2114H

Digital Multi-Thermometer

Operation Manual

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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.

 : 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

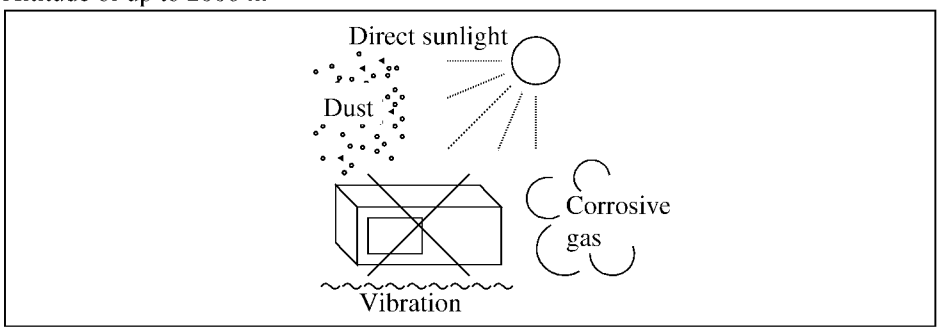


Figure-1 Environmental Conditions

- Operating position

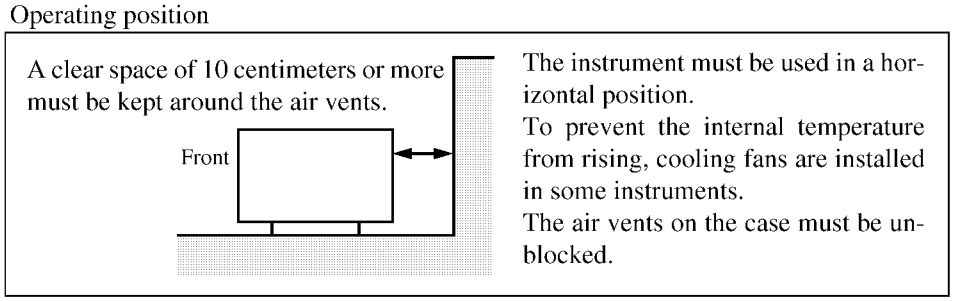


Figure-2 Operating Position

- Storage position

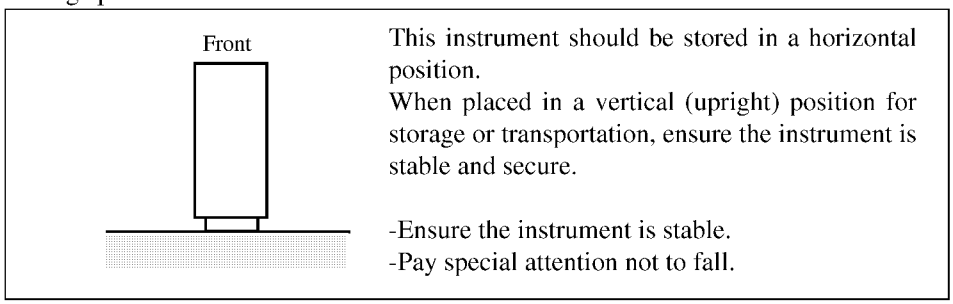


Figure-3 Storage Position

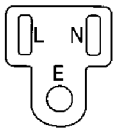
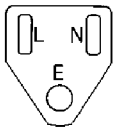
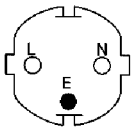
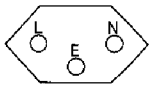
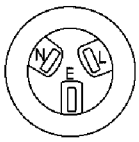
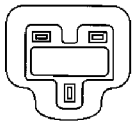
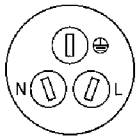
- The classification of the transient over-voltage, which exists typically in the main power supply, and the pollution degree is defined by IEC61010-1 and described below.

  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

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SECTION 1
GENERAL INFORMATION

1-1. GENERAL

The 2114H Digital Multi-Thermometer is a high-performance multimeter which ADC Corp. developed by enhancing its multifunctional measurement techniques and making coordinated design of its unique A/D conversion application techniques, high-stability thin-film resistor production techniques, and microprocessor application techniques.
Its standard functions include not only those for measuring DC voltages, resistances, and temperatures (by the use of thermocouples and RTDs) but also those for analog conversion output, smoothing, and data comparison.
The 2114H using an plug-in adapter system permits such input terminal blocks as the 21141 Input Block (standard accessary), the 21142 Input Block (for high-precision 2-channel input), and the 21143 Input Block (for multichannel input) to be installed in the mainframe.
Since this instrument is designed to use a small amount of power, its measuring operation is less affected by internal heat generation, and it can continuously operate for many hours on a battery unit if employed.
It incorporates a CMOS-type microprocessor and a 4-1/2 digits LCD (liquid crystal display), and features high resolution of 1 μV for DC voltage measurements, 10 mΩ for resistance measurements, and 0.1^{o}C for temperature measurements.
Seven types of thermocouples and a platinum RTD (resistance temperature detector) can be used with this instrument to measure a wide range of temperatures (-270^{o}C to +1820^{o}C). It can measure temperatures in either of ^{o}C, ^{o}F, or K. (For the 2114H, nine types of thermocouples can be used.)
Furthermore, this instrument enables the measurement function, measuring range and other conditions to be externally controlled via a GPIB interface.
If an overload, conduction, or comparison alarm occurs, or when a key is pressed, an electronic tone sounds for easy confirmation by the operator.

The measuring range may be switched either automatically to keep the range selection optimum or manually using the UP and DOWN keys as required.
The standard features of the 2114H also include a high-speed sampling function and various computation functions.

1-2. ACCESSORIES

Many accessories are available for this instrument so that it may be used for a variety of purposes; for research, development, manufacture, maintenance, etc.
The accessories are as follows:

(1) A01006 Input Cable (4-wire cable for resistance measurement)
(2) A02016 Panel Mount Kit
(3) A02226 JIS Rack Mount Kit
(4) A02423 EIA Rack Mount Kit
(5) 1101-100 Sheath-Type Thermocouple T
(6) 1101-110 Sheath-Type Thermocouple J
(7) 1101-120 Sheath-Type Thermocouple E
(8) 1101-130 Sheath-Type Thermocouple K
(9) 1102-100 Sheath-Type Thermocouple T
(10) 1102-110 Sheath-Type Thermocouple J
(11) 1102-120 Sheath-Type Thermocouple E
(12) 1102-130 Sheath-Type Thermocouple K
(13) 1104-001 Sheath-Type Platinum RTD
(14) 1104-002 Sheath-Type Slender Platinum RTD
(15) 1107-001 Sensor for Surface Temperature Measurement (Probe-Type Thermocouple E)
(16) 1107-002 Sensor for Surface Temperature Measurement (Probe-Type Thermocouple E)
(17) 1107-003 Sensor for Surface Temperature Measurement (Probe-Type Thermocouple E)
(18) 1107-004 Sensor for Surface Temperature Measurement (Probe-Type Thermocouple E)
(19) 1111 Terminal Adapter
(20) TR1300 Current Adapter
(21) TR1640 Carrying Case

(22) TR6198 Digital Recorder

(23) 7021 Zero Conditioner

(24) TR13003 BCD Data Output Unit

(25) 13206A GPIB Adapter Unit

(26) TR15802 Battery Unit

(27) 19001 Auto Channel Selector

(28) 21142 Input Block (for 2-channel input and difference measurement)

(29) 21143 Input Block (for multichannel input using 19001)

SECTION 2

SPECIFICATIONS

2-1. ELECTRICAL PERFORMANCE

2-1-1. DC Voltage Measurement

Maximum indicatable value: ±19999

Measurement accuracy:

Range	Resolution	Measurement accuracy (temperature: +23°C ±5°C, humidity: 85% max., period: 6 months)
20.000 mV	1 µV	±0.045% of rdg ±5 digits
200.00 mV	10 µV	±0.045% of rdg ±2 digits
2000.0 mV	100 µV	±0.045% of rdg ±2 digits
20.000 V	1 mV	±0.05% of rdg ±2 digits
200.00 V	10 mV	±0.05% of rdg ±2 digits

Temperature coefficient (at 0°C to +18°C and +28°C to +50°C):
±(0.005% of reading + 0.8 digit)/°C in 20 mV range
±(0.005% of reading + 0.2 digit)/°C in 20 mV to 200 V ranges

Input impedance: 1000 MΩ min. in 20 mV to 2000 mV ranges
10 MΩ ±1% in 20 V and 200 V ranges

Maximum appliable voltage: 200 Vdc, 200 Vrms ac (continuous)

Noise rejection ratio:

Effective common mode noise rejection ratio (ECMRR) at unbalanced resistance of 1 kΩ

120 dB min. for DC

120 dB min. for AC line frequency of 50/60 Hz ±0.1%

Normal mode noise rejection ratio (NMRR)

Approx. 60 dB for AC line frequency of 50/60 Hz ±0.1%

2-1-2. Resistance Measurement

Maximum indicatable value: 19999

Measurement accuracy:

Range	Resolution	Applied current	Applied voltage	Measurement accuracy (temperature: +23°C ±5°C, humidity: 85% max., period: 6 months)
200.00 Ω	10 mΩ	1 mA	0.2 V	±0.04% of rdg ±2 digits*
2000.0 Ω	100 mΩ	1 mA	2 V	±0.04% of rdg ±2 digits
20.000 kΩ	1 Ω	100 μA	2 V	±0.04% of rdg ±2 digits
200.00 kΩ	10 Ω	10 μA	2 V	±0.04% of rdg ±2 digits
2000.0 kΩ	100 Ω	1 μA	2 V	±0.1% of rdg ±6 digits

*: 2-wire conductor: ±0.04% of rdg ±14 digits (error attributable to measurement cable resistance is excluded.)

3-wire conductor: ±0.04% of rdg ±4 digits (error attributable to the difference between the measurement cable HI line and LO line resistance is excluded.)

Temperature coefficient (at 0°C to +18°C and +28°C to +50°C):
±(0.004% of reading + 0.1 digit)/°C

Open circuit voltage (between HI and LO terminals): 5 V max.

Conductor type: 2-,3-, or 4-wire type

Allowable conductor resistance: 10 Ω or less for 3- and 4-wire conductors

Maximum appliable voltage: 120 Vdc, 200 Vrms ac (continuous)

2-1-3. Temperature Measurement (Using the Thermocouple)

The measuring ranges, resolutions, and accuracies are as follows:

Thermocouple	Measuring range	Resolution	Measurement accuracy (temperature: +23°C ±5°C, humidity: 85% max., period: 6 months)
T(CC)	-270°C to -250°C -250°C to -180°C -180°C to +400°C	0.1°C	±0.06% of rdg ±2.7°C ±0.06% of rdg ±1.0°C ±0.06% of rdg ±0.3°C
J(IC)	-210°C to 0°C 0°C to +1200°C	0.1°C	±0.06% of rdg ±0.4°C ±0.06% of rdg ±0.3°C
E(CRC)	-270°C to -250°C -250°C to -200°C -200°C to +1000°C	0.1°C	±0.06% of rdg ±1.4°C ±0.06% of rdg ±0.5°C ±0.06% of rdg ±0.3°C
K(CA)	-270°C to 250°C -250°C to -200°C -200°C to +1372°C	0.1°C	±0.06% of rdg ±2.4°C ±0.06% of rdg ±0.6°C ±0.06% of rdg ±0.3°C
S(PR10)	-50°C to 0°C 0°C to +1769°C	0.1°C	±0.06% of rdg ±2.0°C ±0.06% of rdg ±0.8°C
R(PR13)	-50°C to 0°C 0°C to +350°C +350°C to +1769°C	0.1°C	±0.06% of rdg ±2.0°C ±0.06% of rdg ±1.0°C ±0.06% of rdg ±0.6°C
B(PR30)	+100°C to +500°C +500°C to +1820°C	0.1°C	±0.06% of rdg ±3.0°C ±0.06% of rdg ±0.8°C
*Chrome/gold (iron)	4 K to 280 K (-268°C to +7°C)	0.1 K	±0.06% of rdg ±0.4 K
*Normal silver/gold (iron)	4 K to 40 K (-268°C to -233°C)	0.1 K	±0.06% of rdg ±0.4 K

* Usable only with the 2114H.

Note: ● Calibration of thermocouples, T, J, E, K, S, R, and B must comply with JIS C1602-1981.
● Calibration of chrome vs. gold (iron) and normal silver vs. gold (iron) thermocouples must comply with the NBS table of 1972.
Chrome vs. gold (iron): 0.07% Fe
Normal silver vs. gold (iron): 0.07% Fe
● The accuracy of the reference junction compensation is not included.

Temperature coefficient (at 0°C to +18°C and +28°C to +50°C):
±(0.005% of reading + 0.2°C)/°C

Linearization: By digital computation method

Input impedance: 1000 MΩ min.

Maximum appliable voltage: 220 Vdc, 220 Vrms ac (continuous)

Measurement units: Selectable from °C, °F, and K

Reference junction compensation:

Internal: Input terminal temperature measurement compensation is made using transistors.

Compensation accuracy (internal compensation accuracy is included in measurement accuracy):

- ±1.0°C when 21141 used
- ±0.5°C when 21142 used
- ±1.0°C when 21143 and 19001 used

Temperature coefficient: ±0.04°C/C° at 0°C to +18°C, and +28°C to +50°C

External: Ice point: 0°C (273.2 K)

Liquid nitrogen boiling point: -195.9°C (77.3 K)

Liquid helium boiling point: -269.0°C (4.2 K)

Arbitrary temperature (settable): T°C

2-1-4. Temperature Measurement (Using a Platinum RTD (Resistance Temperature Detector))

Resistance temperature detector:

Pt100 (complying with JIS C1604-1989)

JPt100 (complying with JIS C1604-1981)

Measuring range: -200°C to +649°C

Resolution: 0.1°C

Measurement accuracy: ±0.06% of reading ± 0.2°C (temperature: +23°C ±5°C, humidity: 85% max., period: 6 months), not applicable to 2-wire conductor type

Temperature coefficient (at 0°C to +18°C and +28°C to +50°C):

±(0.004% of reading + 0.1°C)/°C

Applied current: 1 mA

Conductors: 2-, 3-, or 4-wire type

Allowable conductor resistance: 10 Ω or less for 3- and 4-wire conductors

Linearization: By digital computation method

Maximum appliable voltage: 120 Vdc, 220 Vrms ac (continuous)

Measurement unit: Selectable from °C, °F, and K

2-1-5. Computation Functions

R: Result of computation (value to be indicated)

X: Measured value

Y, Z: Constants (settings and measurements)

(1) Scaling

$$R = \frac{X - Z}{Y}$$

(2) Deviation in %

$$R = \frac{X - Y}{Y} \times 100 \ (\%)$$

(3) Comparator *

R (HIGH): $X > Y$

R (LOW): $X < Y$

R (GO): $Y \geq X \geq Z$

HIGH, LOW, and GO indicators are provided.

When HIGH, LOW, GO, or HIGH & LOW occurs, an electronic tone is sounded.

(4) Maximum R (max.)

(5) Minimum R (min.)

(6) Average R (ave.) $R = \Sigma X/Y = x$

* The TR2114 has the comparator function only as its standard computation function. (The 2114H has all the above-listed functions as its standard computation functions.)

Note: For (4) thru (6), the maximum, minimum, and average values of data obtained by making measurement Y times are computed. If the value of Y is between 1 and 100, they are indicated at every Yth measurement and both digital and analog data are output.

If the value of Y specified to obtain the maximum, minimum, or average is equal to or greater than 101, the present maximum or minimum value of data collected after Y was set is indicated, or the average is output every 100 measurements.

2-1-6. Input Terminals

21141: Binding post type terminal; 2-, 3-, or 4-wire type; used to measure DC voltages, resistances, and temperatures (thermocouples and RTD) (standard accessory).

21142: Horizontal screw (M4) type terminal; 2-wire type; used for 2-channel measurement; provided with a difference measurement function (optional)

21143: Terminal used to connect 19001 for multichannel measurements (optional).

2-1-7. Other Functions

Filter function: Digital smoothing system
The number of times smoothing is used can be arbitrarily set in the 1 to 100 range.

Buzzer function: If a key is pressed, if an overload occurs, or if the comparator function is used, intermittent electronic tones are sounded by a piezo-electric buzzer. (The buzzer mode can be switched on and off.)

Analog output: Analog converted output isolated from the measuring system can be obtained via a jack on the rear panel (standard feature).

Output data: Measured values; results of computations; outputs (0 V, 1 V) for recorder calibration

Converted output: 3 digits 000→999 (0 V→0.999 V)

Digit selection: 19999 19999 19999 19999

Output offset: 50% offset can be set.

Offset output: 500→0 V
000→0.5 V
499→0.999 V

Polarity conversion: Absolute value (ABSOLUTE)
Value with polarity (NORMAL)

Conversion accuracy: ±0.3% of full scale (temperature: +23°C ±5°C, humidity: 85% max., period: 6 months)

Output impedance: 0.5 Ω or less (up to 100 μA)

Remote control: The functions, range, unit (^{o}C, ^{o}F, K), and reference junction compensation (internal/external) can be set, and measurement can started by remote control via a 13206A or TR13003.

2-2. GENERAL SPECIFICATIONS

Measuring system: Integration type

Input system: Floating method

Maximum indicatable value: 19999 (except for temperature indication)

Indication: 7-segment liquid crystal indicator consisting of 5 decimal digits.
A character representing a unit or a function is indicated on a 5x7 dot matrix liquid crystal indicator.

Overload indication: If data outside the measuring range is input, the OVER indicator comes on.

Low battery indication: If the voltage of the AC power supply or Ni-Cd batteries goes below the required level, the BATT indicator comes on.

Range switching: Automatic or manual

Automatic range: Up level: 20000
Down level: 1799

Measuring speed:

With the sampling rate set to FAST:

TR2114: About 2.5 times/s

2114H: 15 to 20 times/s (for measurements of DC voltages, or of temperatures using a thermocouple)
7 to 10 times/s (for measurements of resistances, or of temperatures using an RTD)

With the sampling rate set to SLOW:

Can be set to 1/2, 1/5, 1/10, 1/20, 1/50, or 1/100 of the measuring speed in the FAST mode.

Withstanding voltage: 500 V (DC and AC peak) between LO terminal and chassis, and between AC power lines

Operating environment:

Temperature: 0°C to +50°C (0°C to +40°C when TR15802 used)

Humidity: 85% RH max.

Storage temperature: -25°C to +70°C

Power requirements: 100 V, 120 V, 220 Vac ±10% or 240 Vac $^{+4\%}_{-10\%}$

Line frequency: 50 or 60 Hz

Power consumption: 4 VA or less (main unit only)
6 VA or less (including accessories)

DC power supply: TR15802 can keep the main unit in operation for about 20 hours.

Dimensions: About 190 (W) x 70 (H) x 260 (D) mm, excluding handles and feet

Weight: Less than 2 kg (including input block)

2-3. ACCESSORIES (STANDARD)

Name	Part Number	Quantity	Remarks
Power cable	A01402	1	
Input cable	A01007	1	DCV, 2-wire type for resistance measurements
Analog output cable	A01204	1	
Power fuse	DFT-AAR16A	0	Slow-blow fuse, 0.16 A (for power supply circuit of 100 V and 120 V)
	DFT-AAR08A	2	Slow-blow fuse, 0.08 A (for power supply circuit of 220 V and 240 V)
Thermocouple(T)	1101-100	1	
Label		1	
Instruction manual	E2114H	1	

SECTION 3

OPERATING PROCEDURES

3-1. INSPECTION

Upon receiving the 2114H Digital Multi-Thermometer, check it for damage caused in transit. If damage is found, or if operation of the instrument does not conform to the specifications, notify your nearest ADC CORPORATION sales representative.

3-2. STORAGE

When the 2114H will not be operated for a long period of time, put it in a cardboard box after wrapping it in vinyl sheet, and store it in a place with low humidity protected from the direct sunlight. Keep the storage temperature between $-25^{\circ}C$ and $+70^{\circ}C$.
When storing the TR15802, take similar precautions. For the TR15802, however, keep the storage temperature between $-25^{\circ}C$ and $+40^{\circ}C$.

3-3. PREPARATIONS BEFORE USE AND GENERAL PRECAUTIONS

(1) When using the 2114H with AC power, be sure to use the attached power cable. The power requirements are 100 Vac ±10% (alteration for operation on 120 or 220 V ±10%, or 240 V $^{+4\%}_{-10\%}$ is possible depending on country's destination), with line frequency of 50 or 60 Hz. Make sure that the POWER switch is turned off before connecting the power cable to the 2114H or installing the TR15802 battery unit in the instrument.

(2) Make sure that the POWER switch of the 2114H is turned off before installing an accessory unit in the instrument.

(3) Allow the instrument to warm up for about 30 minutes on the AC power or DC power supplied by the battery unit so that the measurement accuracies indicated in Section 2 may be ensured.

(4) Use the instrument at a temperature between $0^{\circ}C$ and $+50^{\circ}C$ with 85% RH or less in a well-ventilated place protected from the direct sunlight.

(5) Handle the instrument taking care not to knock or bump it excessively.

3-4. GROUNDING

When using the instrument on AC power, be sure to connect the central prong of the power cable plug to ground for protection against electrical shock. The plug attached to the power cable has three prongs. The round prong in the center is for grounding. When the cable is plugged into an AC receptacle of the corresponding type, the central prong is connected to ground.

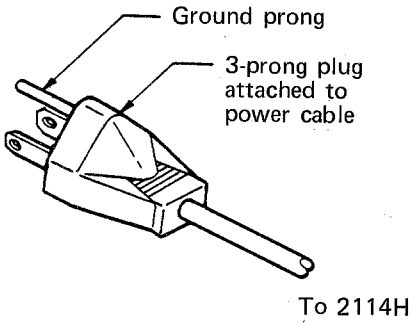


Fig. 3-1 Power cable

3-5. HANDLE LOCK

The handle of this instrument can be locked in any of the positions shown in Figure 3-2 as required. To release the handle lock, pull the knobs that hold the handle to the instrument outwards as shown in Figure 3-3. When the handle lock is released, change the handle position as required, and lock it again.

When using this instrument with an accessory units such as the TR13003 or 13206A, lock the handle in the position shown in Figure 3-4 (a). The position shown in Figure 3-4 (b) causes the accessory case or accessory connection cable to contact the base and possibly causes some inconvenience.

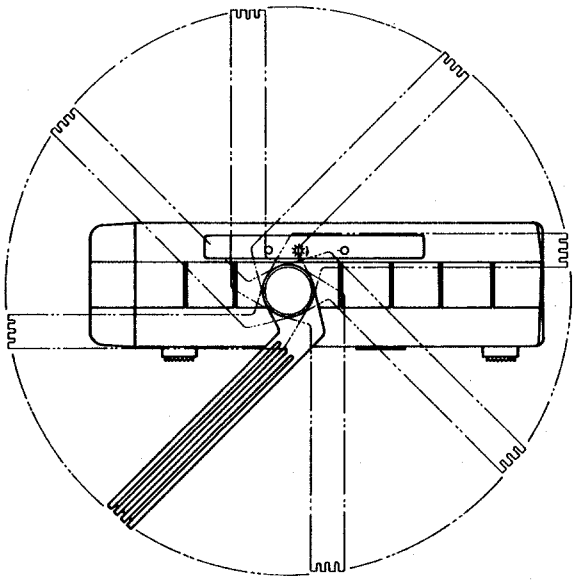


Fig. 3-2 Handle locking positions

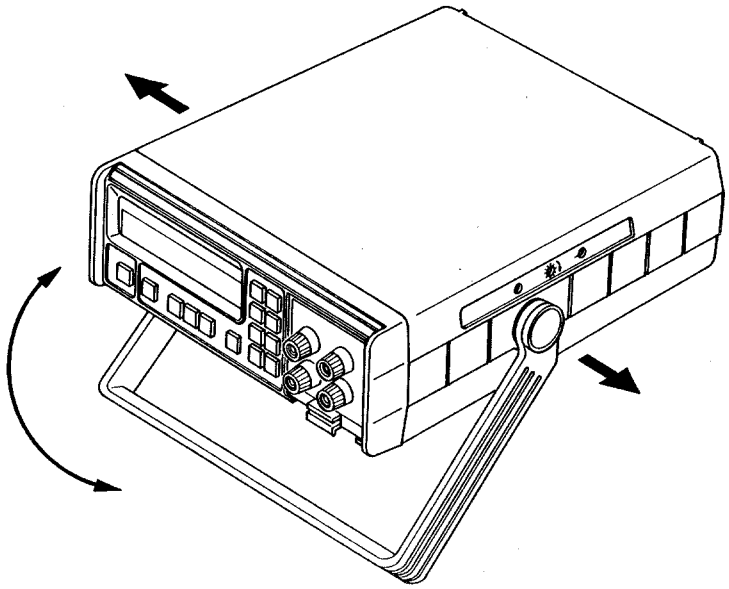
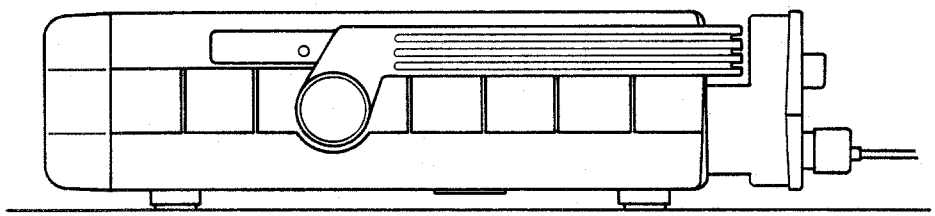
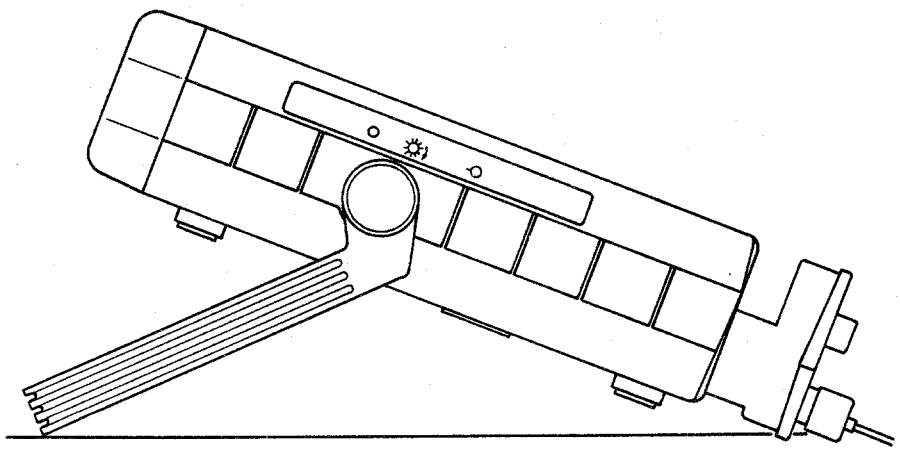


Fig. 3-3 Releasing handle lock



(a) Correct position



(b) Undesirable position

Fig. 3-4 Handle position for operation with accessory connected

3-6. PANEL DESCRIPTION

3-6-1. Front Panel Description (See fig. 3-5)

(1) Indicators

① Sampling indicator

Indicates that measurements are being made.

