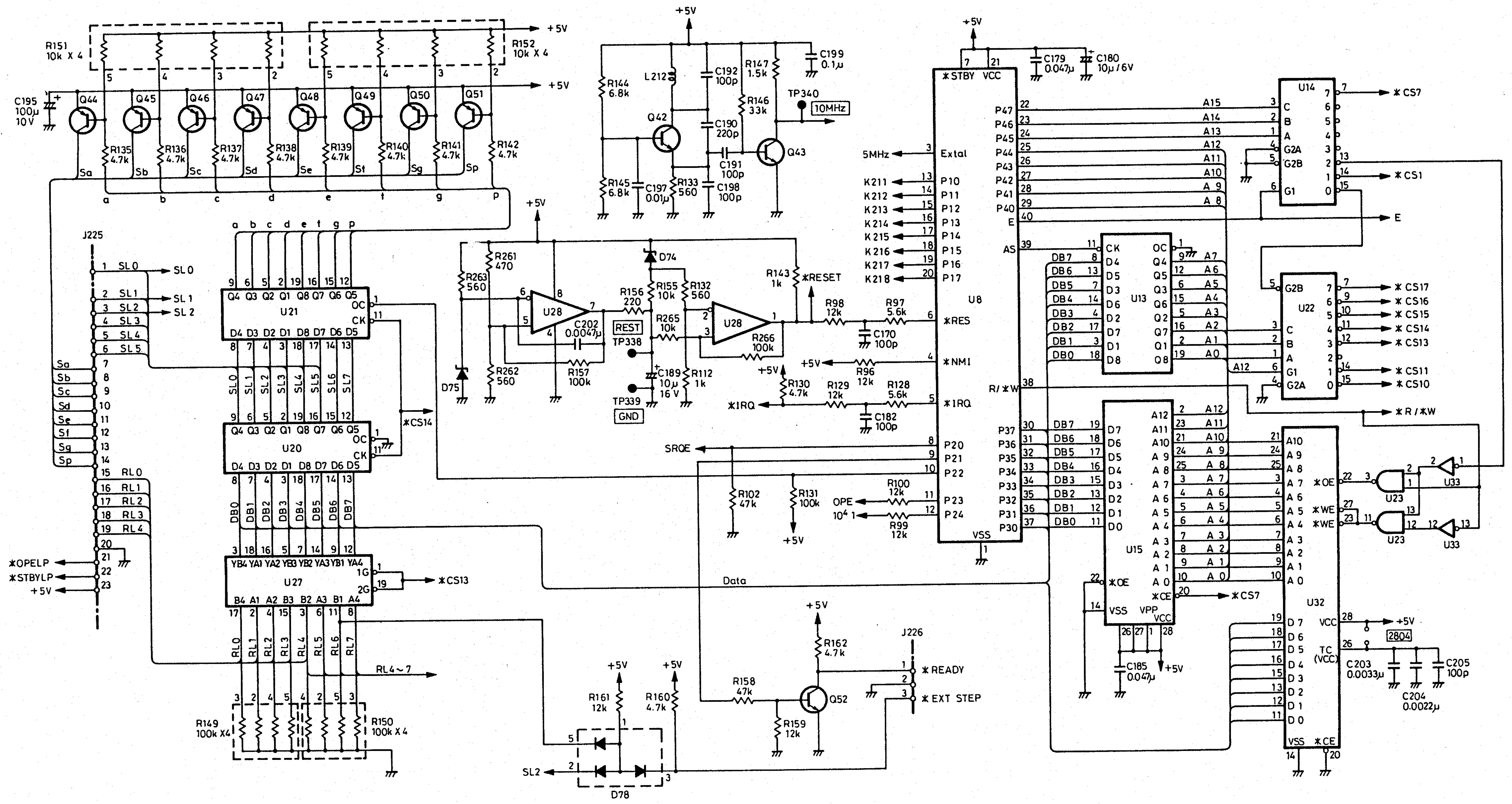

TR6142
CONTROLLER
BLK-011457 2/3