② OVER indicator

Indicates that the result of the measurements is outside the measuring range.

③ Buzzer indicator

Indicates that the buzzer mode has been set. (This indication does not appear when the buzzer mode has not been set.)

④ Battery indicator

Indicates that the battery voltage is lower than the required level.

⑤ MNL indicator

Indicates that the manual range-switching mode has been set.

⑥ SM indicator

Indicates that the smoothing function has been set.

⑦ HIGH indicator

Indicates that the result of comparator operation was $X > Y$ (X = measured value, Y = higher limit value).

⑧ GO indicator

Indicates that the result of comparator operation was $Y \geq X \geq Z$ (X = measured value, Y = higher limit value, Z = lower limit value).

⑨ LOW indicator

Indicates that the result of comparator operation was $X < Z$ (X = measured value, Z = lower limit value).

⑩ COMP indicator

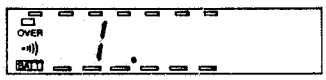
Indicates that a computation function has been set.

⑪ REMOTE indicator

Indicates that the instrument connected with a 13206A GPIB Adapter Unit or TR13003 BCD Data Output Unit is under remote control by the controller.

⑫ Numerical indicator

This indicator consists of 4-1/2 digits and can indicate values up to 19999. The decimal point is automatically set according to the range setting. The polarity is indicated only when the measured signal value is negative.
When the result of measurement exceeds 19999, this indicator gives an indication as shown below; the decimal point and the units are determined according to the measuring range.



⑬ Unit and function indicator

Indicates a unit, a function, or other information depending on the measuring function and range settings.

⑭ Cursor

Indicates the digit whose setting can be changed in the program mode (see Section 3-9).

(2) Key switches

⑮ POWER switch

Turning this switch on (depressed position) causes all circuits to be powered. Turning it off (projected position) causes the power to be cut off.
The TR15802, if installed in this instrument, can be charged regardless of this POWER switch setting. To keep the charging circuit powered, the current is kept flowing through the primary side of the transformer whether the POWER switch is on or off (see Section 6 for details).

⑯ PRGM/ENTER key

This key is used to set and cancel the program mode, and also to cancel the CAL (calibration) mode. When the program mode is set, the cursor appears in the indicator section.

In the program mode, the measurement conditions (range, unit, conductor type, reference junction, and computation function) can be set for the DCV, OHM, TC, and RTD functions.

Example: Range setting for DCV and OHM functions

: The previously set parameter is indicated.

: Move the cursor to the 10^3 digit.

: Set the parameter corresponding to the desired range.

: The newly set parameter is stored, and measurement is started again.

⑰ AUTO/MNL key

The selection between the AUTO and MNL range switching is made using this key.

If the MNL (manual) mode is selected, the MNL indicator in the indicator section comes on and manual range switching is enabled.

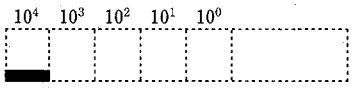
If the AUTO mode is selected, the automatic range switching is enabled to dynamically keep the range selection optimum.

If this key is pressed after the AUTO mode is selected, the present range selection is fixed.

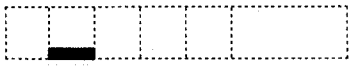
If this key is pressed after the MNL mode is selected, the selection changes to the AUTO mode.

In the program mode, this key is used to shift the data settable digit.

Example: If ⇨ key is pressed in the program mode with the cursor positioned at the 10^4 digit as shown below,



the cursor moves to the 10^3 digit meaning that data can be set as the 10^3 digit.



(If ⇨ key is pressed while the cursor is positioned at the 10^0 digit, the cursor moves to the 10^4 digit.)

⑱ DOWN key

This key is used to shift the range down in the MNL mode. If this key is pressed when the AUTO mode has been selected, the MNL mode is entered, and the range is then shifted down.

In the program mode, this key is used to decrement the number set as the specified digit.

Note: The number that appears as each digit in the program mode indicates the selection of a function. It cyclically changes every time the DOWN key is pressed. The number combination differs from digit to digit. (See Table 3-1.)

⑲ UP key

This key is used to shift the range up in the MNL mode. If this key is pressed when the AUTO mode has been selected, the MNL mode is entered, and the range is then shifted up.

In the program mode, this key is used to increment the number set as the specified digit.

Note: The number that appears as each digit in the program mode indicates the selection of a function. It cyclically changes every time the UP key is pressed. The number combination differs from digit to digit. (See Table 3-1.)

⑳ Buzzer mode/decimal point setting key

This key is used to set the buzzer mode. When the buzzer mode is set, the buzzer indicator in the indicator section. (It does not appear in the mode where the buzzer is not activated.) The buzzer mode setting alternates between ON and OFF every time this key is pressed.
In the program mode, this key is used to set a decimal point.

㉑ DCV/FAST key

This key is used to set the DC voltage measurement (DCV) function. When the DCV function is set, the previously programmed range setting is restored.
In the sampling hold mode, a measurement function and a measuring range can be set, but measurements can not be made. Measurement is performed according to the function and range settings, if the sampling hold mode is released.
In the program mode, this key is used to set the sampling rate to FAST.

㉒ OHM/SLOW key

This key is used to set the resistance measurement (OHM) function. When the OHM function is set, the previously programmed range and conductor type settings are restored.
In the program mode, this key is used to set the sampling rate to SLOW. Every time this key is pressed, the sampling rate changes in a cyclic pattern;
1/2→1/5→1/10→1/20→1/50→1/100→1/2 .....
of the sampling rate for FAST.

㉓ TC/CE key

This key is used to set the function for temperature measurement using a thermocouple (TC). When the TC function is set, the previously programmed sensor, unit and reference junction compensation settings are restored.
In the program mode, this key is used to clear a numerical value and a decimal point to 0s.

㉔ RTD/MD key

This key is used to set the function for temperature measurement using a resistance temperature detector (RTD). When the RTD function is set, the previously programmed sensor, unit and conductor type settings are restored.
In the program mode, this key is used to set the result of measurement as a constant (see Section 3-9-9).

Example:

One measurement is made, and result is indicated.

The result of measurement is set as constant T (Y,Z).
The constant is dependent on the measuring range and unit.

㉕ SM/SM TIME key

This key is used to set the smoothing function.
When the smoothing function is set, the SM indicator in the indicator section comes on, the moving average of measurements equal to the specified number of times of smoothing is computed, and the computed value is indicated.
In the program mode, this key is used to set the number of times of smoothing (see Sections 3-8-4. and 3-9-11.)

㉖ COMP/T key

This key is used to execute computation according to the computation function setting; no computation is executed if no computation function has been set. Every time this key is pressed, its setting alternates between ON and OFF. When this key is set to ON, the COMP indicator in the indicator section comes on.

In the program mode, this key is used to set constant T.

㉗ TRIG/Y key

This key is used to issue a command to make a single measurement during the sampling hold mode.

Pressing this key with a 19001 and a 21143 connected to this instrument causes measurements to be made as follows:

- In auto scan mode

  The first channel through to the last channel are scanned once to make measurements on each of them.

- In other modes

  A measurement is made once on the selected channel.

  In the program mode, this key is used to set constant Y.

  It is also used to reset the CAL mode.

㉘ HOLD/Z key

This key is used to set and cancel the sampling hold mode.

In the program mode, this key is used to set constant Z (see Section 3-9-9.)

Pressing this key in the remote control mode causes the mode to be changed to local control. (Clearing the remote control mode does not affect the sampling mode.)

When the remote control mode is set, the REMOTE indicator in the indicator section comes on.

(3) Connecting terminals

㉙ SENSE terminal HI

Terminal for inputting HI data from a 4-wire conductor to measure resistances and temperatures (using an RTD).

㉚ INPUT terminal HI

Terminal for inputting HI data for all measurement functions. Connect the HI-side end (red) of the input cable to this terminal.

㉛ SENSE terminal LO

Terminal for inputting LO data from a 3- or 4-wire conductor to measure resistances and temperatures (using an RTD).

㉜ INPUT terminal LO

Terminal for inputting LO data for all measurement functions. Connect the LO-side end (black) of the input cable to this terminal.

㉝ Input block catch

The input block can easily be pulled out using this catch.

3-6-2. Rear Panel Description (See fig. 3-5)

㉞ Option cover

When connecting an optional unit to the instrument, remove this cover. When it is removed, the option connectors appear. The input-output signals that pass the option connectors are not isolated from the signals in the measuring system. Therefore, incorrect use of the option connectors may affect the measurements, or even damage the internal circuits of the instrument. Do not connect any apparatus other than the TR13003, 13206A, and TR15802 to the option connectors.
When no option is connected to the instrument, keep the cover in place; it is dangerous to use the instrument uncovered.

㉟ Power connector

Connector for AC power. When connecting the attached power cable to this connector, lift its safety cover.
If the safety cover is lifted while the instrument is powered by a TR15802, the battery power supply is cut off.

㊱ Analog output terminal

Output jack for outputting the analog voltage generated based on the conditions programmed on the front panel. When using this jack, connect the attached analog output cable (A01204) to it.

㊲ 50/60 Hz selection switch

Set this slide switch according to the frequency of the AC mains to be used.

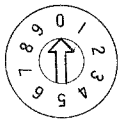
3-6-3. Side Panel Description (See fig. 3-5)

(38) CONTRAST control

The contrast of liquid crystal indication can be adjusted by turning this knob.

(39) CAL switch

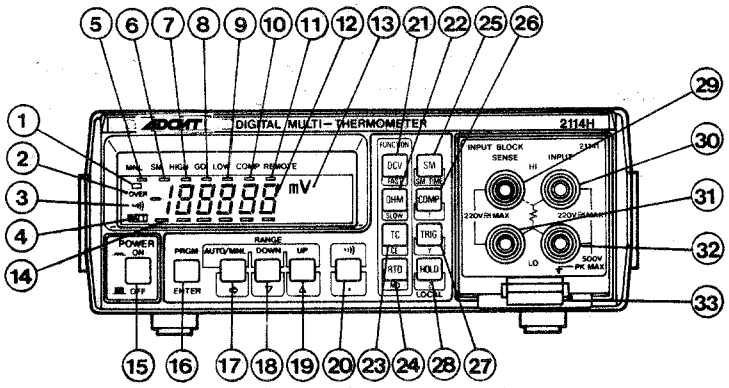
When calibrating the instrument, set this rotary switch to the number representing the function for which calibration is to be made. The setting is indicated on the indicator section on the front panel.



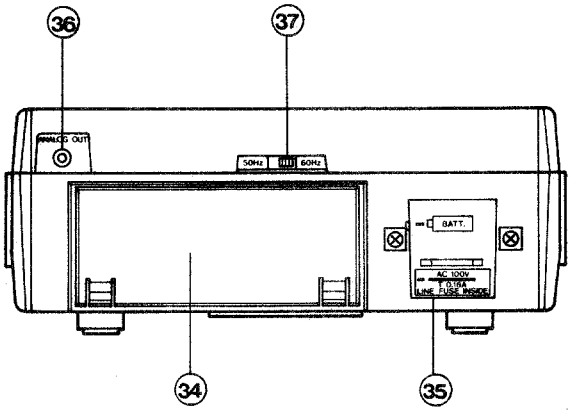
0: Normal measurement
1: Calibration for DC voltage and resistance measurements
8: Calibration for analog output
9: Calibration for DC voltage and resistance measurements to be made using a GPIB

(40) CAL ON switch

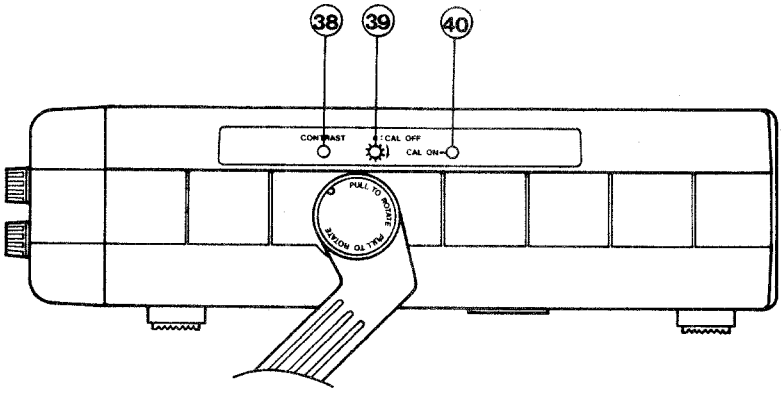
This switch is used to set (ON) and clear (OFF) the CAL (calibration) mode.



Front panel



Rear panel



Righthand side panel

Fig. 3-5 Panels

3-7. BASIC OPERATIONS

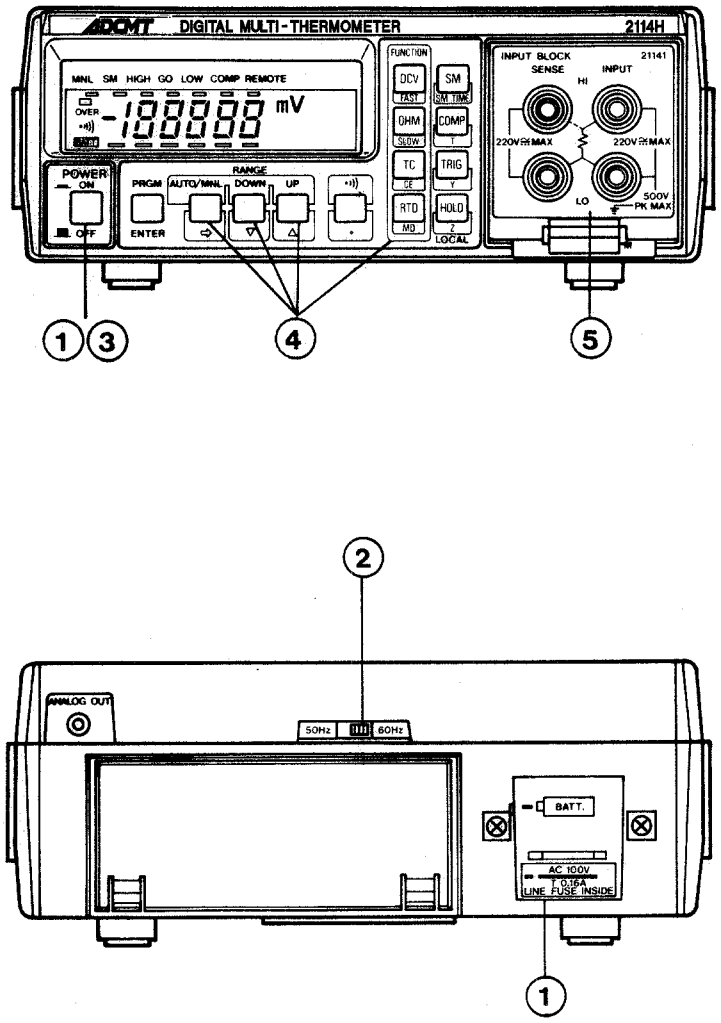


Fig. 3-6 Basic operations

The basic operation procedures are as follows (see Figure 3-6):

(1) Set the POWER switch to OFF, and connect the attached power cable (MP-43) or a TR15802 Battery Unit to the power connector. Be sure to confirm that the AC supply voltage matches to the voltage indication on the rear panel.

② Set the 50 Hz/60 Hz selection switch according to the local frequency of the AC mains to be used. Even if the instrument is to be powered by a TR15802, set this switch according to the frequency of the AC mains used for the peripheral equipment.

③ Set the POWER switch to ON. If no input block has been installed, "Input Error" is indicated. Install an input block beforehand.

④ Select and set the FUNCTION keys according to the signal to be measured.

⑤ Connect the input cable for the measurement function to be used.

This instrument can operate in the following three modes:

(1) Normal measurement mode

This mode is used to make measurements according to the settings of the measurement function, measuring range, sampling control, etc. by using the front panel keys.

(2) Program mode

This mode is set by pressing the PRGM key. It is used to set or specify the measurement function, measuring range, temperature sensor, measurement unit, conductor type, reference junction, analog output conditions, computation function, constants, sampling rate, number of times of smoothing, scan channel, GPIB output format, and buzzer/relay mode.

(3) CAL (calibration) mode

This mode is used to calibrate the instrument for its measurement functions and measuring ranges so as to maintain its measurement accuracies as specified.

3-8. OPERATIONS IN NORMAL MEASUREMENT MODE

The basic measurements are made in the normal measurement mode. The following control operations can be made using panel key switches:

a. Measurement function selection
b. Measuring range selection
c. Sampling control
d. Smoothing function ON/OFF setting
e. Operation function ON/OFF setting

3-8-1. Measurement Function Selection

Select the desired function from among DCV, OHM, TC, and RTD; and press the corresponding FUNCTION key.

(1) DC voltage measurement

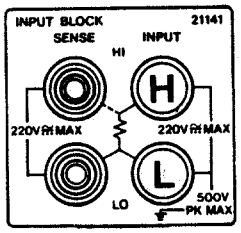
> **CAUTION**
>
> The maximum voltage appliable for DC voltage measurement is 220 Vdc, 220 Vrms ac. Be careful not to allow the maximum voltage to be exceeded.

① Press the DCV function key, and connect the input cable to the signal to be measured (see Figure 3-7).

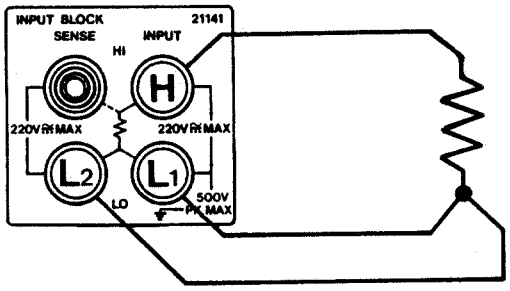
② Input impedance
20 mV, 200 mV, and 2000 mV ranges: 1000 MΩ or more
20 V, and 200 V ranges: 10 MΩ ±1%

2-wire system for measuring resistances and temperatures (using a thermocouple)

H : HI input cable (red), or + terminal (thermocouple)
L : LO input cable (on shield side), or – terminal (thermocouple)



3-wire system for measuring resistances and temperatures (using an RTD)
H : Current source and voltage measuring terminal
L_1 : Current source terminal (on shild side)
L_2 : Voltage measuring terminal1



4-wire system for measuring resistances and temperatures (using an RTD)
H_1 : Current source terminal
L_1 : Current source terminal (on shield side)
H_2 : Voltage measuring terminal
L_2 : Voltage measuring terminal

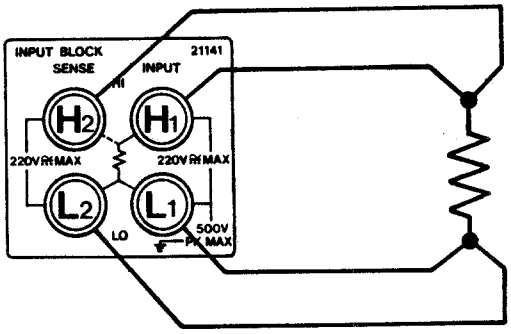


Fig. 3-7 Input cable connections

The instrument is particularly sensitive in the 20 mV and 200 mV ranges. In these ranges, if the terminal of the device under test and the end of the input cable in contact with it are of different metals, or if a temperature difference exists between terminals, a thermoelectromotive force is generated which causes measurement errors.

If a significant temperature difference exists between terminals in the measuring system, it may be necessary to attach a heat sink. If the room where the instrument is used is airconditioned, position or cover the measuring system in such a way as to prevent it from being exposed to the direct air flow from the air-conditioner.

If the thermal balance in the input terminal section is lost and causes a thermoelectromotive force to be generated and the zero point to be shifted, wait for about 10 minutes for the thermal balance to be regained and the original zero point to be restored before starting the measurements.
Avoid using the instrument near devices such as motors and transformers which cause induction to affect measurement. If this cannot be avoided, take steps to prevent measurements being affected by the induction, by using shielded input cables or twisting two input cables together, for example.
Whenever possible, ground the device under test to prevent a high common mode voltage being generated between it and the instrument.
For information in cases when the device under test cannot be connected to ground, the effective noise rejection ratio of the instrument is as follows:
For DC: 120 dB or more
For AC, 50/60 Hz ±0.1%: 120 dB or more

(2) Resistance measurement

CAUTION

- The maximum voltage appliable for resistance measurement is 120 Vdc (continuous), or 220 Vrms ac (continuous). Be careful not to allow the maximum voltage to be exceeded.
- If a voltage is applied across the resistor under test, its resistance cannot correctly be measured. Take care not to allow a thermoelectromotive force to be generated at the contact between the input cable and the resistor under test.
  Be particularly careful not to allow induction caused by peripheral devices to affect measurements.

① Press the OHM function key, and connect the input cable to the resistor under test (see Figure 3-7).

② When the input terminals are open, the maximum voltage between them is 5 V. The measuring current and voltage for each measuring range are listed in the table below.

Measuring range	Measuring current	Measuring voltage
200 Ω	1 mA	0.2 V
2000 Ω	1 mA	2 V
20 kΩ	100 μA	2 V
200 kΩ	10 μA	2 V
2000 kΩ	1 μA	2 V

(3) Temperature measurement (using a thermocouple)

CAUTION

- The maximum voltage appliable for temperature measurement (using a thermocouple) is 220 Vdc, or 220 Vrms ac. Be careful not to allow the maximum voltage to be exceeded.
- If the thermocouple is connected with reverse polarity, accurate measurements cannot be made.
- If the input terminals are touched, wait 5 to 10 minutes to allow the temperature of the input terminal section to become uniform before starting measurement.

① Press TC function key, and connect the thermocouple to the device under test (see Figure 3-7).

See Section 3-8-2 for information on thermocouple selection; Section 3-9-4 for information on unit selection for data indication; and Section 3-9-5 for information on reference junction temperature selection.

(4) Temperature measurement (using an RTD)

CAUTION

- The maximum voltage appliable for temperature measurement (using an RTD) is 120 Vdc, or 220 Vrms ac. Be careful not to allow the maximum voltage to be exceeded.
- Take care not to allow measurements to be affected by induction caused by peripheral devices.

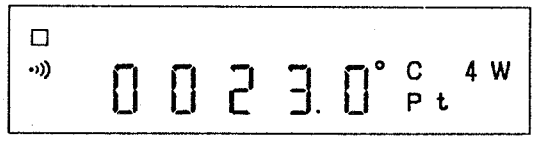
(a) Operation Method

Pt is displayed if the measurement using RTD function is for Pt of JIS C1604-1989, or JPt is displayed if it is for JPt. To perform measurement conforming to JIS C1604-1981, JPt must be displayed.

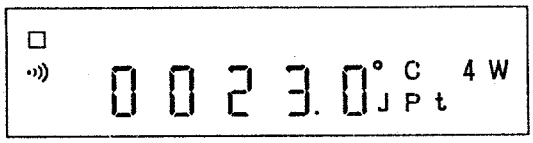
To change Pt indication to JPt indication (or JPt to Pt), turn off the power switch once. Then turn on the power switch with depressing RTD switch.

This setting is stored into the internal memory. When turning the power switch to on, the system starts operation at the previously set condition.

Indication example of Pt setting



Indication example of JPt setting



① Press RTD function key, and connect the input cable to the RTD (see Figure 3-7).

② When measurement is made by the 2-wire method, the specified measuring accuracy cannot be guaranteed.

(b) Revisions of JIS C1604-1989

Pt100 of JIS C1604-1989 applies the value defined in the table of standard resistance value in accordance with IEC Standard (industrial platinum resistance thermometer of Publication 751).

The value in accordance wih non-revised JIS Standard is symboled as JPt100.

Symbol	R_{100}/R_0 value
Pt100	1.3850
JPt100	1.3916

R_{100} shows resistance value of resistance element at 100°C.

R_0 shows resistance value of resistance element at 0°C.

Linearizing table in TR2114 and 2114H satisfies both Pt100 and JPt100.

3-8-2. Measuring Range and Temperature Sensor Selection

(1) Measuring range selection

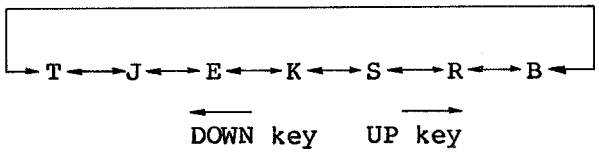
① The AUTO mode and the MNL mode for measuring ranges are alternately selected every time the AUTO/MNL key is pressed. When the MNL mode is selected, the MNL indicator in the indicator section comes on.
The MNL mode is automatically entered when the DOWN key or the UP key is pressed in the AUTO mode.

② Press the DOWN key or the UP key to set the desired range.

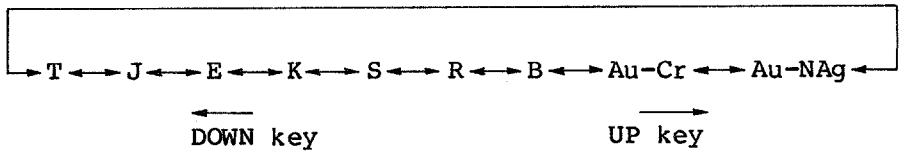
(2) Temperature sensor selection

Pressing the DOWN key or the UP key causes different types of temperature sensors to be cyclically selected as shown below. The current selection is indicated in the upper right corner of the indicator section on the front panel.

For TR2114:



For 2114H:



3-8-3. Sampling Control

This instrument is capable of sampling in the free-run mode and the hold mode.

In the free-run mode, sampling can be made either at the FAST speed, that is, the maximum speed determined by the measurement function and the measuring range, or at one of the six SLOW speeds obtained by dividing the FAST speed by six different constants. The selection of FAST and SLOW is switchable (see Section 3-9-10).

Pressing the HOLD key during an operation in the free-run mode causes the operation to be suspended and the data indication to be fixed (hold mode). At this time, an indication of "Hold" appears in the lower right corner of the indicator section on the front panel.

Pressing the HOLD key again causes the free-run mode to be restored and sampling to be resumed.

Pressing the TRIG key in the hold mode causes single measurement to be made and the hold mode to be entered again.

If the TRIG key is pressed in the hold mode with a 19001 Auto Channel Selector connected to the instrument and the auto scan mode set, the first through to last channels set as explained in Section 3-9-12 are scanned once to make a measurement on each of them, then the hold mode is entered again.

Setting the hold mode with a 13206A GPIB Adapter Unit or a TR13003 BCD Data Output Unit connected to the instrument enables the instrument to be triggered by an external start signal.

3-8-4. Smoothing Function

The smoothing function can be described as a digital filter function. It is used to obtain the moving average of a specified number of measurements, for example, when noise is superimposed on the measurement signal (see Figure 3-8).

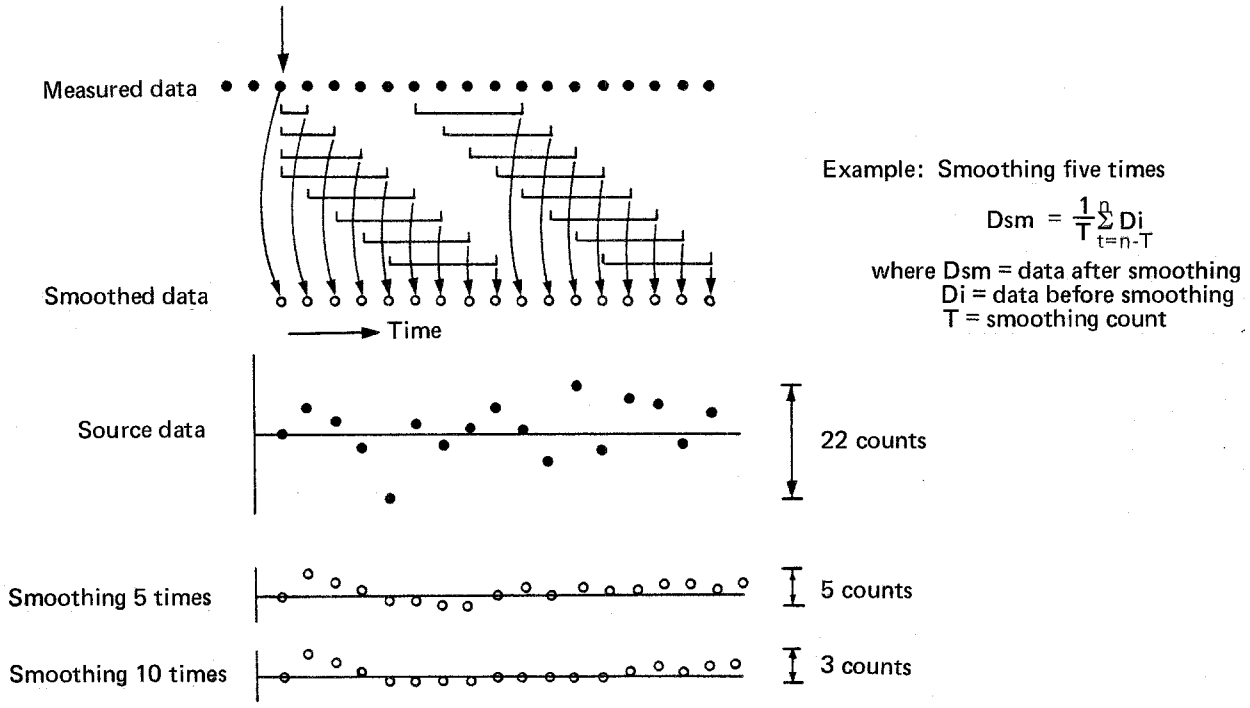


Fig. 3-8 Smoothing

The number of times of smoothing (the number of data whose moving average is to be calculated) can arbitrarily be set between 1 and 100 on the front panel (see Section 3-9-11). The smoothing function is set by pressing the SM key on the front panel. When it is set, the SM indicator in the indicator section comes on.
The SM indicator repeatedly turns on and off after smoothing is started until the specified smoothing count is reached. Therefore, read the data after the SM indicator stops turning on and off.

If the setting of the measurement function, measuring range, thermocouple type, or channel number is changed during smoothing operation, or if the limit value is exceeded during smoothing, the data already collected for smoothing is cleared, and smoothing is started again. In such cases, the SM indicator starts turning on and off to indicate that data is being collected. When the specified smoothing count is reached, the SM indicator stops blinking and stays on. (See Figure 3-9.)

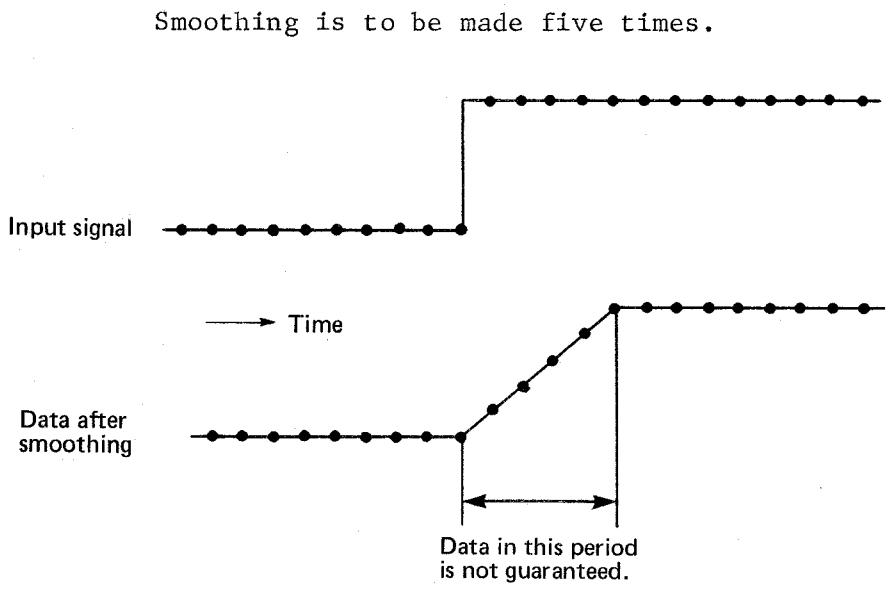


Fig. 3-9 Example of input signal change during smoothing

3-8-5. Computation Functions

The computation functions can be set by pressing the COMP key on the front panel. When a computation function is set, the COMP indicator on the indicator section comes on. When the COMP key is pressed again, the computation function is cleared and the normal data indication is restored. The available computation functions are listed below. The TR2114 has the comparator function as its only standard computation function, whereas the standard functions of the 2114H include all the following computation functions.

① Scaling

$$R = \frac{X - Z}{Y}$$

where R = result of computation

X = measured value

Y, Z = constants (settings)

If 1 is set as Y: R = X - Z

If 0 is set as Z: R = X/Y

② Deviation in %

$$R = \frac{X - Y}{Y} \times 100\ (\%)$$

③ Comparator

R (HIGH): X > Y

R (LOW): X < Y

R (GO): $Y \geqq X \geqq Z$

④ Maximum

⑤ Minimum

⑥ Average

$R = \Sigma X/Y$

To compute the maximum, minimum, or average data, data is collected as many times as the value of Y. The result of the computation is indicated.

If the value of Y is between 1 and 100 ($1 \leqq Y \leqq 100$), computation is made after every Yth data collection, and the result is indicated.

If the value of Y specified to obtain the maximum, minimum, or average data is equal to or greater than 101 ($101 \leqq Y$), the present maximum or minimum value of data collected after Y was set is indicated, or the average is computed and indicated every 100 measurements.

Notes:
- In computation, constants Y and Z are processed based on the decimal point determined by the measuring range. Therefore, if the range setting is automatically changed causing the unit setting to be also changed (for example, from mV to V), the results of computations involving constants become very different.
- In the maximum, minimum, or average computation, the polarity and the portion below the decimal point of the value of Y are ignored. If a value smaller than 1 is set as Y, an error code (99999) is indicated when computation is executed.
- See Section 3-9-9 for the procedures for setting constants Y and Z.
- If a computed value exceeds ±19999, or if a measured value exceeds the limit, an error code (99999) is indicated in the numerical indicator, and five 9s are output as data.
- The maximum, minimum, or average is computed according to the value of Y even if the channel number setting is changed.

3-9. MEASUREMENT CONDITION SETTING IN PROGRAM MODE

The program mode is a mode used to set operating conditions for various functions.

(1) Press the PRGM key to set the program mode.
(2) Set the required conditions (see Table 3-1).
(3) Press the ENTER key to restore the normal measurement mode.

The above steps complete the setting of the required measurement conditions.
Table 3-1 lists the numbers that can be set for each indicator digit in the program mode, and the functions and conditions represented by such numbers.

Table 3-1 Settings that can be made in program mode

10^4 digit		10^3 digit		10^2 digit		10^1 digit		10^0 digit
Function	DCV: 1	Range	AUTO: 0 20 mV: 2 200 mV: 3 2000 mV: 4 20 V: 5 200 V: 6					Computation functions No computation function: 0 Scaling: 1 Deviation in %: 2 Comparator: 3 Maximum: 4 Minimum: 5 Average: 6 (Settable only for 2114H)
	OHM: 2		AUTO: 0 200 Ω: 3 2000 Ω: 4 20 kΩ: 5 200 kΩ: 6 2000 kΩ: 7			Conductor type	2-wire type: 2 3-wire type: 3 4-wire type: 4	
	TC: 3	Sensor	T: 0 J: 1 E: 2 K: 3 S: 2 R: 5 B: 6 Au-Cr, Fe: 7 Au-NAg, Fe: 8	Unit	°C: 0 °F: 1 °K: 2	Internal reference conjunction: 0 External reference, 0°C: 1 External reference, 77.4°K: 2 External reference, 4.2°K: 3 External reference, T°C: 4		
	RTD: 4					Conductor	2-wire type: 2 3-wire type: 3 4-wire type: 4	
Analog output: 5		Output data	Measured value: 0 CAL 0 V: 2 CAL 1 V: 3	Output digit	19999: 0 19999: 1 19999: 2 19999: 3	Output mode	NORMAL: 0 OFFSET NORMAL: 1 ABSOLUTE: 2 OFFSET ABSOLUTE: 3	
Scan channel: 6 (to be set when 19001 is used)		First channel				Last channel		
		10^1 digit: 0 thru 4		10^0 digit: 0 thru 9		10^1 digit: 0 thru 4		10^0 digit: 0 thru 9
GPIB output format: 7		Channel data 0: No data 1: Data existing						
Buzzer or relay mode: 8						Buzzer output for OVER Buzzer to be sounded: 0 Buzzer not to be sounded: 1		Buzzer and relay output to indicate result of comparator operation Not to be tuned on: 0 To be tuned on for HIGH: 1 To be tuned on for LOW: 2 To be tuned on for GO: 3 To be tuned on for HIGH and LOW: 4

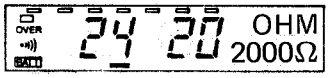
3-9-1. Measurement Function Setting

When the PRGM key is pressed, an indication determined by the current function setting appears as the example shown below.

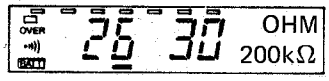
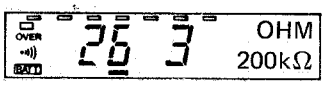
The cursor is positioned at the 10^4 digit in which the measurement function setting is indicated. If ▽ key is pressed with 2 indicated as the 10^4 digit as shown above, the number changes to 1; if the same key is pressed again, the number changes to 8 and so forth. If △ key is pressed with 2 indicated, the number changes to 3; if the same key is pressed again, the number changes to 4 and so forth.
Set the number that corresponds to the required function to be used (see Table 3-1), then press the ENTER key to start the measurements.

3-9-2. Measuring Range Setting

Press the PRGM key, when 1 (DCV function) or 2 (OHM function) is set as the 10^4 digit, and shift the cursor to the 10^3 digit (the second digit from the left) using ⇨ key. Set the number selected from the table below using △ or ▽ key.

Function	Range	10^3 digit number	Examples of indications on 2114H
DCV	AUTO	0	 
	20 mV	2	
	200 mV	3	
	2000 mV	4	
	20 V	5	
	200 V	6	
OHM	AUTO	0	 
	200 Ω	3	
	2000 Ω	4	
	20 kΩ	5	
	200 kΩ	6	
	2000 kΩ	7	

Press the ENTER key to complete the range setting and restore the normal measurement mode.

Note: The examples of indications shown in Section 3-9-1 thru 3-9-15 are for the 2114H. To apply them also to the TR2114, just blank the 10^0 digits. For example, an indication of  on the 2114H will be  on the TR2114.

3-9-3. Temperature Sensor Type Setting

Press the PRGM key, when 3 (TC function) is set as the 10^4 digit, and shift the cursor to the 10^3 digit (the second digit from the left) using ⇨ key.
Set the number selected from the table below using ▽ or △ key.

Function	Sensor type	10^4 digit number	10^3 digit number	Indicator section
TC	T	3	0	
	J	3	1	
	E	3	2	
	K	3	3	
	S	3	4	
	R	3	5	
	B	3	6	
	Au-Fe, Cr	3	7	
	Au-Fe, NAg	3	8	

Press the ENTER key to complete the sensor type setting and restore the normal measurement mode.

3-9-4. Temperature Unit Setting

Press the PRGM key when 3 (TC function) or 4 (RTD function) is set as the 10^4 digit, and shift the cursor to the 10^2 digit (the third digit from the left) using ⇨ key.
Set the number selected from the table below using ▽ or △ key.

Function	Unit	10^2 digit number	Indicator section
TC, RTD	^oC	0	
	^oF	1	
	^oK	2	

Press the ENTER key to complete the temperature unit setting and restore the normal measurement mode.

3-9-5. Reference Junction Temperature Setting for Temperature Measurement (Using a Thermocouple)

Press the PRGM key when 3 (TC function) is set as the 10^4 digit (the uppermost figure), and shift the cursor to the 10^1 digit (the fourth digit from the left) using ⇨ key.
Set the number selected from the table below using ▽ or △ key.

Reference junction temperature	Indication	10^1 digit number	Indicator section
Internal reference junction compensation	INT	0	
External reference, 0°C (Ice point)	EX 0°C	1	
External reference, 77.4°K (liquid nitrogen)	EXL N	2	
External reference, 4.2°K (liquid helium)	EXL He	3	
External reference, T°C (arbitrary temperature)	EX T	4	

Press the ENTER key to complete the reference junction temperature setting and restore the normal measurement mode.

Note: If EXL He is selected for sensor J(IC), or if EXL N or EXL He is selected for sensor S(PR10), R(PR13), or B(PR30), measurement results in an OVER.

3-9-6. Conductor Type (for Resistors and Resistance Temperature Detectors) Setting

Press the PRGM key when 2 (OHM function) or 4 (RTD function) is set as the 10^4 digit, and shift the cursor to the 10^1 digit (the fourth digit from the left) using ⇨ key.
Set the number selected from the table below using ▽ or △ key.

Function	Conductor type	10^1 digit number	Indicator section
OHM	2-wire type	2	
RTD	3-wire type	3	
	4-wire type	4	

Press the ENTER key to complete the conductor type setting and restore the normal measurement mode.

3-9-7. Analog Output Setting

Press the PRGM key; the cursor indicated at the 10^4 digit (the leftmost position). Set 5 as the 10^4 digit using ▽ or △ key.

(1) Output data setting

Shift the cursor to the 10^3 digit (the second digit from the left) using ⇨ key, and set the number selected from the table below.

Output data	Indication	10^3 digit number	Indicator section
Measured value (indicated value)	MEAS.	0	
CAL 0 V	Cal 0 V	2	
CAL 1 V	Cal 1 V	3	

Press the ENTER key to complete the output data setting and restore the normal measurement mode.

Measured value (indicated value): The measured (indicated) value is output after conversion into analog data.

CAL 0 V: Output for calibration. 0 V is output regardless of the indicated value.

CAL 1 V: Output for calibration. 1 V is output regardless of the indicated value.

(2) Output digit setting

Shift the cursor to the 10^2 digit (the third digit from the left) using ⇨ key, and set the number selected from the table below.

Output digit	Indication	10^2 digit number	Indicator section
19999	199AA	0	
19999	19AAA	1	
19999	1AAA9	2	
19999	AAA99	3	

Note: If 0 is set as the 10^2 digit, a voltage of 0.000 to 0.990 V is output.

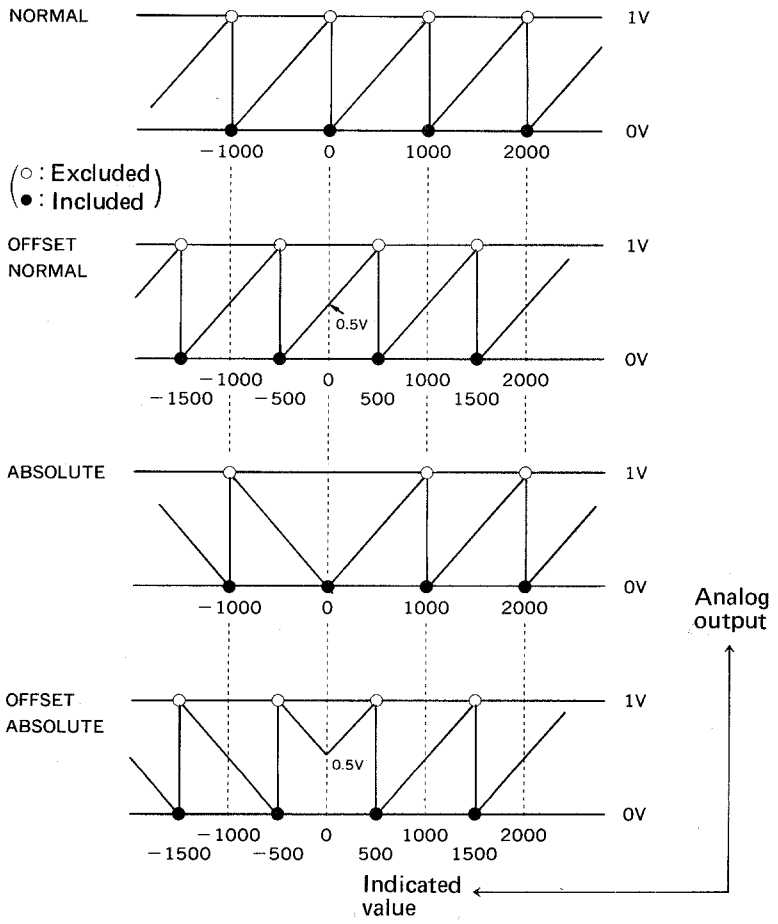
Press the ENTER key to complete the output digit setting and restore the normal measurement mode.

(3) Output mode/offset setting

Shift the cursor to the 10^1 digit (the fourth digit from the left) using ⇨ key, and set the number selected form the table below.

Output mode	Indication	10^1 digit number	Indicator section
NORMAL	Nor	0	
OFFSET NORMAL	Of Nor	1	
ABSOLUTE	Abs	2	
OFFSET ABSOLUTE	Of Abs	3	

Press the ENTER key to complete the output mode setting and restore the normal measurement mode. The relationship between the data indication and analog output in each output mode is illustrated below. When the indicated value represents an OVER, and during the time until the first Y (up to 100) measurements have been completed to compute the maximum, minimum, or average, the analog output stays at 0.999 V.



3-9-8. Computation Function Setting (for 2114H only)

Press the PRGM key, and shift the cursor to the 10^0 digit (the rightmost digit) using ⇦ key.

Set the number selected from the next table using ▽ or △ key.

Computation function	Indication	10 digit number	Computation	Indicator section
Scaling	SCALE	1	R=(X-Z)/Y	
Deviation in %	Δ%	2	R=(X-Y)/Yx100(%)	
Comparator*	H/G/L	3	R(HIGH):X>Y R(LOW):X<Z R(GO):Y≧X≧Z	
Maximum	MAX	4	R(Max)	
Minimum	MIN	5	R(Min)	
Average	AVE	6	$R(Ave)=\sum_{n=1}^{Y} X/Y=\overline{X}$	

* The TR2114 has the comparator function as its only standard computation function.

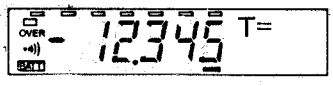
Notes: • HIGH, LOW, or GO is indicated according to the result of the comparator operation. The state of HIGH, LOW, or GO causes the buzzer to sound or the relay of the TR13003 to make depending on the ALARM setting. (See Section 3-9-14(2).)
• To compute the maximum, minimum, or average, data is sampled as many times as the value of constant Y.

Press the ENTER key to complete the computation function setting and restore the normal measurement mode.

3-9-9. Setting Constants T, Y, and Z

① Press the PRGM key, then the T key.

② Shift the cursor to the digit where a constant is to be set using ⇨ key. Set the constant using ▽ (numerical decrement) or △ (numerical increment) key, and the decimal point using . key.



③ The number set as a digit and the decimal point can be cleared by pressing the CE key.

④ If the MD key is pressed, single measurement is made according to the present function setting and the measured value is set as a constant; the decimal point is positioned according to the measured value.

The value set using the MD key can be changed using keys such as ⇨, ▽, △, and ·.

When using the MD key, proceed in the order of: PRGM→ T (or Y or Z)→ MD→ENTER.

⑤ Press the ENTER key to complete the constant setting and restore the normal measurement mode.

Constants Y and Z can also be set using the same procedure given above.

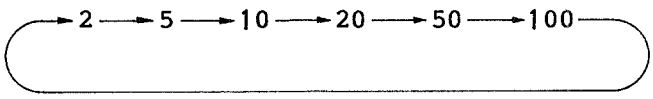
Note) T : Reference junction temperarure
external reference ($T^{o}C$)

Y,Z: Constants used in computation

3-9-10. Sampling Rate Setting

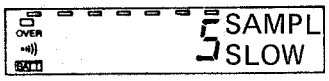
① To set the maximum sampling rate for the present measurement function and measuring range, press the PRGM, FAST, and ENTER keys in that order.

② To set a lower sampling rate, press the PRGM key, then select the rate using the SLOW key. Repeatedly pressing the SLOW key causes the sampling rate setting to cyclically change as shown below.



If, for example, 5 is set, sampling is made at the rate equal to one fifth of the maximum rate.

Indication example:



Press the ENTER key to complete the sampling rate setting.

3-9-11. Setting Number of Times of Smoothing

Press the PRGM key, then the SM TIME key.

Next, set the desired number between 1 and 100 using ⇨ (digit selection), ▽, and △ keys.

Press the ENTER key to complete the setting of the number of times of smoothing.

3-9-12. Scan Channel Setting (for Operation Made Using 19001)

Press the PRGM key, and set 6 as the 10^4 digit.

Next, set the first and last channels to be scanned using ⇨, ▽, and △ key.

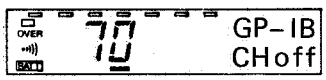
Press the ENTER key to complete the scan channel setting.