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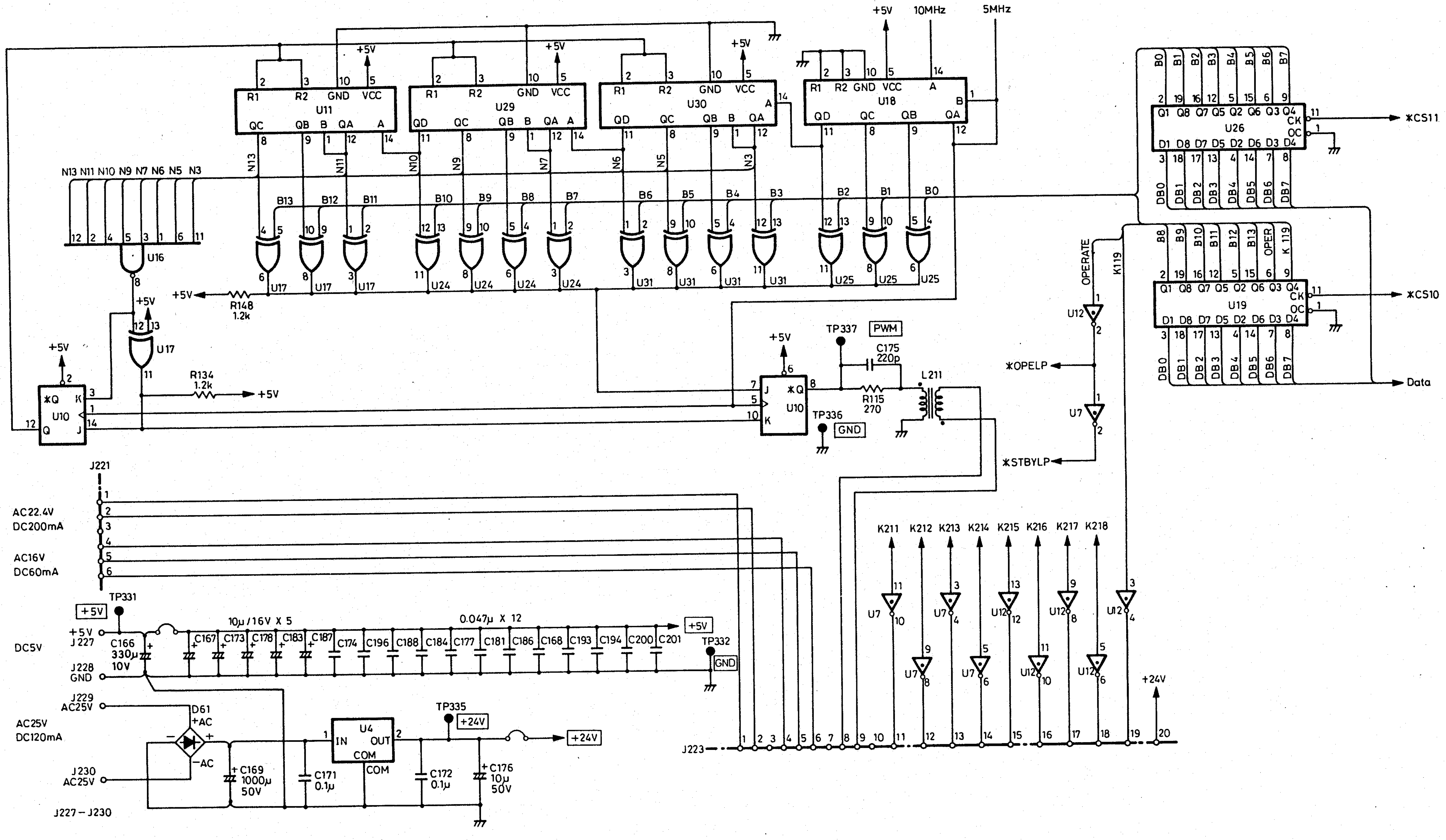