Note: If the number of channels to be scanned exceeds 40, or if the first-channel number is greater than the last-channel number, an ERROR indication is given.

If an ERROR indication is given in such a case, press the ENTER key again after correcting the settings.

3-9-13. GPIB Output Format Setting

To specify whether to include the channel data in the GPIB output data format, press the PRGM key, set 7 as the 10^4 digit (the leftmost digit), shift the cursor to the 10^3 digit (the second digit from the left) using ⇨ key, and set the number selected from the table below.

Whether to include channel data	Indication	10^3 digit number	Indicator section
No	CH off	0	
Yes	CH on	1	

Press the ENTER key to complete the setting of whether to include the channel data in the GPIB output format.

3-9-14. Buzzer and Relay Mode Setting

Press the PRGM key, and set 8 as the 10^4 digit (the leftmost digit).

(1) Setting buzzer mode in connection with OVER

Shift the cursor to the 10^1 digit (the fourth digit from the left) using ⇨ key, and set the number selected from the table below using ▽ or △ key.

Buzzer output	Indication	10^1 digit number	Indicator section
Off	NO	0	
On for OVER	OVER	1	

Press the ENTER key to complete the setting of the buzzer mode in connection with OVER.

(2) Setting buzzer and relay mode in conjunction with comparator operation results

Shift the cursor to the 10^0 digit (the rightmost digit) using ⇨ key, and set the number selected from the table below using ▽ or △ key.

Buzzer and relay output	Indication	10^0 digit number	Indicator section
Off	NO	0	
On for HIGH	HIGH	1	
On for LOW	LOW	2	
On for GO	GO	3	
On for HIGH and LOW	H & L	4	

Note: The buzzer does not sound when the buzzer mode has not been set (buzzer indicator comes on).

3-9-15. Program Mode Application Examples

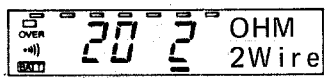
(1) Making settings to turn the buzzer on when resistance measured by 2-wire method is 10.00 Ω or less

① Press the OHM key.

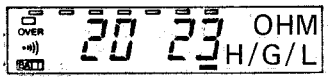
② Press the PRGM key.

③ Position the cursor as shown in indication example 1 below (or in indication example 2 for 2114H) using ⇨ key, and set the number using ▽ or △ key.

<Indication example 1>



<Indication example 2>



④ Press the ENTER key.

⑤ Press the PRGM key.

⑥ Press the Y key.

⑦ Position the cursor as shown in indication example 3 below using ⇨ key, and set the number and decimal point using ▽, △, and · keys.

<Indication example 3>

⑧ Press the ENTER key.

⑨ Press the PRGM key.

⑩ Press the Z key.

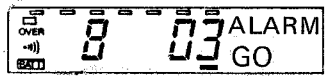
⑪ Press the CE key to clear previously set number.

⑫ Press the ENTER key.

⑬ Press the PRGM key.

⑭ Position the cursor as shown in indication example 4 using ⇨ key, and set the number using ▽ or △ key.

<Indication example 4>



⑮ Press the ENTER key.

⑯ Press the COMP key and the COMP indicator comes on.

⑰ Make sure that the buzzer indicator is appeared. If not, press •)) key.

Note: Changing the value of constant Y through steps ⑤ thru ⑧ changes the upper limit value.

The above steps complete the settings. If a resistance of 10.00 Ω or less is detected in the measurements made by the 2-wire method, the buzzer sounds.

(2) Making settings to record analog data results of temperature measurements made using temperature sensor T

① Press the TC key.

② Press the PRGM key.

③ Position the cursor as shown in indication example 5 (or in indication example 6 for 2114H) using ⇨ key, and set the number using ▽ or △ key.

<Indication example 5>

<Indication example 6>

④ Press the ENTER key.

⑤ Press the PRGM key.

⑥ Position the cursor as shown in indication example 7 using ⇨ key, and set the number using ▽ or △ key.

<Indication example 7>

⑦ Press the ENTER key.

The above steps complete the settings required to record analog data results of temperature measurements made using temperature sensor T.

If measurements are started with the above settings made and with a temperature sensor T connected to the instrument, the temperatures are measured according to the internal reference junction compensation, the measured temperature is indicated in ^{o}C, and an analog output of 10 mV/^{o}C is obtained from the analog output terminal.

3-10. THE BATTERY UNIT OPERATION

The 2114H can incorporate a battery unit, TR15802, to operate on battery power.

(1) General precautions

a. If the battery indicator (BATT) comes on indicating that the battery voltage has lowered and charging is required, immediately switch to AC power to charge the battery.

b. When the power cable is connected to the power connector of the 2114H and the AC mains receptacle, its battery power supply circuit is automatically opened, and it starts operating on AC power.

c. As long as the 2114H is plugged into an AC receptacle, the TR15802 incorporated in it is kept being charged regardless of the POWER switch setting on the 2114H.

d. The TR15802 can be set either to the FULL charging mode or the TRICKLE charging mode depending on the setting of its FULL/TRICKLE switch.

When the battery is sufficiently charged, set the unit to the TRICKLE charging mode to avoid overcharging. (See also Section 6 "TR15802 Battery Unit.")

(2) Installation and removal of battery unit

When connecting a battery unit or any other optional unit to the 2114H, remove the option cover from the rear panel of the 2114H, and insert the accessory (see Figures 3-10 and 3-11). To take out the accessory, pull the bottom lever and its lock is released permitting it to be pulled out. (See Figure 3-12.)

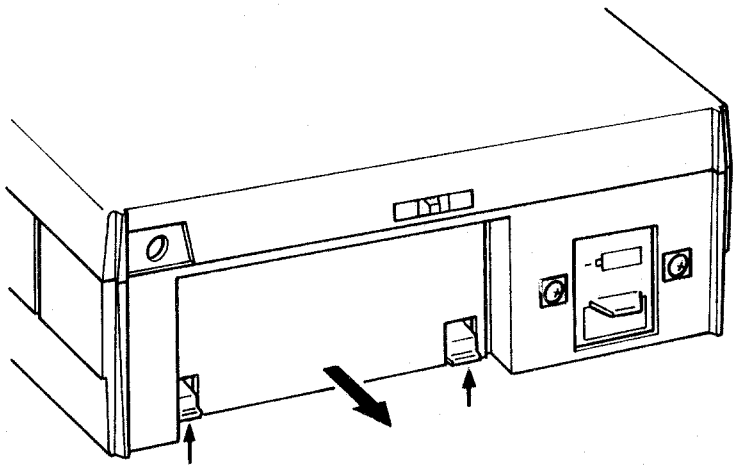


Fig. 3-10 Removing the option cover

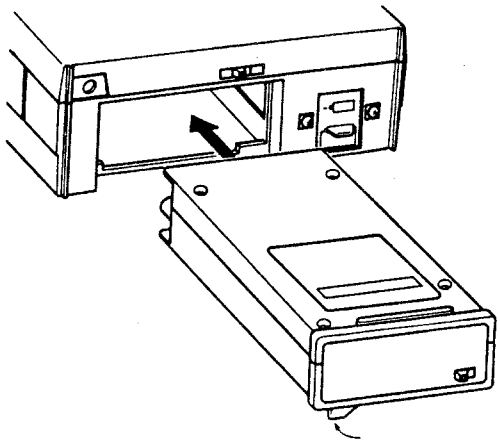


Fig. 3-11 Installing the accessory

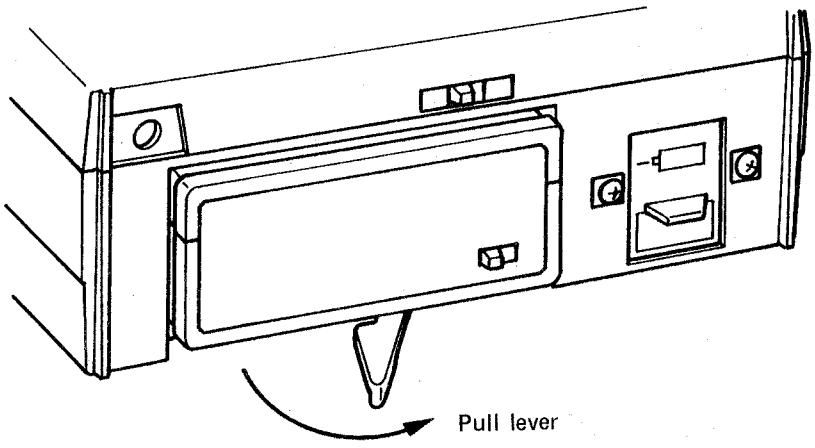


Fig. 3-12 Removing the accessory

3-11. FUSE REPLACEMENT

If the instrument is not powered when the POWER switch is set to ON, its power fuse may have blown. If the fuse has blown, replace it.
The power fuse is a slow-blow fuse with a capacity of 0.08 A for 220 and 240 Vac (and 0.16 A for 100 and 120 Vac). The fuse replacement procedure is as follows:

① Disconnect the power cable from the power connector of the 2114H, and take out the TR15802 or any other accessory installed in the instrument.
Do not forget to disconnect the power cable; if it remains connected, the primary side of the transformer stays powered regardless of the POWER switch setting.

② Removing the case
Remove the two screws located on the power connector of the rear panel, and pull the instrument outwards by one hand while holding the top and bottom sides of the front panel with the other hand (see Figure 3-13).

③ The power fuse is located near the transformer (see Figure 3-14). To remove it, push it in the arrow direction ① indicated in Figure 3-15. When installing it, press it into position from above.

Note: Visual inspection of the fuse is not reliable. Measure its resistance; it is satisfactory if its resistance is 15 Ω or less.

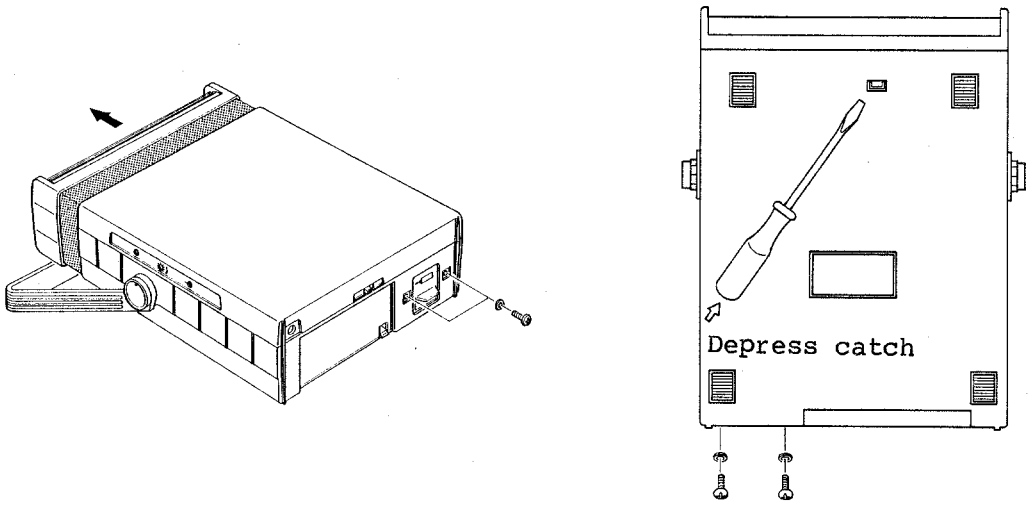


Fig. 3-13 Removing the case

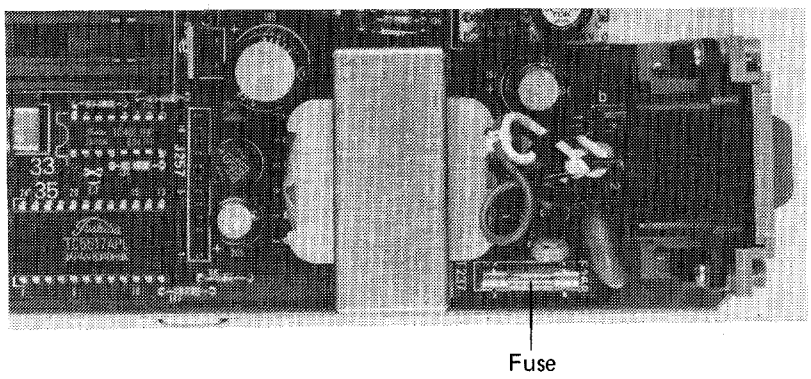


Fig. 3-14 Location of the power fuse

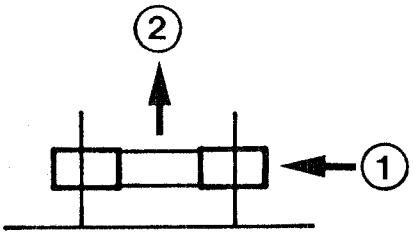


Fig. 3-15 Removing the fuse

3-12. EXTERNAL CONTROL USING ACCESSORIES

(1) The use of accessories, such as the TR13003 BCD Data Output Unit and 13206A GPIB Adapter, enables the 2114H to be started by by an external signal when it is set in the sampling hold mode.

(2) The TR13003 and 13206A also make it possible to externally control the measurement function and measuring range of the 2114H. While the 2114H is under external control, its REMOTE indicator stays on, and its panel key switches remain invalid. Pressing the HOLD key in the remote control state clears the remote control state and sets the instrument in the local control state to enable panel key operation.

See Sections 7 and 8 for details.

SECTION 4

CALIBRATION

4-1. GENERAL PRECAUTIONS ON CALIBRATION

(1) Use either of the following power supplies:
AC: Voltage as indicated on the rear panel, with line frequency of 50 or 60 Hz
DC: TR15802 Battery Unit

(2) Allow the 2114H to warm up for 30 minutes or more on the power supply specified in (1).

(3) Arrange the environment as follows:
+23°C ±5°C with 85% RH or less

(4) Also allow each standard to warm up for the specified length of time.

(5) Select a clean place free from vibration and noise.

(6) To maintain the measuring accuracies of the 2114H as specified, calibrate it at least at every sixth month and, if necessary, calibrate it more frequently.

(7) When the instrument is calibrated, it is advisable to append a card or sticker indicating the date of the calibration and the deadline for the next calibration on the instrument.

(8) Calibrating the 2114H for DC voltage or resistance measurement requires the 21141.

4-2. STANDARDS REQUIRED FOR CALIBRATION

Standard	Range	Accuracy	Recommended model
DC voltage standard	0 V to 180 V (200 V)	Within ±0.005%	6161 , TR1323*
Standard resistor	0 Ω to 1.8 MΩ (2 MΩ)	Within ±0.01%	
Digital voltmeter	DCV, 100 μV resolution	±0.1%	7461A
0°C standard			7021

* The TR1323 Standard Divider is to be used together with the 6161 to calibrate the 20 mV and 200 mV ranges on the 2114H.

When calibrating the 2114H, prepare a standard screwdriver with a blade width of 2 mm to set the CAL and CAL ON switches.

4-3. CALIBRATION PROCEDURE

Calibration of this instrument consists of zero point and fullscale adjustments made using the calibration switches (CAL and CAL ON switches) located on the righthand side panel.
Figure 4-1 shows the locations of the CAL and CAL ON switches.

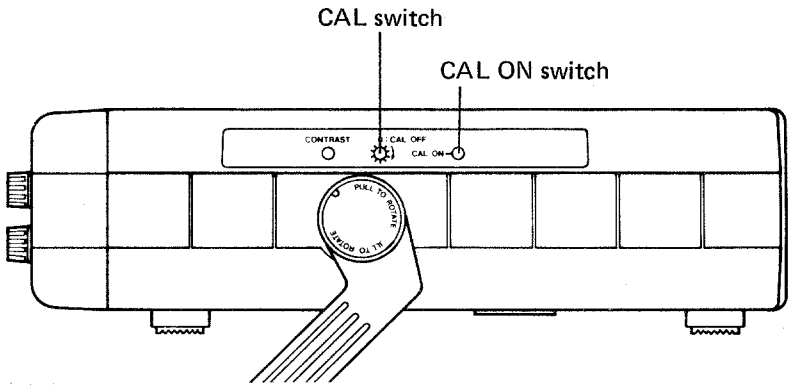


Fig. 4-1 Locations of the calibration switches

4-3-1. Calibration for DC Voltage Measurement

Standard required: DC voltage standard

- Press the DCV function key.
- Turn the CAL switch to set it to 1; "CAL1" appears in the lower right corner of the indicator section.
- Press the CAL ON switch to set it to ON.
  This switch is a pushbutton switch. When it is set to ON, "CAL ON" appears in the indicator section.

(1) Zero point adjustment for each range

① Set the measuring range to 20 mV, and shortcircuit the input cable.

② Press the PRGM key.

③ Check whether the indication is the same as for indication example 1.

[Indication example 1]

If it is the same as indication example 1, press the ENTER key; otherwise set 0 for each digit using ⇨, ▽, and △ keys, then press the ENTER key.

④ Confirm that a # is displayed to indicate that the instrument is being calibrated.

[Indication example 2]

⑤ When calibration has ended, the # disappears.

Now the zero point adjustment for the 20 mV range has been completed. To make the zero point adjustment for a higher range, shift the range up using UP key and repeat steps ② thru ⑤.

(2) Fullscale adjustment for each range

① Set the measuring range to 20 mV.

② Input a positive voltage, whose value is close to the fullscale value of the range, from a DC voltage standard.

③ Press the PRGM key; the three least significant digits of the numerical indicator indicate three 0s. Equalize the indication with the input voltage value using ⇨, ▽, and △ keys.

④ Confirm that the indicated value and the input voltage value are identical, and press the ENTER key.

⑤ On the negative side, input a negative voltage, whose value is chose to the fullscale value of the range, from a DC voltage standard, repeat steps ③ thru ④ for the same adjustment .

Note: To change the polarity, press ▽ or △ key with the cursor positioned as shown in indication example 1.
For the negative fullscale adjustment, make sure that a minus sign "-" is indicated.

Now, the fullscale adjustment for the 20 mV range has been completed.
To make the fullscale adjustment, on both the positive and the negative sides, for a higher range, shift the range up using UP key and repeat steps (2) thru (5). To restore the normal measurement mode, turn the CAL switch to set it to 0.

4-3-2. Calibration for Resistance Measurement

Standard required: Standard resistor

- Press the OHM function key.
- Select the 2-wire conductor type (see Section 3-9-6).
- Turn the CAL switch to set it to 1; "CAL1" is indicated in the lower right corner of the indicator section.
- Press the CAL ON switch to set it to ON.

(1) Zero point adjustment for each range

(1) Set the measuring range to 200 Ω, and shortcircuit the input.

(2) Press the PRGM key, and check whether the same indication as in indication example below is obtained.

[Indication example 3]

If the same indication is obtained, press the ENTER key; otherwise set 0 on each digit using ⇨, ▽, and △ keys, then press the ENTER key.

③ Confirm that a # is displayed to indicate that the instrument is being calibrated.

[Indication example 4]

When calibration has ended, the # disappears.

Now the zero point adjustment for the 200 Ω range has been completed. To make the zero point adjustment for a higher range, shift the range up using UP key and repeat steps ② and ③.

(2) Fullscale adjustment for each range

① Set the measuring range to 200 Ω.

② Connect a standard resistor whose resistance value is close to the fullscale value of the range of the instrument.

③ Press the PRGM key; the three least significant digits of the numerical indicator indicate three 0s. Equalize the indication with the value of the connected resistance using ⇦, ▽, and △ keys.

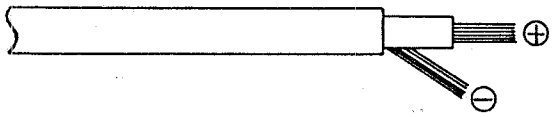
④ Confirm that the indicated value and the connected resistance value are identical, and press the ENTER key.

Now the fullscale adjustment for the 200 Ω range has been completed. To make the fullscale adjustment for a higher range, shift the range up using UP key and repeat steps ② thru ④. To restore the normal measurement mode, turn the CAL switch to set it to 0. The same fullscale adjustment procedure is also applicable when the instrument is set to make measurements by the 3- or 4-wire method but no zero point adjustments are required.

4-3-3. Calibration for Analog Output

① Connect the attached analog output cable (A01204) to the analog output terminal located on the rear panel.

② Connect the other end of the analog output cable to a digital voltmeter. The cable may be connected to the 2114H if the instrument has been calibrated with respect to DCV; when connecting it to the instrument, press the DCV function key. The output polarity of the analog output cable is shown below.



③ Set the CAL switch located on the righthand side panel to 8. "CAL8" is indicated in the lower righthand corner of the indicator section (see indication example 5).

[Indication example 5]

④ Set the CAL ON switch to ON. The measuring range is set to DCV 20 V, the analog output value setting is indicated in the upper righthand corner of the indicator section, and "CAL DA" is indicated in the lower righthand corner of the indicator section (see indication example 6).

[Indication example 6]

⑤ Set the analog output (digital voltmeter indication) to 0 V (±1 mV) using ⇨, ▽, △, and · keys.

⇨: Greatly decreases the analog output value.

▽: Decreases the analog output value.

△: Increases the analog output value.

·: Greatly increases the analog output value.

⑥ Press the PRGM key.

⑦ Set the analog output value to 1 V (±1 mV) in the same way as for step ⑤.

⑧ Return the CAL switch to the 0 position to restore the normal measurement mode.

SECTION 5

PRINCIPLES OF OPERATION

5-1. INTRODUCTION

The 2114H Digital Multi-Thermometer with its built-in microprocessor controls the following units: the input switching unit for DC voltage, resistance, and reference junction temperature measurements, LCD indicator, panel setting keys, D-A converter for analog outputs, and accessory output units for BCD and GPIB outputs. To keep higher measurement accuracies, high-precision thin-film resistors are used for the input block, and the selected reference-voltage ICs are used for the reference power supply block.

This TR2114 consists of the blocks given below. Fig. 5-1 is a simplified block diagram of the unit.

- Ranging amplifier for amplifying voltage to a magnitude of 1/100, 1/10, 1, 10, or 100
- Current generator of 1 mA, 100 μA, 10 μA, 1 μA, and 100 nA for the OHM or RTD function
- Input switch that selects four input terminals, or the output voltage for the terminal temperature sensing transistor
- A-D converter for digitizing the analog voltage
- LCD (liquid crystal diode) indicator which indicates the measurement or setting values, and the LCD driver
- D-A converter which converts two or three MSDs of the displayed values into analog voltages
- Microprocessor for controlling the entire TR2114 operation
- Battery backed-up RAM which stores the calibration data and setting parameters
- Power supply circuit

To describe each block function below, assume that the DC voltage measurement mode has been set.

The input voltage is fed into the input amplifier block from the input terminal (between Hi and Lo terminals) via the input switch.

That input voltage is amplified with a magnitude of 100 through 1/100 according to the selected range, and then input to the A-D converter block. A switch for input conversion is provided before the input amplifier block, and is set into zero-input status for internal calibration to measure errors of amplifier offset voltage.

The A-D converter operates on the principle of integration: the reference voltage is integrated after a certain period of time for input voltage integration (20 ms for the line frequency setting of 50 Hz, and 16.667 ms for 60 Hz) until the integrated output result equals to the voltage level of the initial state; the input voltage is converted to digital values by counting the clock pulses for this period.

When input value conversion is repeated for a specified number of times in A-D conversion, zero volt input conversion is automatically carried out for the measurement of the zero calibration value. The A-D conversion result during input measurement is compared with the value at the time of zero measurement, and the display or output data value is calculated using the calibration coefficient prestored upon calibration before display or output. The calibration value is stored in the battery backed-up RAM.

The D-A converter for analog output transmits the output signal, which is converted to conform to the power source pulse and pulse width being isolated from the measuring system, via the pulse transformer. The pulse width signal is shaped using the reference voltage in the output block, and the resultant analog signal is output through the filter circuit.

The serial signal sent from the mainframe is isolated from the measuring system in the GPIB adapter unit or the BCD data output unit by the built-in optical isolator. Hence, the power is supplied from the power source transformer in another system.

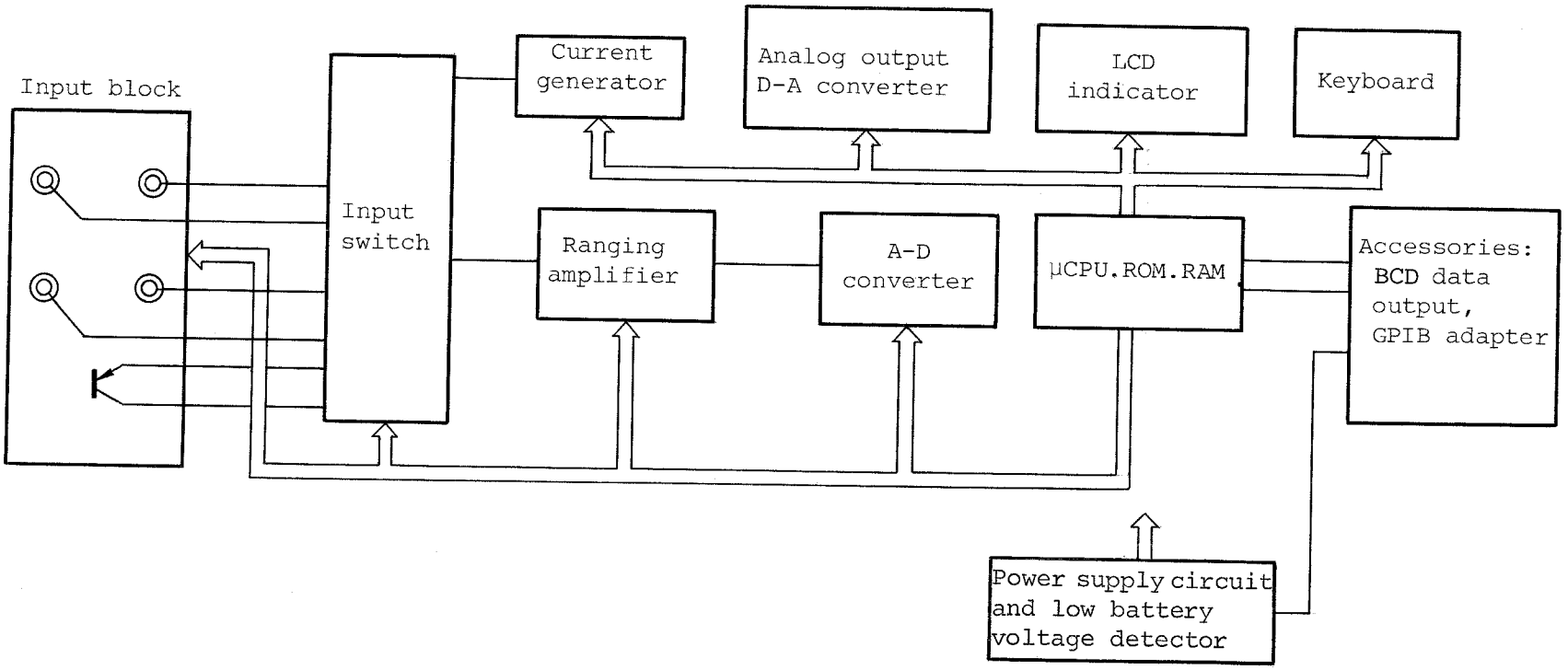


Fig. 5-1 Schematic block diagram for 2114H

5-2. OPERATION FOR DC VOLTAGE MEASUREMENT

The voltage to be measured is input from the input terminal to the input amplifier via the input switch. In the input amplifier, the dividing type amplifier of x1/10 and x1/100, or amplifier of x1, x10, and x100 is selected depending on the voltage range. The inverting amplifier consisting of U5 and R91, as shown in Fig. 5-2, functions as an input amplifier with a voltage range of 20 V and 200 V. R91 is a composite high-resolution resistor of an input resistance of 10 MΩ and feedback resistance of 1 MΩ, or 100 kΩ range is magnified by 1/10 or 1/100 whose U5 (SIA-442) contains two operational amplifier circuits: A and B. Amplifier B operates so that the resistance in the closed semiconductor switch at U1 (SIA-4052) does not influence measurement efficiency. When set below a range of 2 V, the input voltage is connected by relay K1 to the input block at amplifiers of x1, x10 and x100.
Amplifier A1, as shown in Fig. 5-3, works as a low noise FET input amplifier with a combination of the dual FET and OP amplifiers. Analog switch U8 (SIM-4051) is located between amplifier A1 and input block. This analog switch is used to select the following: the input terminal for voltage measurement or zero-V measurement, the transistor voltage inputs for internal reference junction temperature measurement, the U4 amplifier outputs for 20 or 30 V range setting, and the reference voltage inputs during operation checking.

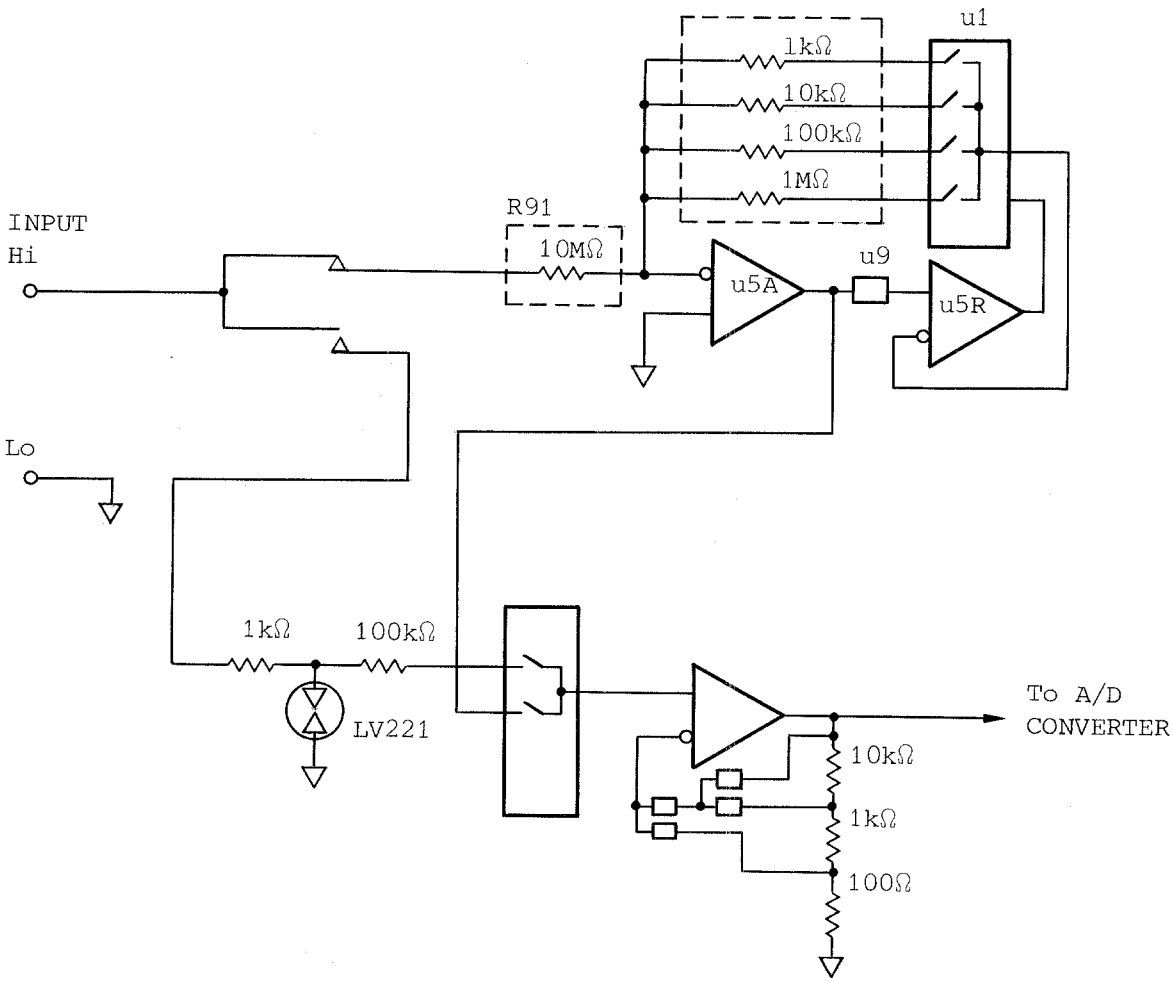


Fig. 5-2 Input amplifier (x1/10, x1/100)

Table for shifting switches

Range	K1		U8		U1							
	4-5	9-8	0	7	0	1	2	3	0Z	1Z	0Y	1Y
20.000 mV		o	o									o
200.00 mV		o	o							o	o	
2000.0 mV		o	o						o		o	
20.000 V	o			o	o							
200.00 V	o			o		o						

o: ON

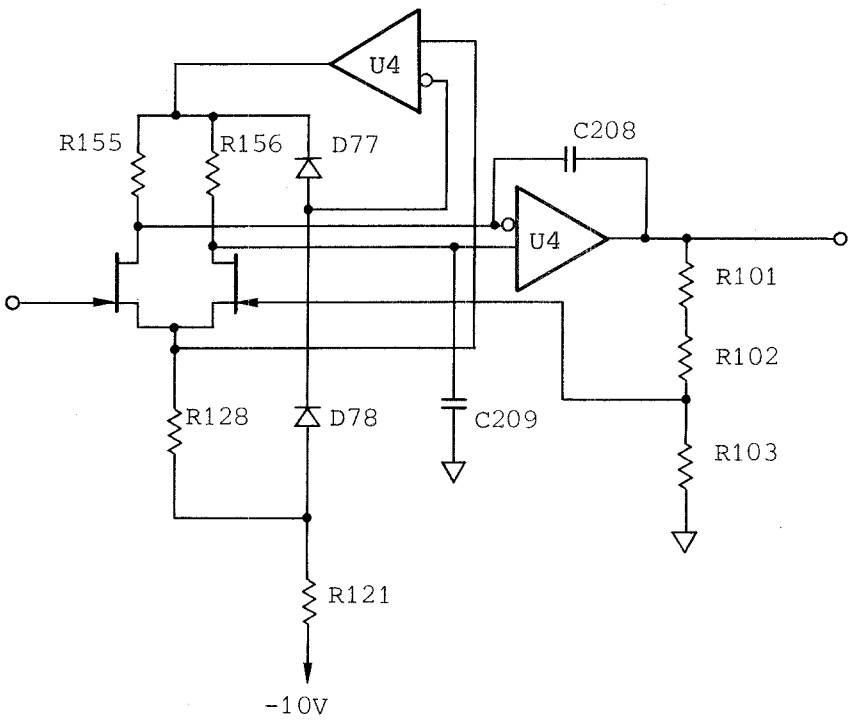


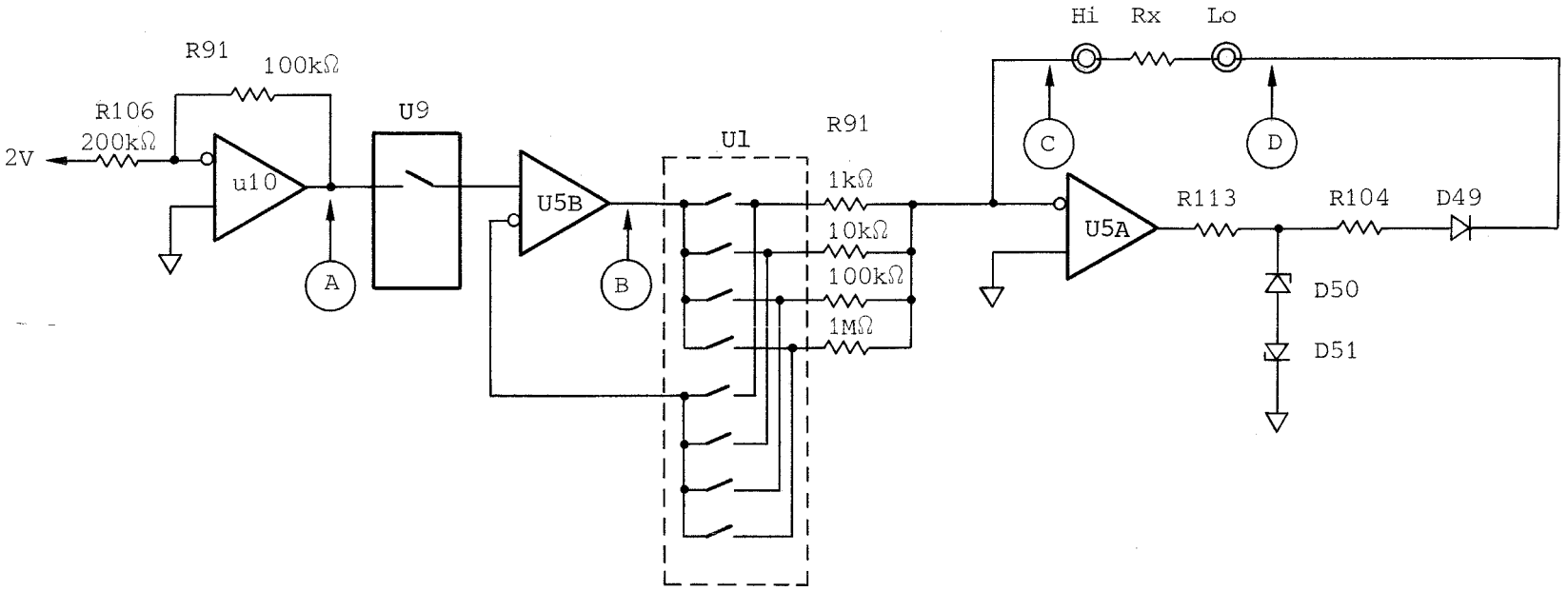
Fig. 5-3 Input amplifier (x1, x10, x100)

5-3. OPERATION FOR RESISTANCE MEASUREMENT

Once the OHM function is set up, the switch is connected so that a constant current flows across the input terminals according to the setting range. Fig. 5-4 shows the relationship between each range switch and currents to be measured. R91 is a set of thin-film resistors with reference resistors of 1 kΩ, 10 kΩ, 100 kΩ, and 1 MΩ for use as a reference of measurement currents of 1 mA, 100 μA, 10 μA, and 1 μA. U10 compensates for the temperature-varying resistance of thin-film resistors. A reference voltage of +2 V is input and the combination of resistors R106 and R91, which have small temperature coefficients, sends out a compensated voltage of -1 V to section Ⓐ. The switches at U1 and the operational amplifier at U5B sets the reference resistance value for R91 according to the set range.

The voltage across the input terminals, between sections Ⓒ and Ⓓ, is connected to the input amplifier for measurement, then fed into the A-D converter. In the input amplifier, the voltage is routed via amplifiers of x1, x10, and x100 as in the DC voltage measurement.

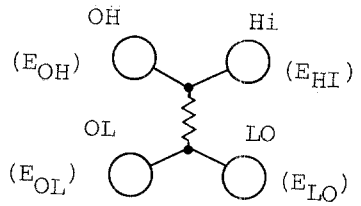
The resistance measurement depends on the selection of the conductor variations, 2W, 3W, or 4W (2-, 3-, or 4-wire mode) in which twice (2W or 4W) or three-time (3W) measurement is made.
With this method, the voltages across the input terminals can be calculated, and the resultant output value can also be calculated by the equation given in Table 5-1 .



Resistance range	R91	Measurement current	Input amplifier multiplication
200Ω	1kΩ	1mA	10
2000Ω	1kΩ	1mA	1
20kΩ	10kΩ	100μA	1
200kΩ	100kΩ	10μA	1
2000KΩ	1MΩ	1μA	1

Fig. 5-4 Relationship of switching by range with measurement currents during resistance measurement

Table 5-1 Operation formula by conductor variation



Conductor variation	Operation formula	Measuring input terminal
2W	$E_{HI} - E_{LO}$	HI LO
3W	$E_{HI} - E_{LO} - 2(E_{OL} - E_{LO})$	HI, LO, OL
4W	$E_{OH} - E_{OL}$	OH, OL

5-4. OPERATION FOR TEMPERATURE MEASUREMENT

The thermocouple measurement function (TC) has the same range composition as for voltage measurements of 20 mV and 200 mV range. Thermocouples T, S, R, and B functions like 20 mV range, and the others functions like 200 mV range.

When the reference junction is set to external (0^{o}C, the boiling point of liquid nitrogen, the boiling point of liquid helium, and any degree of temperature), the measured voltage value is linear-operated directly to yield the output value; however, if the reference junction is set to internal, the reference junction temperature compensation value is computed according to the kind of thermocouple, then added to the input value to be linear-operated.

The reference junction temperature compensation measures the output voltage of the transistor, which is mounted on the input terminal block, with the same coefficient that was used for 2 V range, and uses that value to calculate the temperature of the input terminal.

Figure 5-5 shows the detailed circuit described above. Q1 is an input terminal temperature sensing transistor attached to the input terminal. The temperature coefficient value of the output voltage, E_F, is fixed by connecting the thermocouple to the input terminal, by setting conditions for measuring an ice break point temperature ($0^{\circ}C$), and by regulating the currents to Q1 with variable resistor R12 so as to set the display value to $0.0^{\circ}C$.

Any deviation of Q1 characteristics from the R12 variable width must be corrected by disconnecting the jumper wire W1.

The Resistance Temperature Detector function (RTD) measures the resistance value in the same composition as for the 200Ω range. The resistance value is linear-operated, and then the resultant temperature value is output.

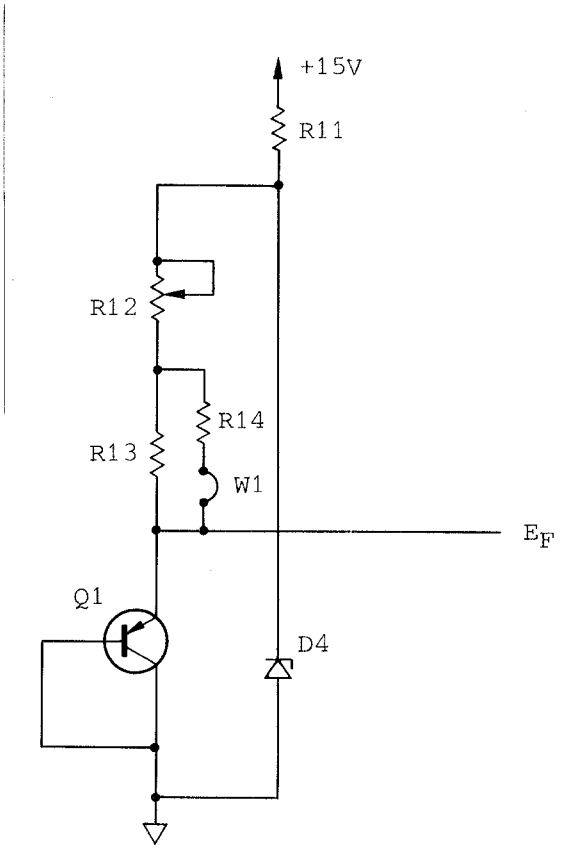


Fig. 5-5 Reference junction temperature compensation circuit

5-5. A-D CONVERTER

The A-D converter operates on the principles of integration. This converter consists of a switch for selecting input voltages and reference voltages, integrater, and comparater. The control of the switch is connected to the resident I/O port on the microprocessor. The comparater output block is connected to the resident counter input block on the microprocessor. A reference voltage of +2 V is produced by a combination of U6 and the high-precision resistor R91. The polarity of this voltage is inverted by the CMOS switch in U20 to generate a reference voltage of -2 V. At this time, S5 and S7 are both turned on; they are turned off when a minus polarity voltage is needed. The polarity is inverted again if S6 and S8 are turned on.

In the initial integration operation (A), S1 is turned on to set the input voltage to zero; S10 and S11 are turned on to discharge the load of the integrating capacitor. Next, after a certain period of time (20 ms; 50 Hz setting, 16.667 ms; 60 Hz setting), the input voltage integration (B) is started to make the polarity decision according to the comparator (U11-B) outputs.

Then, the reference voltage of the same polarity as for the input voltage is integrated for a fixed short period of time (C). Then, the refernce voltage of the reverse polarity is integrated until the comparater output is inverted for measuring time intervals T1 (D).

Next, the reference voltage of the same polarity as for the input voltage is integrated for a fixed period of time (E), and then the reference voltage of the reverse polarity is considered as the input voltage. By turning off S10, the integration resistance is multiplied approximately by 10 and is integrated until the comparater is inverted again. Finally, the time intervals for this period, T2, is calculated (F). This operation ends the integration for A-D conversion (See Figure 5-7.)

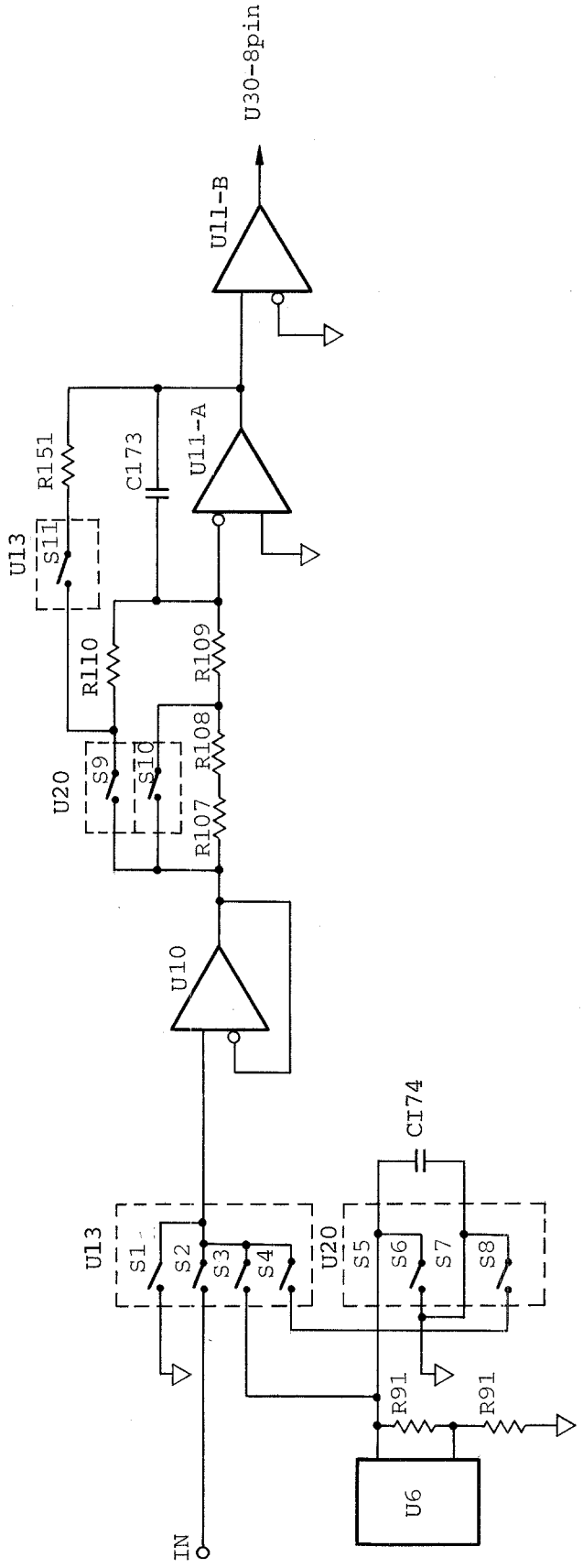


Fig. 5-6 A-D converter

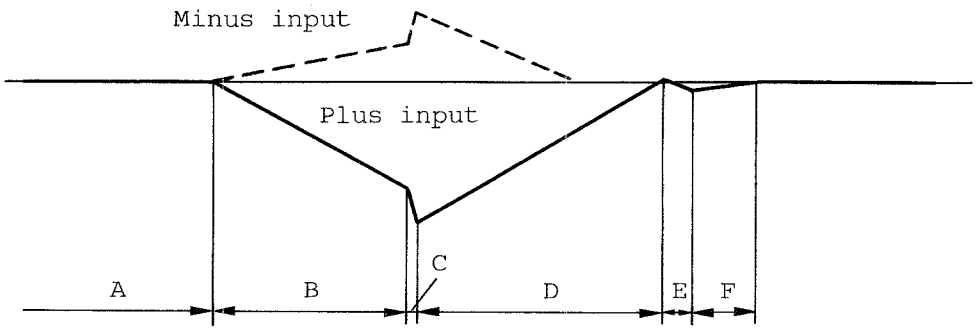


Fig. 5-7 Integrator output

5-6. OPERATIONS OF A-D CONVERTER

The output digital values are found by using the two reference voltage integration time intervals T1 and T2, which were computed at the A-D converter operation as follows:

$$S = K \times T1 + T2$$
$$D = G * (S - S0)$$

where k is a constant which is determined with the ratio of the integration resistance, S0 is the value for S stored at calibration, and G is a value to be fixed after full-scale calibration.
Values for S0 and G are stored independently for each range; some of which correspond to the set range and are recalled for use in output value operations.

5-7. INTERNAL CALIBRATIONS

Because the input offset in the input amplifier and the current in the semiconductor switch vary with time, the indicated or output values may contain some errors due to the measurement variations. To avoid these errors, the 2114H Digital Multi-thermometer measures the state in which zero voltage is input at each fixed period of time. It then handles the measured value as a reference value, outputting reliable measurement results.

Interval calibrations are made during the self-checking done immediately after power-on, and when and after functions OHM or RTD are switched to DCV or TC, and at intervals of a certain number of A-D conversions in DCV or TC function.

To execute the internal calibration, the input switch must be connected to the Lo input terminal, and the outputs through the input amplifier can be A-D converted. The A-D conversion operates differently depending on the polarities, therefore, the calibration for both polarities must be operated at the same time. In this A-D conversion the polarity of the comparator at the time of completing the first integration is ignored to execute the plus or minus polarizing operation. The voltages are calibrated at each calibration timing, not only in the range for calibration execution during measurment but also in other ranges.

The output voltage value of the input terminal temperature sensing transistor for TC function is also calibrated periodically during calibration.

5-8. MICROCOMPUTER

The microcomputer HD6301, used in this thermometer, mainly consists of a 16 K-byte ROM with a 2 K-byte RAM surrounding it. The I/O port in the microprocessor is used as the A-D converter. The latch and bus buffer ICs connected to the data bus are used to control the input amplifier, key switch, and indicator.

The RAM is always powered from the lithium battery to save calibration and setting data. To keep those data unchanged, a circuit (as the peripheral circuit) is added to prevent erroneous signals which may be generated at power-off.