TR6142
CONTROLLER
BLK-011457 3/3

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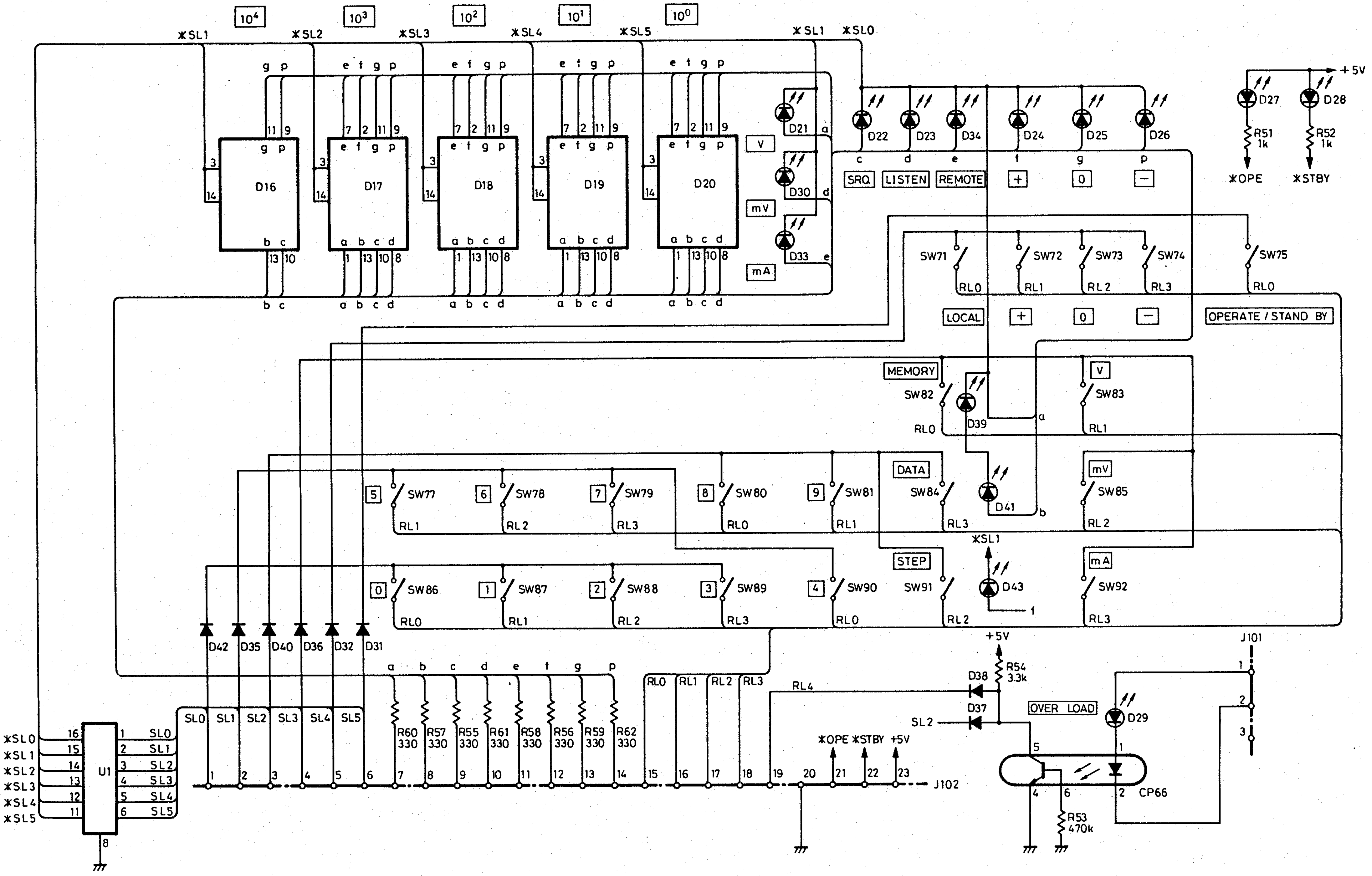