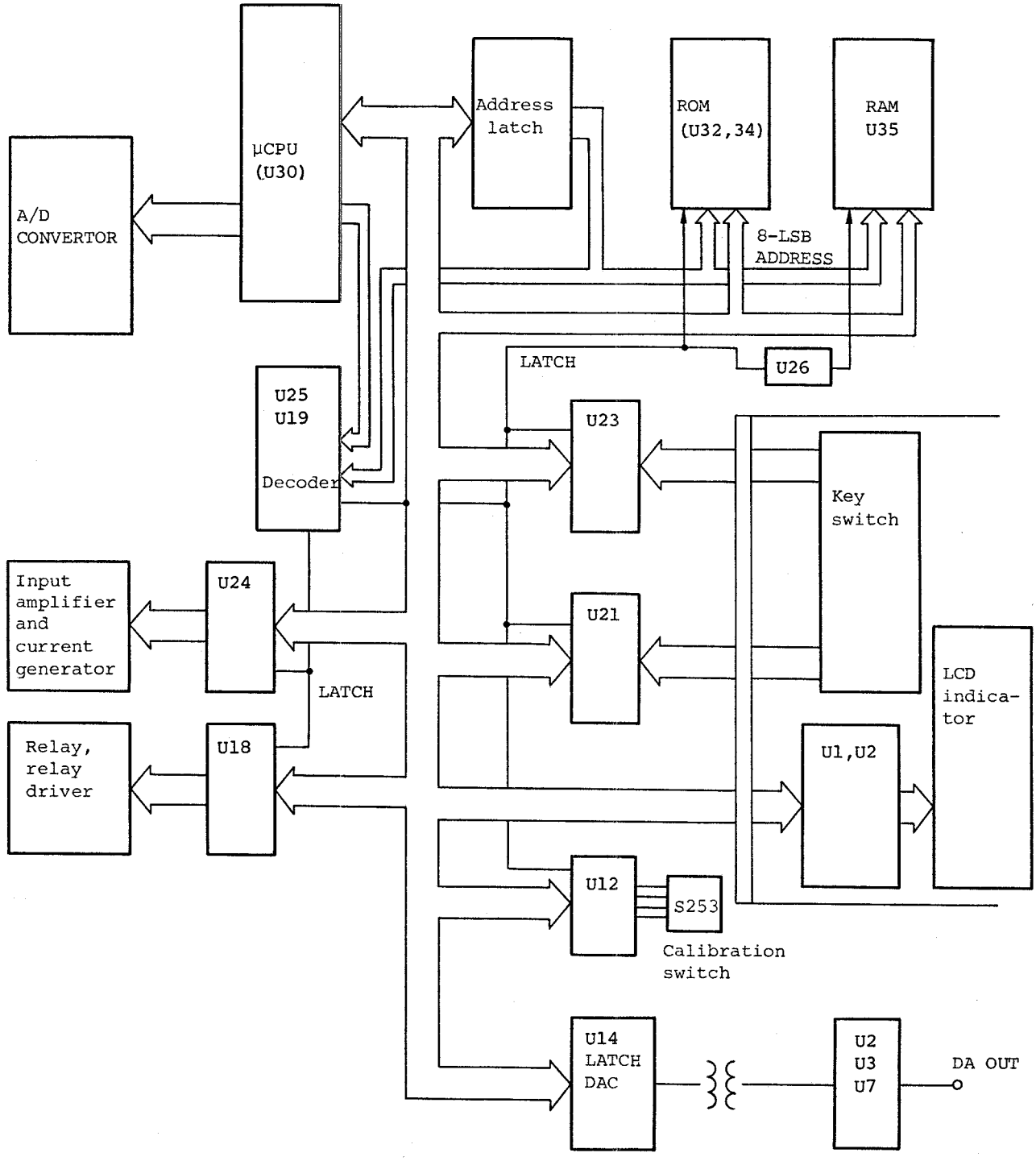
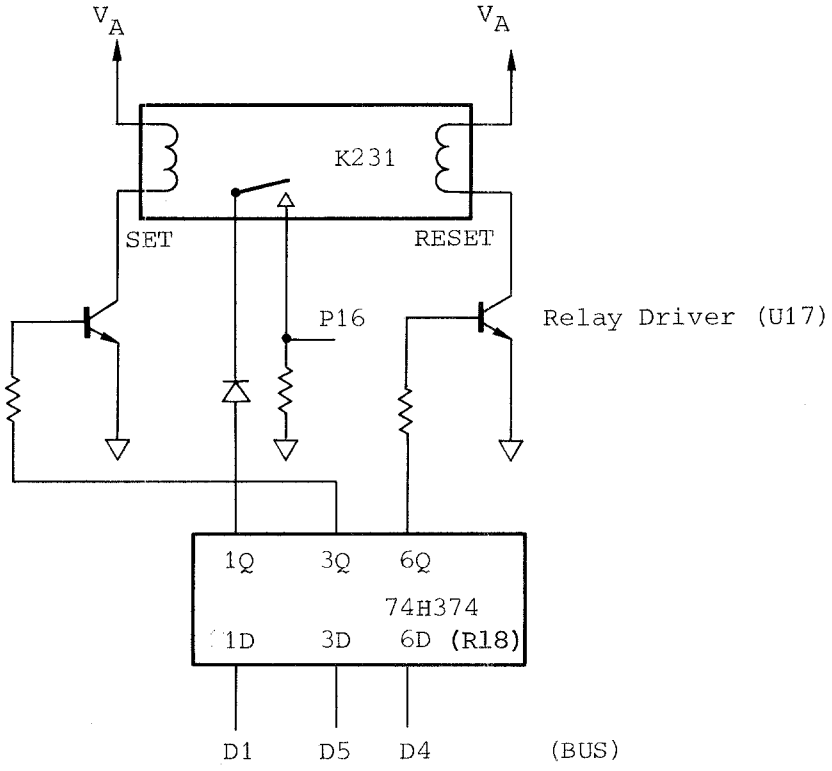


Fig. 5-8 Microcomputer

5-9. RELAY CONTROL

Relay K231 is used to switch the input amplifier between 300 and 30 V, and others in a DCV function. Relay K232 switches functions OHM and RTD to and from functions DCV and TC.



K231 and K232 are magnetic-type self-holding relays which are normally not supplied with the current. The current is only supplied to the SET or RESET side coil to change the ON/OFF state of the contact.
To detect the contact state, one of the four contacts is connected to I/O port P16 of the CPU for the detection of setting error and coil current cut-off timing.

5-10. KEY SWITCH DETECTION

The depression of the panel key is detected when signal lines T1, T2, T3, T4, T5, T6, and T7 at output port U23 go high, line by line. Input port U21 is connected to the opposite side of the junction to detect when a key is being pressed at the time the lines go high.

5-11. LCD DRIVER

The indicator is an LCD type. To allow dot-matrix character display in the dynamic lighting system, two LSIs are used for the dot-matrix LCD indicator which controls driver (U1), and for the LCD indicator driver (U2). The data bus line of the microcomputer is connected directly to the LSI at U1. The characters to be displayed and the positions where they are displayed are controlled by the microcomputer.

5-12. POWER SUPPLY CIRCUIT

The power supply circuit installed in this thermometer supplies four levels of voltages, +15V, +5 V, -5 V, and -10 V.
According to the AC power voltage available, transformer T237 is rewired to operate within $\pm$10% of 100 V, 120 V, 220 V, and 240 V, but not to exceed 250 V. The output of 9 V AC voltage in secondary of the transformer is fed into two channels; one channel is used for the mainframe operation, and the other is used for the accessory output units. The AC voltage of 9 V for the mainframe operation is rectified by D65, which is set at +5 V level by the triple terminal regulator U31, and connected to the power supply unit U28 via the power switch.
When using the battery unit, the power source is connected to V_B (battery power output) by S251.

SECTION 6

TR15802 BATTERY UNIT (OPTION)

6-1. INTRODUCTION

The TR15802 Battery Unit is a chargeable battery power supply for the 2114H. It can operate the 2114H for about 20 hours.

6-2. SPECIFICATIONS

Built-in batteries: 4 rechargeable nickel-cadmium batteries
Continuous operation time: About 20 hours (for DC voltage measurement made by 2114H incorporating 21141 or 21142)
Charging time: About 15 hours when charged with the TRICKLE/FULL switch set to FULL
Charging method: Charging by AC power obtained through its connection with the 2114H
External dimensions: About 97 (W) x 47 (H) x 143 (D) mm
Weight: Less than 370 g

6-3. PREPARATIONS BEFOR USE AND PRECAUTIONS

(1) When charging the batteries, install them in the 2114H beforehand.

(2) When using the instrument for the first time after purchase or after an interval of one month or more, charge the batteries for about 15 hours with the TRICKLE/FULL switch set to FULL.

(3) If the [BATT] indication comes on indicating that the battery voltage has lowered and the battery requires charging, immediately switch to a different power supply, or charge the batteries.

(4) Fully charge the batteries once a month or at every 15th cycle of charging and discharging, so as to balance the power in the four batteries.

(5) Ni-Cd batteries are most efficient in the ambient temperature range of +20°C to +40°C. They can be repeatedly charged and discharged through 300 cycles or more until their capacity deteriorates to 80% of their 1200 mAH nominal capacity.

(6) The ambient temperature range recommended for charging the batteries is from $0^{\circ}C$ to $+45^{\circ}C$, and that for discharging them is from $-20^{\circ}C$ to $+50^{\circ}C$.

(7) Do not allow the batteries to receive any strong impacts which may break the battery electrodes causing them to internally shortcircuit.

(8) Leaving the TRICKLE/FULL switch set to FULL after the batteries are fully charged may overcharge the batteries and cause their life to be shortened. To continue charging the batteries after they are fully charged, set the switch to TRICKLE.

6-4. CHARGING PROCEDURE

① Take out the option cover from the rear panel of the 2114H, and insert the TR15802 all the way until its lock lever is locked.

② Connect the power cable to the power connector of the 2114H, and provide the instrument with the AC power voltage indicated on the rear panel, with line frequency of 50 or 60 Hz.

③ The batteries can be charged regardless of the POWER switch setting on the 2114H.

④ The time required to fully charge the batteries after the [BATT] indication comes on is about 15 hours with the TRICKLE/FULL switch set to FULL. Charging the batteries with the TRICKLE/FULL switch set to TRICKLE takes three times as long.
To continue charging the batteries after they are fully charged, be sure to set the switch to TRICKLE.

⑤ When operating the 2114H incorporating a TR15802 on AC power, make it a rule to set the TRICKLE/FULL switch to TRICKLE. In the TRICKLE mode, overcharging does not occur; the batteries are charged only to make up for their self-discharging.

6-5. FUSE REPLACEMENT PROCEDURE

If the instrument is not powered when its POWER switch is turned on, its power fuse may have blown. If the fuse has blown, replace it. The power fuse is a slow-blow fuse with a capacity of 0.8 A. The fuse replacement procedure is as follows:

① Remove the TR15802 Battery Unit from the 2114H.

② Remove the four screws that hold the upper case of the instrument, and remove the upper case (see Figure 6-1).

③ The fuse is located on the PC board (see Figure 6-2). Remove it by pushing in the arrow direction ① shown in Figure 6-3. To install a fuse, push it into position from above.

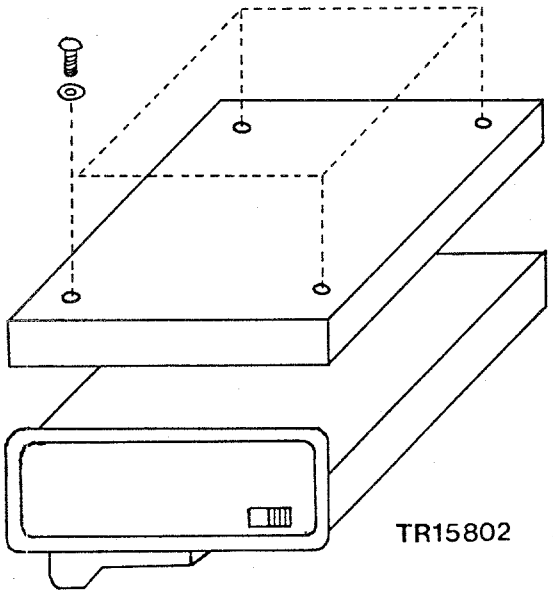


Fig. 6-1 Removing the case

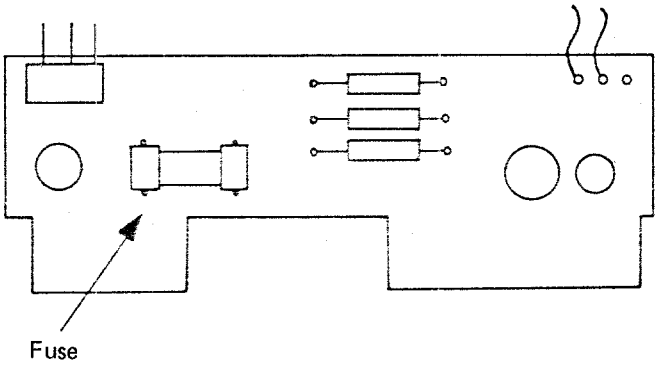


Fig. 6-2 Location of the fuse

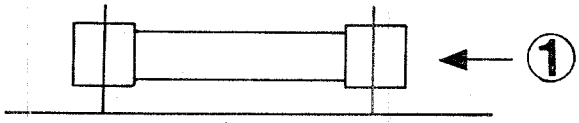


Fig. 6-3 Removing the fuse

SECTION 7

TR13003A BCD DATA OUTPUT UNIT (OPTION)

7-1. INTRODUCTION

The TR13003A BCD Data Output Unit is an option which can be installed in the 2114H. It can output the results of measurement (indicated values) to an external digital device such as a digital recorder after converting them into BCD parallel codes.
It also has remote control functions which enable the measurement functions and measuring ranges of the 2114H to be externally specified or permit the measurement operations of the instrument to be started by an external signal.
The data output by this option includes the results (HIGH/GO/LOW) of comparator operations, and this unit has a relay contact which can be controlled to make contact for HIGHs, GOs, LOWs, or HIGHs and LOWs.
These output data signals and remote control signals are electrically isolated from the measurement signals input to the 2114H, so that the external devices connected to the instrument do not affect the measurements made by the instrument.

7-2. PERFORMANCE

Data output:

Output code: Binary coded decimal (BCD)

Data contents: Measured data, decimal point, polarity, and units

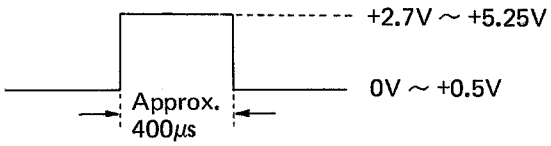
Signal level: TTL level, positive logic

1: +2.7 V to +5.25 V

0: 0 V to +0.5 V

Print command signal output: TTL level, positive pulse

(Pulse width: about 400 µs)



Control signals: Transmitted via 11 lines;
*FCA, *FCB, *UCA, *UCB, *RJCA, *RJCB, *RCA, *RCB, *RCC,
*RCD, *Remote Enable, TTL level, negative logic

External start signal A: TTL level, positive pulse
(Pulse width: 100 μs to 10 ms)

External start signal B: TTL level, negative pulse
(Pulse width: 100 μs to 10 ms)

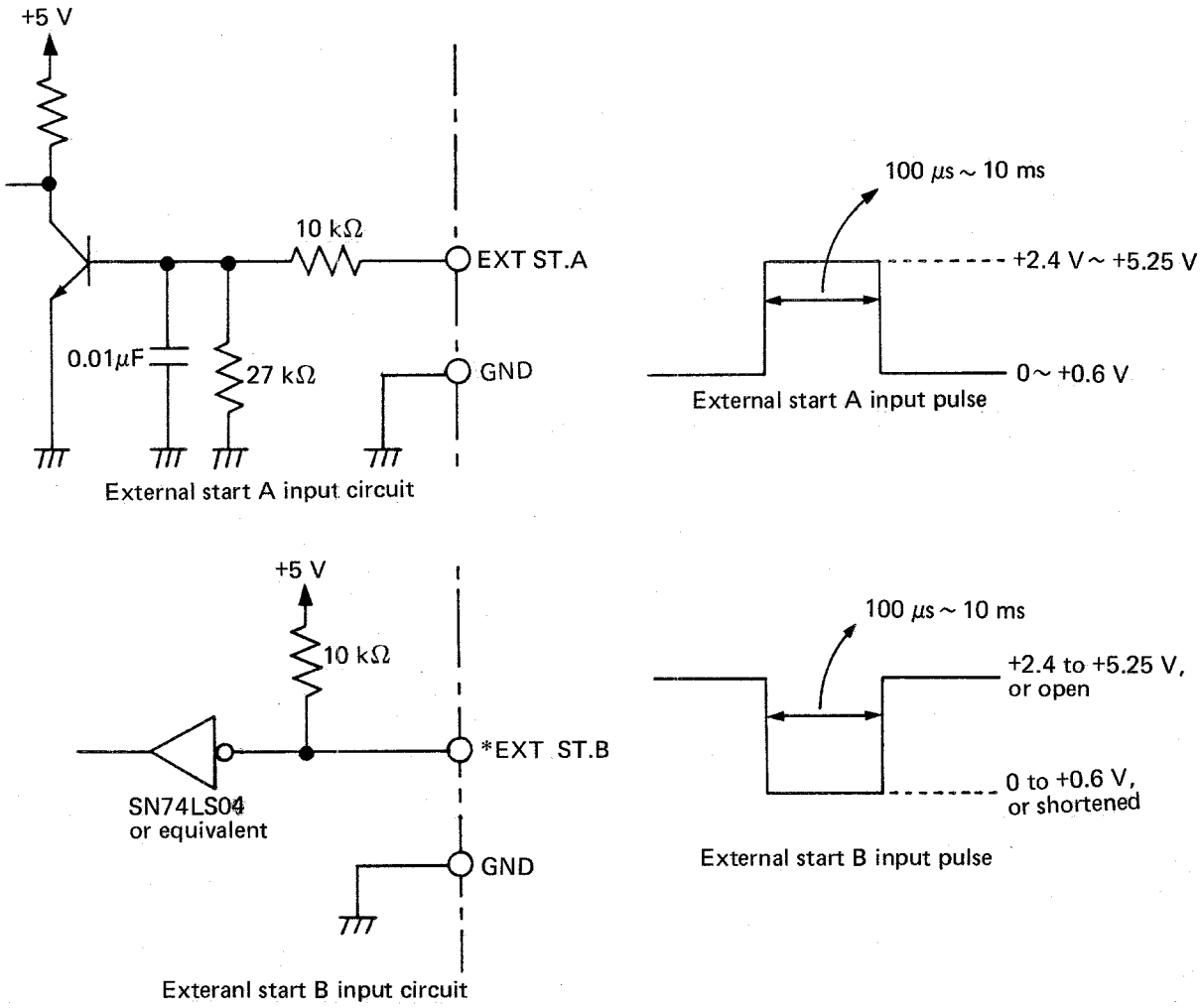


Fig. 7-1 External start input circuits and input pulses

Keeping external start signal A at the high level or external start signal B at the low level causes the measurement operation to be continued.
(* indicates a negative logic signal.)

Data output codes:

Output name	Output signal (printout examples)	Code 8	4	2	1
Data	0	0	0	0	0
	1	0	0	0	1
	2	0	0	1	0
	3	0	0	1	1
	4	0	1	0	0
	5	0	1	0	1
	6	0	1	1	0
	7	0	1	1	1
	8	1	0	0	0
	9	1	0	0	1
	Space	1	1	1	1
Polarity	+	1	0	1	1
	-	1	0	1	0
	Space (Note 1)	1	1	0	0
Decimal point	10^0		0	0	0
	10^1		0	0	1
	10^2		0	1	0
	10^3		0	1	1
	10^4		1	0	0
Function	* (Over)	0	0	0	0
	> (Low)	1	0	0	0
	Space	0	0	1	0
	< (High)	1	0	0	1
Unit	mV	0	0	0	0
	V	0	0	1	0
	Ω	0	1	0	0
	kΩ	0	1	0	1
	°C	0	0	1	1
	Space °F, K (Note 2)	1	1	1	1

Notes: 1) For OHM function, the polarity is output as a space code.
2) °F and K are output as space codes.

Data output connectors:

Pin No.	Function	Pin No.	Function
1	GND	26	1 ⎫ Polarity
2	1 ⎫ Data, 10^0 digit	27	2 ⎪
3	2 ⎪	28	4 ⎪
4	4 ⎪	29	8 ⎭
5	8 ⎭	30	⎫ High level
6	1 ⎫ Data, 10^1 digit	31	⎪
7	2 ⎪	32	⎪
8	4 ⎪	33	⎭
9	8 ⎭	34	A ⎫ Function
10	1 ⎫ Data, 10^2 digit	35	B ⎭
11	2 ⎪	36	⎫ High level
12	4 ⎪	37	⎭
13	8 ⎭	38	C ⎫ Function
14	1 ⎫ Data, 10^3 digit	39	D ⎭
15	2 ⎪	40	1 ⎫ Unit
16	4 ⎪	41	2 ⎪
17	8 ⎭	42	4 ⎪
18	1 ⎫ Data, 10^4 digit	43	8 ⎭
19	2 ⎪	44	1 ⎫ Decimal point
20	4 ⎪	45	2 ⎪ (See Note:2)
21	8 ⎭	46	4 ⎭
22	⎫ High level	47	Print command signal
23	⎪	48	EXT ST.A
24	⎪	49	NC (See Note 2)
25	⎭	50	GND

Pin arrangement

Note 1: Pin 49, NC terminal, is unused. It must not be used as a relay terminal.

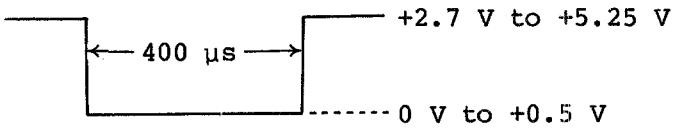
Note 2: The decimal point code corresponds to the indication as follows:

Output signal 10^4 10^3 10^2 10^1 10^0

1 . 9 . 9 . 9 . 9 .

Note 3: The high level is HI output equivalent to 74LS04.

Measurement end output signal: *END



Comparator outputs, HI, LO, GO: TTL level, positive logic

Output \ Decision	HI	LO	GO
HIGH	1	0	0
LOW	0	1	0
GO	0	0	1

1: +2.7 V to +5.25 V
0: 0 V to +0.5 V

Remote control setting codes:

Code		Function	Code		Unit	Code		Reference junction
FCB	FCA		UCB	UCA		RJCB	RJCA	
0	1	DCV	0	0	°C	0	0	INT
1	0	OHM	0	1	°F	0	1	EXT 0°C
1	1	TC	1	0	K	1	0	EXT N
0	0	RTD				1	1	EXT He

Code					Remote/ local mode	Range		
R.E	RCD	RCC	RCB	RCA		DCV	OHM	TC
1	0	0	0	0	Remote	AUTO	AUTO	T
1	0	0	0	1		-	-	J
1	0	0	1	0		20 mV	-	E
1	0	0	1	1		200 mV	200 Ω	K
1	0	1	0	0		2000 mV	2000 Ω	S
1	0	1	0	1		20 V	20 kΩ	R
1	0	1	1	0		200 V	200 kΩ	B
1	0	1	1	1		-	2000 kΩ	Au-Cr
1	1	0	0	0		-	-	Au-N
0	X	X	X	X	Local	Dependent on panel key settings		

1: Shorted to ground, or 0 to +0.6 V (low level)
0: Open, or +2.4 to +5.25 V (high level)
X: 1 or 0

Note: If undesignated codes are used, settings are not guaranteed.

Remote control input connectors:

Pin No.	Function	Pin No.	Function	Pin No.	Function
1	GND	9	*UCB	17	RELAY (Note)
2	*EXT ST.B	10	*RJCA	18	RELAY (Note)
3	HI	11	*RJCB	19	NC
4	LO	12	GND	20	*RCA
5	GO	13	GND	21	*RCB
6	*FCA	14	*RE	22	*RCC
7	*FCB	15	*END	23	*RCD
8	*UCA	16	NC	24	GND

Note:
- Relay contact output (pins 17 to 18)
  Relay contact capacity: 50 Vdc, 150 mA
  Voltage between contact and ground: 150 V peak
- If the buzzer and relay mode is set to HIGH, GO, LOW, or HIGH and LOW, the relay contact becomes ON when the result of comparison is HIGH, GO, LOW, or HIGH and LOW, respectively (see Figure 7-2).

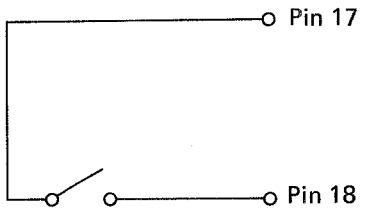


Fig. 7-2 Relay contact

Power supply: From 2114H

Operating temperature: 0 to +50°C

Operating humidity: 85% RH or less

Storage temperature: -25 to +70°C

External dimensions: About 97 (W) x 70 (H) x 182 (D) mm

Weight: Less than 420 g

7-3. PANEL DESCRIPTION

Figure 7-3 shows the panel of the TR13003.

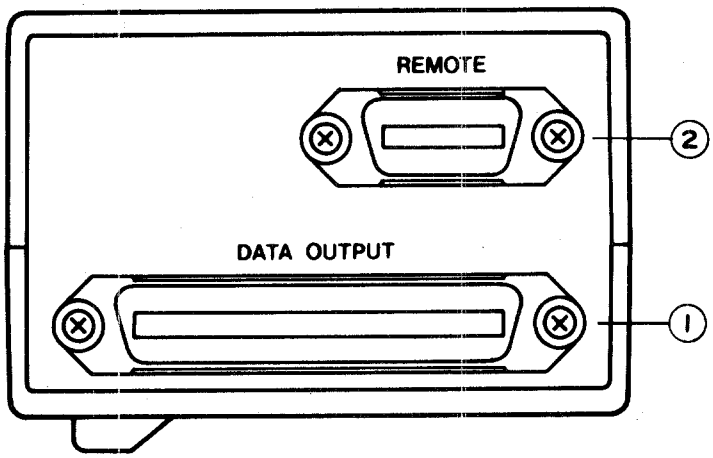


Fig. 7-3 Panel of TR13003

(1) DATA OUTPUT connector
Used to output data. (57FE-40500-20S made by Daiichi Denshi Kogyo) (Matching connector: 57-30500 made by Daiichi Denshi Kogyo, or equivalent)

(2) REMOTE connector
Used to input remote control signals. (57FE-40240-20S made by Daiichi Denshi Kogyo) (Matching connector: 57-30240 made by Daiichi Denshi Kogyo)
Matching connection cable ADVANTEST are MO-09 and MO-28 (option).

7-4. BASIC OPERATING PROCEDURE

Install the TR13003 in the 2114H.

7-4-1. Connection to Digital Recorder

(1) Prepare the TR6198 Digital Recorder.

(2) Connect the connection cable attached to the TR6198 to the DATA OUTPUT connector. (When connecting the two instruments, leave them switched off.)

(3) Follow the digital recorder operating procedures referring to its instruction manual. Figure 7-4 shows examples of printouts made by the TR6198.

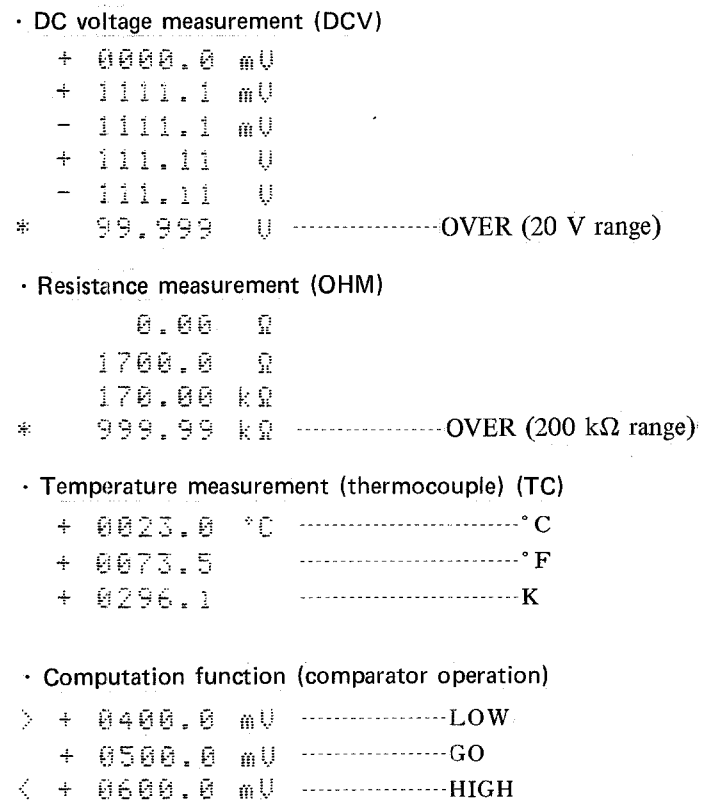


Fig. 7-4 Printout examples

7-4-2. Connection to Devices Other than Digital Recorder

When transferring data from the TR13003 to a device other than the TR6198, note the following:

(1) The input level of the device to be connected should be checked. Figure 7-5 shows the output circuit of the TR13003.

- Data, function, decimal point, print command signal

- Unit output (pins 40 thru 43)
- Other high-level pins

(2) Output data is established when a print command signal is output. To input data to an external device, use the print command signal as a strobe.

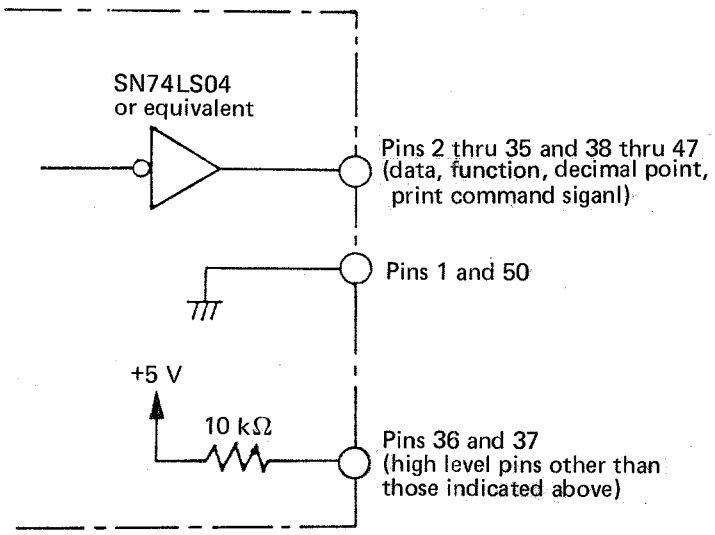


Fig. 7-5 Output circuit of TR13003

7-4-3. Remote Control

When the TR13003 is used to externally control the 2114H, five settings can be made via the TR13003. These are the measurement function, the range, the units, the reference junction, and the measurement start (external start) signal.
For remote control, set the codes for the functions to be used, and set the remote enable (*RE) signal to 1 (low level). Since the *RE signal is a level signal, keep it level at 1 while the remote settings are made. If it is reset to 0 (high level), the remote settings are disabled and the 2114H panel key settings become valid.

The measurement functions are controlled by the *EXT ST.B, *FCA, *FCB, *UCA, *UCB, *RJCA, *RJCB, *RE, *RCA, *RCB, *RCC, and *RCD signals applied to the REMOTE connector. These are negative logic signals. To set them to 1 (to turn them true), connect the corresponding pins to ground (pins 1, 12, 13, 24) (or set them low). To set them to 0 (false), open their lines (or set them high). Figure 7-6 shows the input circuit for the *RCA, *RCB, *RCC, *RCD, and *RE signals.

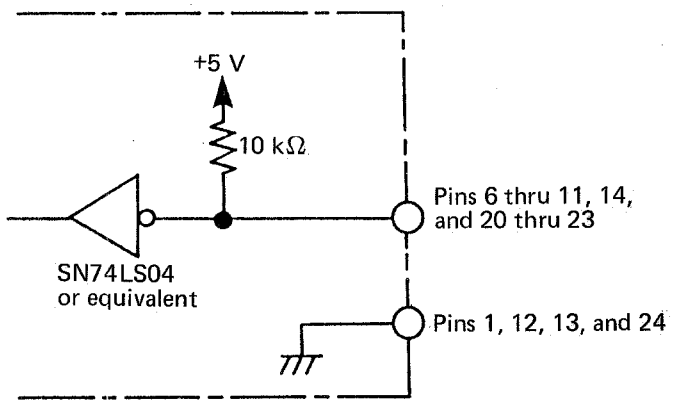


Fig. 7-6 Remote control signal input circuit

NOTE

When the TR13003 is used to set the measuring range of the 2114H, the range width is determined by the measurement function (DCV, OHM, TC, or RTD). (See the table of remote control setting codes provided in Section 7-2.) If an unallowable range is set for the measurement function to be used, the range setting is ignored. In such a case, correct the range setting.

7-4-4. External Start

If the 2114H is placed in the sampling hold mode by pressing the HOLD key on the front panel, an external signal can be used to start sampling. The external start signal can be input either via the REMOTE connector (pin 2) or DATA OUTPUT connector (pin 48) of the TR13003. The two connectors are internally ORed and sampling is started when a 100 µs to 10 ms pulse signal is applied to either pin 2 or 48. (See Figure 7-1.)

7-5. MEASUREMENT TIMING

The timing charts for measurement sequences involving external start input signals and print command signals, and the relevant timing tables are presented in the following.
When incorporating a 2114H provided with a TR13003 into a measuring system, design the system sequence referring to the following timing charts.

7-5-1. SAMPLING RUN Mode

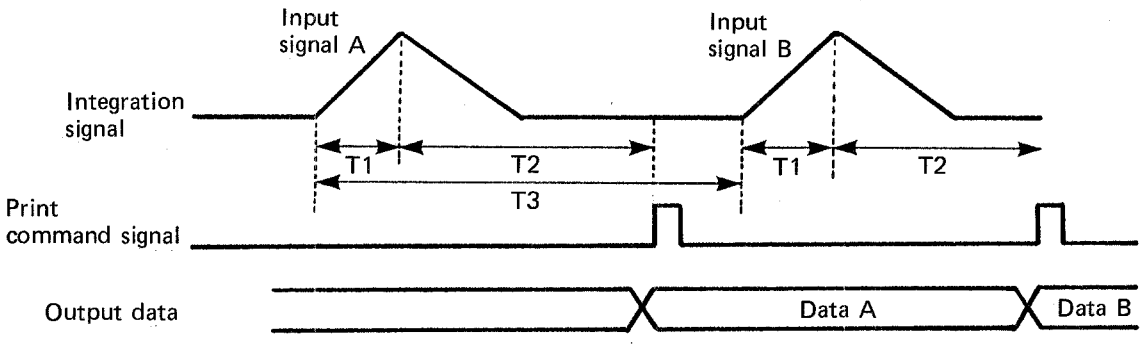


Fig. 7-7 Timing of operations in the SAMPLING RUN mode

Sampling for DCV and TC functions (In FAST mode)

		T1 (input integration time)	T2 (measurement processing time)	T3 (sampling period)
2114H	50 Hz	20 ms	30 ms to 60 ms	50 ms to 80 ms
	60 Hz	16.66 ms	26 ms to 56 ms	42.7 ms to 76 ms
TR2114	50 Hz	20 ms	200 ms to 220 ms	220 ms to 250 ms
	60 Hz	16.66 ms	204 ms to 224 ms	220 ms to 250 ms

- When the OHM or RTD function is used, measurement is made twice (2- or 4-wire method) or three times (3-wire method), so that the sampling period is doubled or tripled, correspondingly.

7-5-2. SAMPLING HOLD Mode

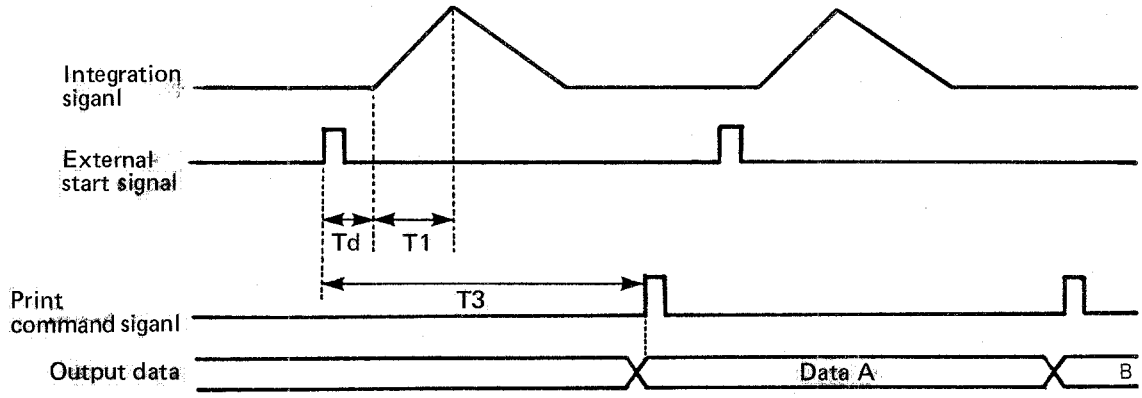


Fig. 7-8 Timing of operations in the SAMPLING HOLD mode

Sampling for DCV and TC functions (in FAST mode)

		Td (internal delay)	T1 (input integration time)	T3 (total time)
2114H	50 Hz	5 ms to 85 ms	20 ms	50 ms to 165 ms
	60 Hz	5 ms to 81 ms	16.66 ms	42.7 ms to 157 ms
TR2114	50 Hz	5 ms to 85 ms	20 ms	220 ms to 250 ms
	60 Hz	5 ms to 81 ms	16.66 ms	220 ms to 250 ms

- The Td (internal delay) may extend up to 285 ms if it coincides with a calibration cycle (occurring once in about 10 seconds).
- When the OHM or RTD function is used, measurement is made twice (2- or 4-wire method) or three times (3-wire method), so that the sampling period is doubled or tripled, correspondingly.

SECTION 8

13206A GPIB ADAPTER UNIT

8-1. INTRODUCTION

The 13206A is a general purpose interface bus (GPIB) adapter designed as an accessory to be installed in the 2114H Digital Multi-Thermometer. Since it is capable of reading data measured by the 2114H and setting the measurement function and measuring range of the 2114H, it can be used to incorporate the 2114H into a measuring system.

The GPIB related signals transmitted from the 13206A are electrically isolated from the measurement signals of the 2114H.

8-2. PERFORMANCE

Standard: IEEE Standard 488-1978

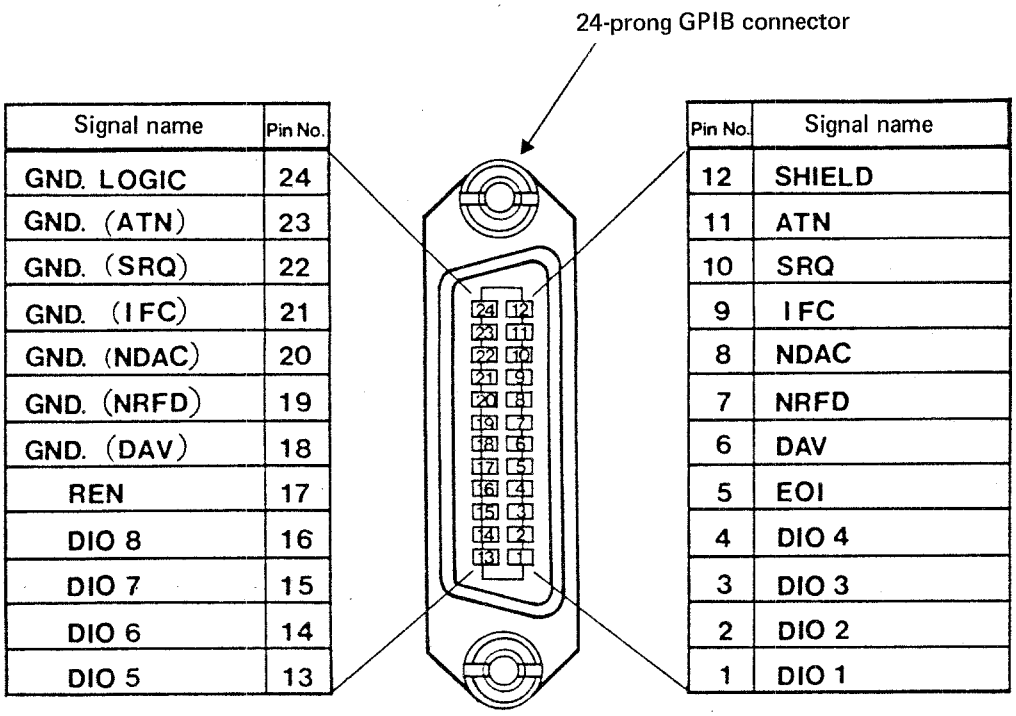
Interface functions: See Table 8-1.

Table 8-1 Interface functions

Code	Function
SH1	Source handshake capability
AH1	Acceptor handshake capability
T5	Basic talker Talk only mode Serial poll Unaddressed to talk if addressed to listen
L4	Basic listener Unaddressed to listen if addressed to talk
SR1	Service request capability
RL1	Remote/local switching capability
PP0	No parallel poll capability
DC1	Device clear capability (SDC and DCL commands can be used)
DT1	Device trigger capability (GET command can be used)
C0	No controller capability
E2	Tristate output

Code: ASCII code

Connector pin configuration:



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

Logical levels: Logical 0 (high state) = +2.4 V or more

Logical 1 (low state) = +0.4 V or less

Signal line termination: The 16 bus lines are terminated as shown in Figure 8-1.

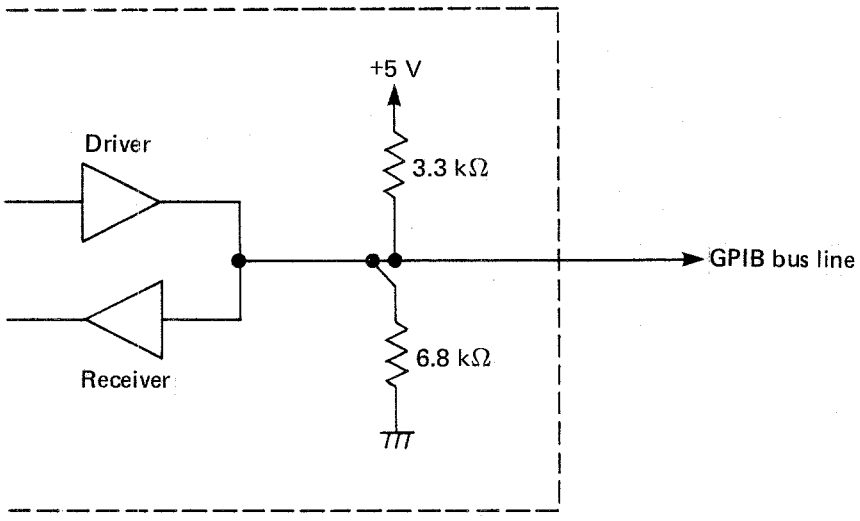


Fig. 8-1 Signal line termination

Driver: Tristate system

Low-state output voltage: 0.4 V or less, 48 mA

High-state output voltage: +2.4 V or more, -5.2 mA

Receiver:

Low-state: +0.6 V or less

High-state: +2.0 V or more

Address specification: 31 different talker addresses and listener addresses can arbitrarily be set using the address select switches.

Data transmission: 13 bytes of measured data and a delimiter are transmitted at one time. (The delimiter can be altered using program codes. See Sections 8-4-5 to 8-4-7.)

Remote programming: The measurement function and measuring range can be set, and an external start signal can be issued by remote programming.

Power supply: Supplied From the 2114H

Operating temperature: 0 to +50°C

Operating humidity: 85% RH or less

Storage temperature: -25 to +70°C

External dimensions: About 97 (W) x 70 (H) x 182 (D) mm

Weight: Less than 400 g

8-3. PANEL DESCRIPTION

Figure 8-2 shows the panel of the 13206A. The parts numbered in Figure 8-2 are described in the following.

(1) Address switch

A 7-bit DIP switch used to set the device address of the 13206 and switch its device header. Header switching is made by its 7th bit switch. When the 7th bit switch is set to OFF (0), three spaces are output as the header. When it is set to ON (1), an alphabetical code corresponding to the measured data is output as the header.

The 1st to 5th bit switches are used for address setting. The address to be set can be selected from up to 31 different addresses. The controller can specify the address set on the five-bit switches only when the 6th bit switch is set to ADDRESSABLE. Setting the 6th bit switch to ONLY sets the 13206 in the TALK ONLY mode to enable it to transfer data regardless of the address specifications made by other devices.

② GP-IB connector

A 24-pin connector for an IEEE-488 bus. Since this is a piggyback type connector, more than one connector of the same type can be stacked to use more than one standard bus cable, but avoid stacking three or more connectors.

③ GPIB status lamps

These lamps indicate the status of the 13206A while it is controlled via the GPIB interface. The SRQ lamp comes on when this adapter unit issues a service request to the controller. The TALK lamp comes on when this adapter unit is addressed to talk to transmit data. The LISTEN lamp comes on when this adapter unit is addressed to listen to receive data. The REMOTE lamp comes on when the instrument enters a state which enables external control using program codes.

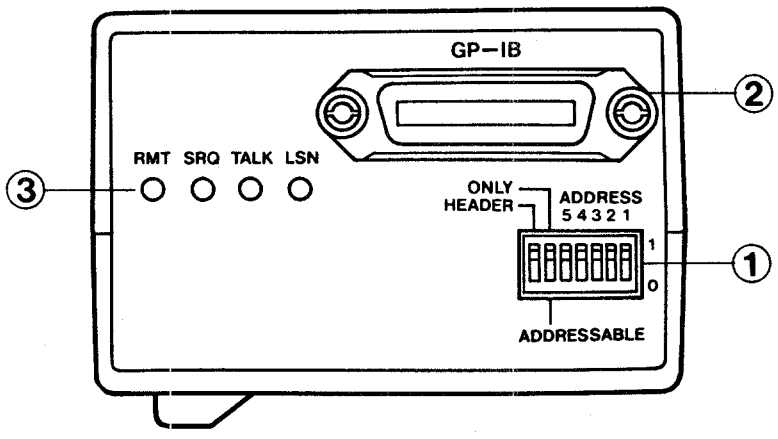


Fig. 8-2 Panel of the 13206A

8-4. TALKER FORMAT

This adapter unit transmits measured data in the format shown below.

Example: xxx±ddddddE±dCR LF
(1) (2) (3) (4)

(1) Header (three letters or spaces)
(2) Mantissa (polarity + decimal point + 5-digit number)
(3) Exponent (E + polarity + 1-digit number)
(4) Delimiter (alterable using a program code)

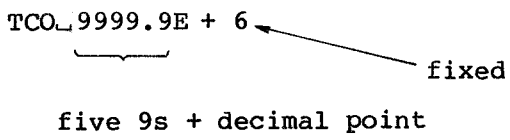
8-4-1. Header

The header indicates the type of measured data. It consists of a 2-character main header and a 1-character subheader. It is transmitted in ASCII code. When the HEADER switch is off, three bytes of space codes are transmitted as a header.

Table 8-2 Headers

	Header code	Transmit data	Computation function (2114H)
Main header	DV	DC voltage measurement	
	R␣	Resistance measurement	
	TC	Temperature measurement (TC, RTD) (in ^{o}C)	
	TF	Temperature measurement (TC, RTD) (in ^{o}F)	
	TK	Temperature measurement (TC, RTD) (in K)	
Sub-header	S	Scaling, R=(X-Z)/Y	1
	P	Deviation in %, R=[(X-Y)/Y]x100(%)	2
	H	Comparator, Y<X	3
	G	Comparator, Z≦X≦Y	3
	L	Comparator, X<Z	3
	A	Average value of data obtained by making measurements Y times R = ΣX/Y	6
	X	Maximum value of data obtained by making measurements Y times R (Max)	4
	N	Minimum value of data obtained by making measurements Y times R (Min)	5
	O	Overscale data	
	E	Computation error	
	␣	Data other than above	

If computation function 4, 5, or 6 is used when a value not greater than 100 is specified as Y, no measured data is output until measurements are made Y times. The maximum, minimum, or average is indicated only after the Yth measurement is made. If, however, the specified value of Y is 101 or more, the maximum or minimum value of the data obtained from when the measurements start until the measurement stop is indicated for function 4 or 5 and the average value of the data obtained every 100 measurements is indicated for function 6. The indicated value is output. If an overscale or a computation error occurs, data as shown below is output.



8-4-2. Mantissa and Exponent

The mantissa part of measured data has a fixed length of seven digits including the polarity and decimal point. The decimal point is output to the corresponding position in the data indication on the 2114H. The data polarity is output as either + or - except for resistance measurements; when resistance is measured, a space code is output as the data polarity. The data in the exponent part is dependent on the measurement function and measuring range, so that any measured data can be represented in basic unit (V, Ω). Table 8-3 gives the data formats of the mantissa part and exponent part for different measurement conditions.

Table 8-3 Mantissa part and exponent part for different measurement conditions

Measurement function	Measuring range	Mantissa part of data	Exponent part of data
DC voltage (DCV)	20 mV	±d d. d d d	E-3
	200 mV	±d d d. d d	E-3
	2000 mV	±d d d d. d	E-3
	20 V	±d d. d d d	E+0
	200 V	±d d d. d d	E+0
Resistance (OHM)	200 Ω	␣d d d. d d	E+0
	2000 Ω	␣d d d d. d	E+0
	20 kΩ	␣d d. d d d	E+3
	200 kΩ	␣d d d. d d	E+3
	2000 kΩ	␣d d d d. d	E+3
Temperature (TC, RTD)	All ranges	±d d d d. d	E+0

Note: d = 0 thru 9 (indicates measured value.)

8-4-3. Contents of Mantissa Part and Exponent Part During Computation

- The data size in the mantissa part is fixed at seven bytes.
- The decimal point is output to the position corresponding to that in the indicated data.
- The data in the exponent data is represented as listed in Table 8-4.

Table 8-4 Contents of exponent part during computation

Function / Computation		DCV	OHM	TC	RTD	Overscale/ computation error
1	Scaling	Same as during normal measurement	Same as during normal measurement	E+0	E+0	E+6
2	Deviation in %	E+0	E+0			
3	Comparator	Same as during normal measurement	Same as during normal measurement			
4	Average					
5	Maximum					
6	Minimum					

8-4-4. Delimiter

A delimiter indicates the end of single data item. Any one of the following three different delimiters can be selected using program codes. (See Sections 8-4-5 to 8-4-7.)