TR6142
DISPLAY
BLF-011458

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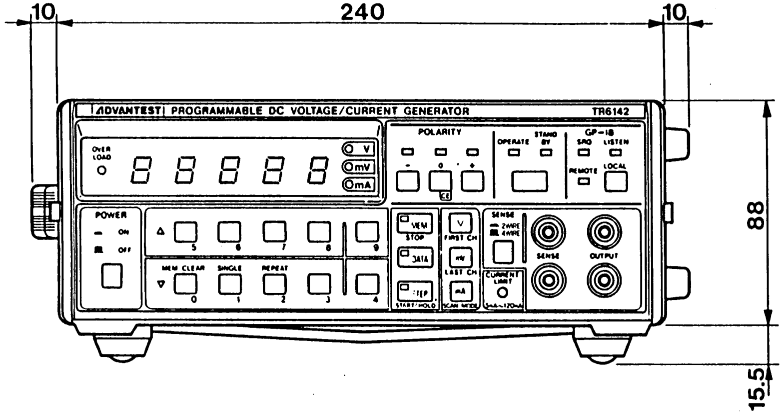
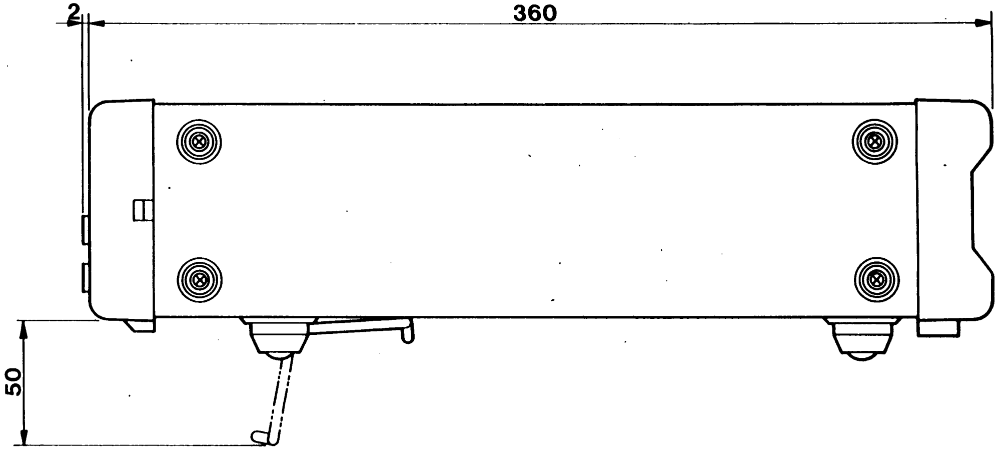
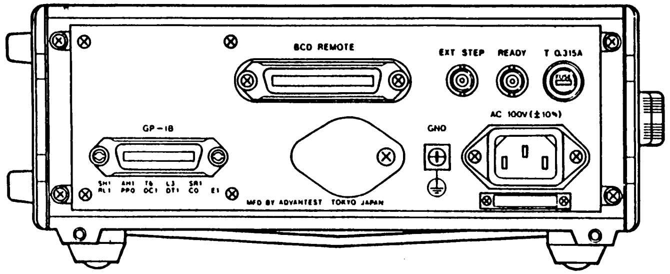


FRONT VIEW



SIDE VIEW



REAR VIEW

TR6142
EXTERNAL VIEW

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   (g) any product exported from a country where the product was sold.

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6. THE REMEDY SET FORTH HEREIN SHALL BE THE SOLE AND EXCLUSIVE REMEDY OF THE PURCHASER FOR BREACH OF WARRANTY WITH RESPECT TO THE PRODUCT.

7. ADC CORPORATION WILL NOT HAVE ANY LIABILITY TO THE PURCHASER FOR ANY INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL OR PUNITIVE DAMAGES, INCLUDING, WITHOUT LIMITATION, LOSS OF ANTICIPATED PROFITS OR REVENUES, IN ANY AND ALL CIRCUMSTANCES, EVEN IF ADC CORPORATION HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES AND WHETHER ARISING OUT OF BREACH OF CONTRACT, WARRANTY, TORT (INCLUDING, WITHOUT LIMITATION, NEGLIGENCE), STRICT LIABILITY, INDEMNITY, CONTRIBUTION OR OTHERWISE.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL BUYER

The product should be thoroughly inspected immediately upon original delivery to buyer. If the product is damaged in any way, a claim should be filed by the buyer with carrier immediately.

CUSTOMER SERVICE DESCRIPTION

Contact an ADC CORPORATION sales representative if a failure occurs.

(1) The repair service lasts ten years from the delivery date of the Product.
(2) The repair and calibration services may be declined if either of the following situations arise.
    1) When required parts cannot be procured.

    2) When the performance of the Product cannot be maintained after repair.

ADCMT® ADC CORPORATION

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