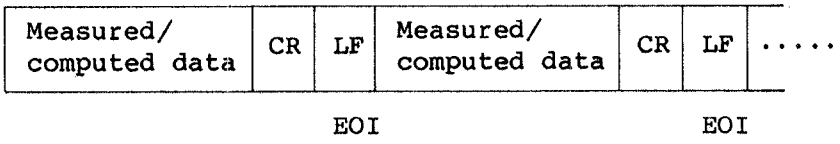
① Delimiter consisting of two bytes, CR (15_8) and LF (12_8). When LF is output, a single line message, EOI, is also output.

② Delimiter consisting of one-byte data, LF (12_8)

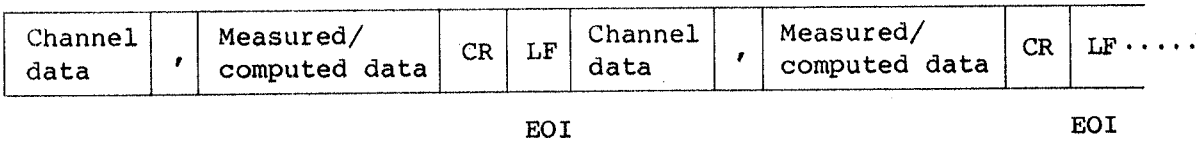
③ Delimiter consisting of the message, EOI. It is output at the same time as the last byte of data.

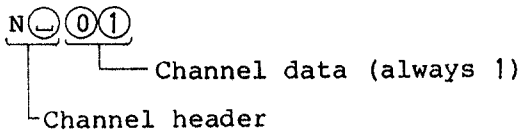
8-4-5. Output Format Used When Measurement Is Made Using 21141

(1) With channel data off



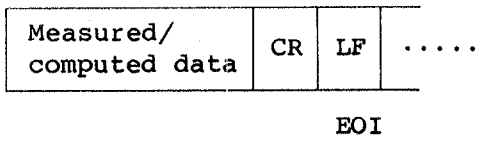
(2) With channel data on (commas are used as string delimiters)



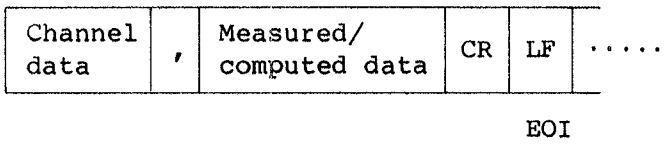


8-4-6. Output Format Used When Measurement is Made Using 21142

(1) With channel data off



(2) With channel data on



(1) Channel header

N plus a space, or two spaces (when HEADER switch is off)

(2) Channel data

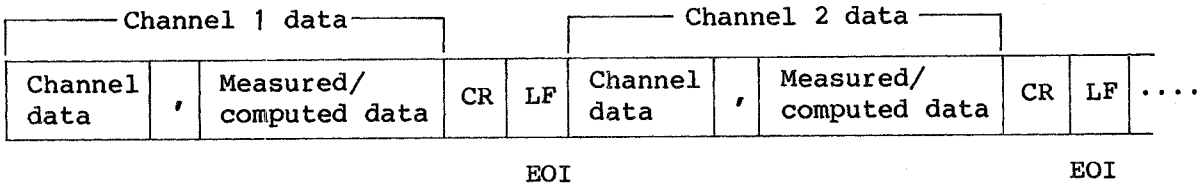
01: Data obtained from channel A

02: Data obtained from channel B

03: Data obtained from channels A and B

8-4-7. Output Format Used When Measurement is Made Using 21143 and 19001

(1) In auto-scan mode



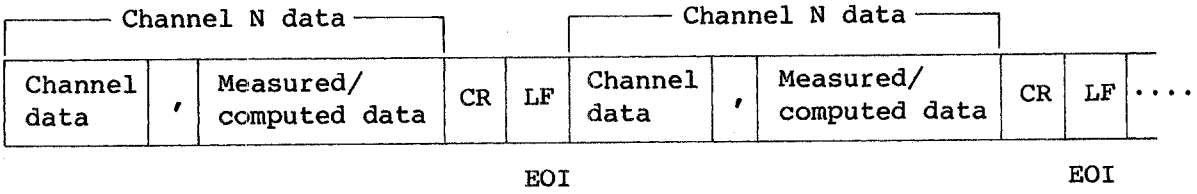
(1) Channel header

N plus a space, or two spaces (when HEADER switch is off)

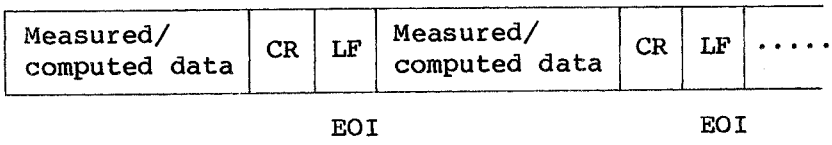
(2) Channel data

01 to 10 to 40

(2) In fixed channel mode



(3) With channel data off



8-5. REMOTE PROGRAMMING

This adapter unit enables the various measurement conditions to the instrument to be set by an external controller.

(1) Measurement function: Fd (initial value: F1)

The following measurement functions can be set (d can be 1 to 4):

Code	Function
F1	DC voltage measurement (DCV)
F2	Resistance measurement (OHM)
F3	Temperature measurement (using a thermocouple) (TC)
F4	Temperature measurement (using an RTD) (RTD)

(2) Measuring range: Rd (initial value: R0)

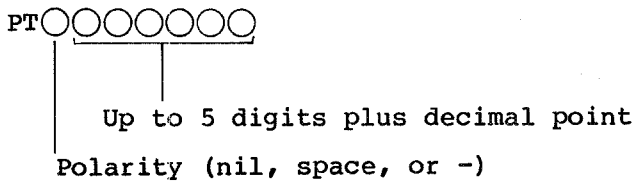
The following measuring ranges can be set (d represents 0 to 8):

Function / Code	DCV	OHM	TC
R0	AUTO	AUTO	T
R1	-	-	J
R2	20 mV	-	E
R3	200 mV	200 Ω	K
R4	2000 mV	2000 Ω	S
R5	20 V	20 kΩ	R
R6	200 V	200 kΩ	B
R7	-	2000 kΩ	Chrome/gold (iron)
R8	-	-	Normal silver/gold (iron)

Note: R7, chrome/gold (iron), and R8, normal silver/gold (iron), can be set for TC (temperature measurement to be made using a thermocouple) only when the instrument in use is a 2114H. If R7 or R8 is set on a TR2114, the previously set range is regarded as valid; no SYNTAX error results.

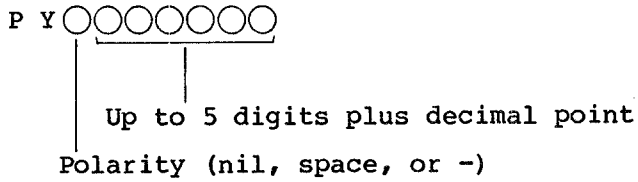
(3) Constant and mode setting

a. Constant T



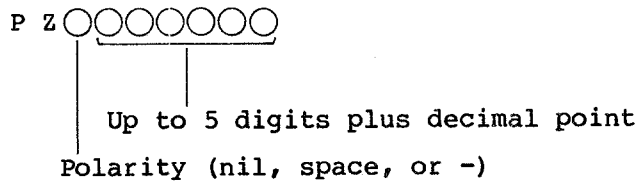
Initial value: 0

b. Constant Y



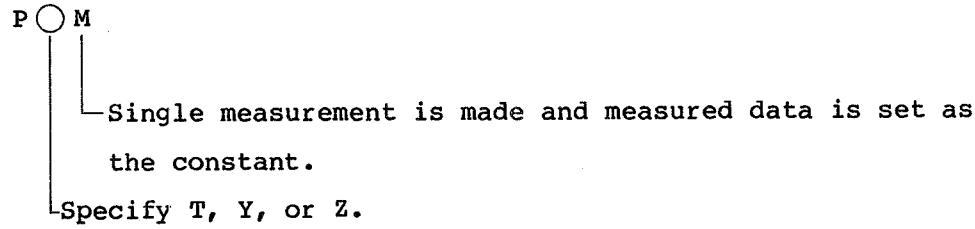
Initial value: 1.0000

c. Constant Z

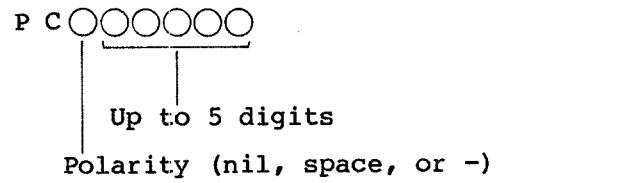


Initial value: 0

d. Setting measured data as constant T, Y, or Z

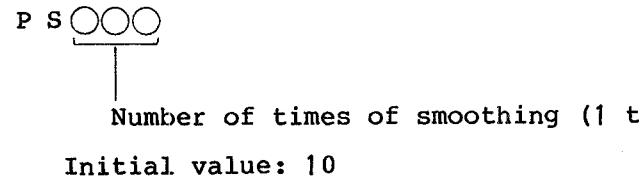


e. Setting calibration data



● Valid only when CAL switch is set at 9.

f. Number of times of smoothing



Initial value: 10

g. Sampling rate

P R ○

└0: Fast sampling
1: Slow sampling, x2
2: Slow sampling, x5
3: Slow sampling, x10
4: Slow sampling, x20
5: Slow sampling, x50
6: Slow sampling, x100
Initial value: 0

h. Clearing constant T, Y, or Z

P ○ C2

└Specify T, Y, or Z

i. Channel select (when 21142, or 21143 + 19001 are used)

N ○○

└Selected channel
Initial value: 01

- This code can be used to specify a channel for measurements to be made using a 21142 (2-channel selector for channels (1 to 3) or a 19001 (auto-channel selector for channels 1 to 40).
- If 3W or 4W is set for the OHM or RTD function, channels 1 to 5 are set for channels 6 to 10, channels 11 to 15 for channels 16 to 20, channels 21 to 25 for channels 26 to 30, and channels 31 to 35 for channels 36 to 40.
- This channel select code "N○○" can set any channel between channels 1 and 40 regardless of the setting of the first and last channels made using the scan channel code "P6,○○,○○."

j. Sampling mode

M ○

└Sampling mode 0: RUN (initial value)
1: HOLD

k. Auto-scan mode (valid when 19001 is used)

A ○

└── Auto-scan mode 0: Auto-scan mode is released (initial value)

1: Auto-scan mode is specified

l. Measurement start

E

- Valid when the sampling mode is set to HOLD.
- This code is issued without the auto-scan mode being specified causes single measurement to be made.
- This code if issued with the auto-scan mode being specified causes the first through to the last channels to be scanned once. (The GET command is equivalent to this code.)

m. SRQ issuing mode

S ○

└── 0: Service request (SRQ) is issued

1: Service request (SRQ) is not issued (initial value)

n. Delimiter mode

D L ○

└── 0: As a delimiter, CR LF is output. In addition, when LF is output, EOI is also output. (Initial value)

1: As a delimiter, only LF is output.

2: As a delimiter, only EOI is output at the same time as the last byte of the data transmission.

o. Buzzer mode

B ○

└── 0: Buzzer off mode

The buzzer is not sounded.

1: Buzzer on mode

The buzzer is sounded when a key is pressed, or when an overrange occurs. (Initial value)

p. Computation function on/off mode

C O ○

└ 0: No computation function is used. (Initial value)

1: A computation function is used.

q. Smoothing on/off mode

S M ○

└ 0: Smoothing is not used. (Initial value)

1: Smoothing is used.

r. Execution of power-on equivalent routine

C The program is executed from its beginning. (The same as when the power is switched on.) Equivalent to the DCL and SDC commands.

s. Parameter initialization

Z The parameters are initialized. Each item is set to its initial value.

Note: Program Codes "E", "C", "Z" should be used independently. No other code may be written in one statement.

(4) Parameter setting (* is for the 2114H.)

Note: Be sure to set each parameter. If only P is set, the parameter is indicated.
For the range and function of each digit, see "Table 3-1 The range and function of each digit in the program mode" on page 3-22.

a. DV voltage measurement

P1, ○, ○

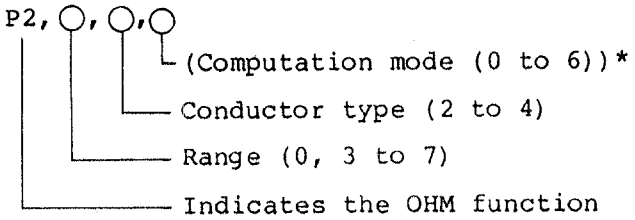
└ (Computation mode (0 to 6))*

└ Range (0, 2 to 6)

└ Indicates the DCV function

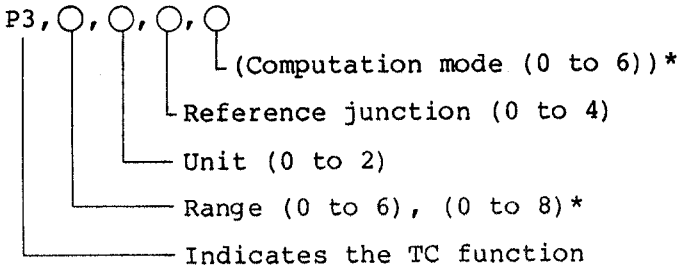
Initial values: P1, 0, 0

b. Resistance measurement



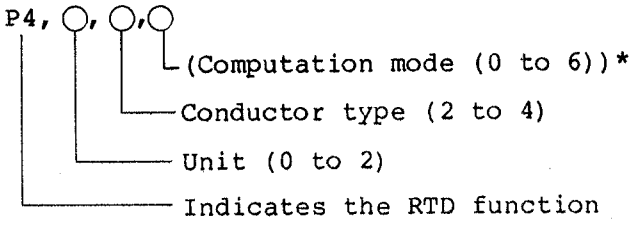
Initial values: P2, 0, 2, 0

c. Temperature measurement (using a thermocouple)



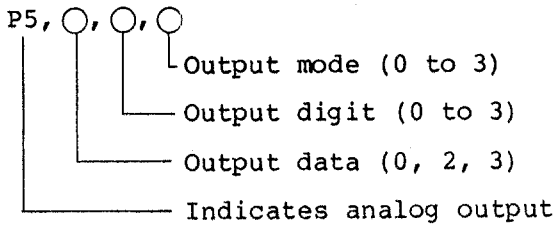
Initial values: P3, 0, 0, 0, 0

d. Temperature measurement (using an RTD)



Initial values: P4, 0, 4, 0

e. Analog output



Initial values: P5, 0, 0, 0

f. Scan channel

P6, ○○, ○○ (P6, ○, ○ can also be used.)

- ○○ — Last channel (01 to 40)
- ○○ — First channel (01 to 40)
- P6 — Indicates scan channel

Note: This setting is made for automatic scanning. In the initial state, the first channel is 01, and the last channel is 10. A single-digit number can be set for the first and last channels.

Initial values: P6, 01, 10

g. GPIB output format

P7, ○

- ○ — Channel data selection
- P7 — Indicates GPIB output

Initial values: P7, 0

h. Buzzer and relay mode

P8, ○, ○

- ○ — Buzzer and relay mode (0 to 4) for HIGH, LOW, GO, and HIGH & LOW
- ○ — Buzzer mode (0, 1) for OVER
- P8 — Indicates buzzer and relay mode setting

Initial values: P8, 0, 0

8-6. SERVICE REQUEST (SRQ)

When a measurement end signal or an undefined code is received by this instrument set in the S0 mode, it issues a service request (SRQ) to the controller. When it is serially polled by the controller after issuing the service request, it sends out the status byte. In S1 mode, it sends out no service request, but is sends out the status byte.

(1) Service request made on completion of measurements

If the instrument is not addresses to talk when the measurements end, it issues a service request. When it is serially polled, it sends out the status byte as shown below. The status byte is not cleared until the instrument is addressed to talk to transmit measured data.

MSB							LSB
0	1	0	0	0	0	0	1

ASCII code: A
Decimal code: 65

(2) Service request resulting from a syntax error

If an undefined program code is received during remote programming operation, this instrument issues a service request. The status byte is as shown below. It is not cleared until the instrument is not addressed to listen to enable remote setting.

MSB							LSB
0	1	0	0	0	0	1	0

ASCII code: B
Decimal code: 66

* If a measurement end and a syntax error occur at the same time, two bits are set in the status byte. (ASCII code: C, decimal code: 67)

(3) Service request made depending on computation result

If the result of a comparator operation is HIGH or LOW, this instrument issues a service request. The status byte is not cleared until the instrument is next addressed to talk.

MSB LSB

0	1	0	0	0	1	0	1

ASCII code: E
Decimal code: 69

* If a measurement end, a syntax error, and a computation result occur at the same time, three bits are set in the status byte. (ASCII code: G, decimal code: 71)

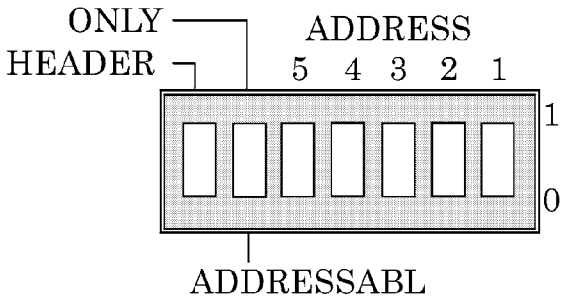
8-7. OPERATION PROCEDURES

(1) Insert the 13206A into the 2114H.

(2) Address setting

When changing the GPIB address of 13206A GPIB unit, the setting method ("1" or "0") of the bits is as follows. The setting method changes depending on the type of DIP switch. Check the DIP switch before changing the settings.

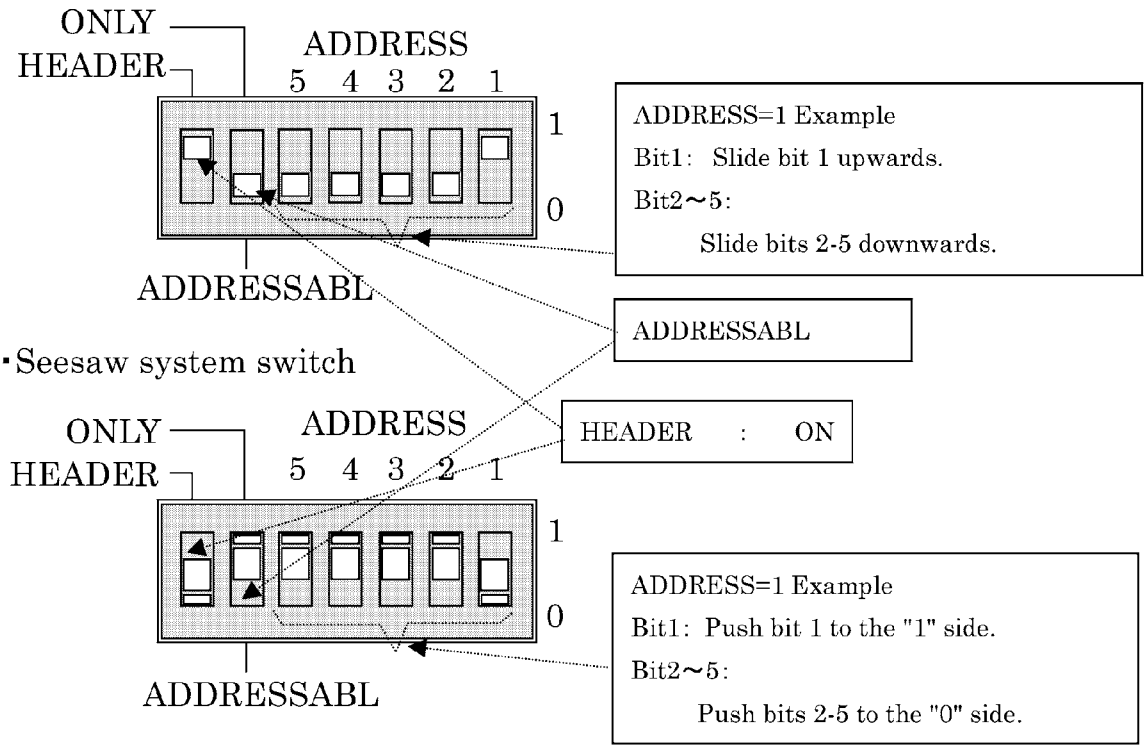
■ Panel display



<An example setting>

(ADDRESS=1 , ONLY mode=ADDRESSABLE and HEADER=ON)

・Slide system switch (Contents indicated by the operation manual)



Cautions

・ The number and sign (ON, OFF), which were displayed on the DIP switch, are not related to this setting procedure.

To set the talk address and listen address of this instrument for operation via the GPIB, use its ADDRESS switch.

Any address selected from up to 31 different addresses may be set on the five bit (position) switches, ADDRESS1 thru 5, of the ADDRESS switch. In the example shown in Figure 8-3, the five bits are set to 01110, which is 14 in decimal notation. In ASCII code, the value represents N for talker or . for listener as listed in Table 8-5.

The address setting is valid only while the sixth bit is set to ADDRESSABLE. If it is set to ONLY, the instrument is set in the TALK ONLY mode and is always addressed to talk regardless of the address setting. Table 8-5 lists the address codes.

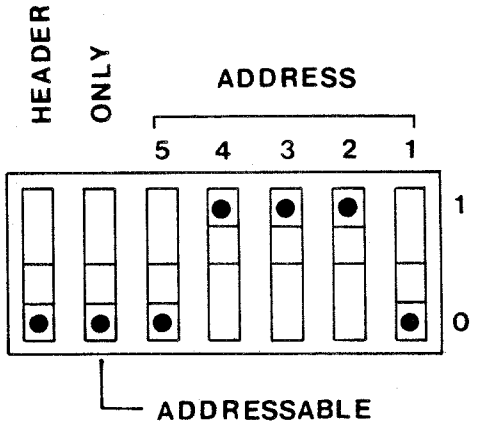


Fig. 8-3 ADDRESS switch

(3) Preparation

① Connect the adapter unit to the 2114H.

② Connect the adapter unit to other system components such as the controller via the bus cable. Also connect to an AC power receptacle and ground.

③ Set the POWER switches of the 2114H and other system components to ON, and set their ADDRESS switches.

(4) General operating precautions

a. Only mode

To use the instrument in the only mode, set the sixth bit of the ADDRESS switch to ONLY. At the same time, also set the device to which this instrument is connected via the bus line to the only mode.

When using this instrument in the only mode, do not use it together with the controller because normal operation cannot be ensured.

b. Alteration of ADDRESS switch setting during operation

If the address of this instrument is altered during operation, the operation is continued under the new address. If its old address is specified by the controller, the specification is ignored. It is therefore necessary to also alter the address in the program.

c. Table 8-6 lists the changes that occur in the state of this instrument when the power is switched on, or when it receives different commands.

Table 8-5 Address codes

ASCII-code character		ADDRESS switch					Decimal code
LISTEN	TALK	A5	A4	A3	A2	A1	
SP	@	0	0	0	0	0	0
!	A	0	0	0	0	1	1
"	B	0	0	0	1	0	2
#	C	0	0	0	1	1	3
$	D	0	0	1	0	0	4
%	E	0	0	1	0	1	5
&	F	0	0	1	1	0	6
'	G	0	0	1	1	1	7
(	H	0	1	0	0	0	8
)	I	0	1	0	0	1	9
*	J	0	1	0	1	0	10
+	K	0	1	0	1	1	11
,	L	0	1	1	0	0	12
-	M	0	1	1	0	1	13
.	N	0	1	1	1	0	14
/	O	0	1	1	1	1	15
0	P	1	0	0	0	0	16
1	Q	1	0	0	0	1	17
2	R	1	0	0	1	0	18
3	S	1	0	0	1	1	19
4	T	1	0	1	0	0	20
5	U	1	0	1	0	1	21
6	V	1	0	1	1	0	22
7	W	1	0	1	1	1	23
8	X	1	1	0	0	0	24
9	Y	1	1	0	0	1	25
:	Z	1	1	0	1	0	26
;	[	1	1	0	1	1	27
<	/	1	1	1	0	0	28
=	]	1	1	1	0	1	29
>	~	1	1	1	1	0	30

Table 8-6 State changes caused by commands

Command	Talker (lamp)	Listener (lamp)	SRQ (lamp)	Status	Transmit data
POWER ON	Cleared	Cleared	Cleared	Cleared	Cleared
IFC	Cleared	Cleared	/	/	/
DCL, SDC, or C	/	/	Cleared	Cleared	Cleared
GET or E	/	/	/	Transmit data indicator bit is cleared	Cleared
2114H addressed to talk	Set	Cleared	/	/	/
Talker unaddressing	Cleared	/	/	/	/
2114H addressed to listen	Cleared	Set	/	/	/
Listener unaddressing	/	Cleared	/	/	/
Serial polling	/	/	Cleared	/	/

Note: A slash (/) indicates that the current state is retained.
DCL: Device Clear
SDC: Selected Device Clear
GET: Group Execute Trigger

Table 8-7 Standard bus cable (option)

Length	Stock No.
0.5 m	408JE-1P5
1 m	408JE-101
2 m	408JE-102
4 m	408JE-104

(5) General GPIB operation

Figure 8-4 shows a simplified operation sequence using GPIB.

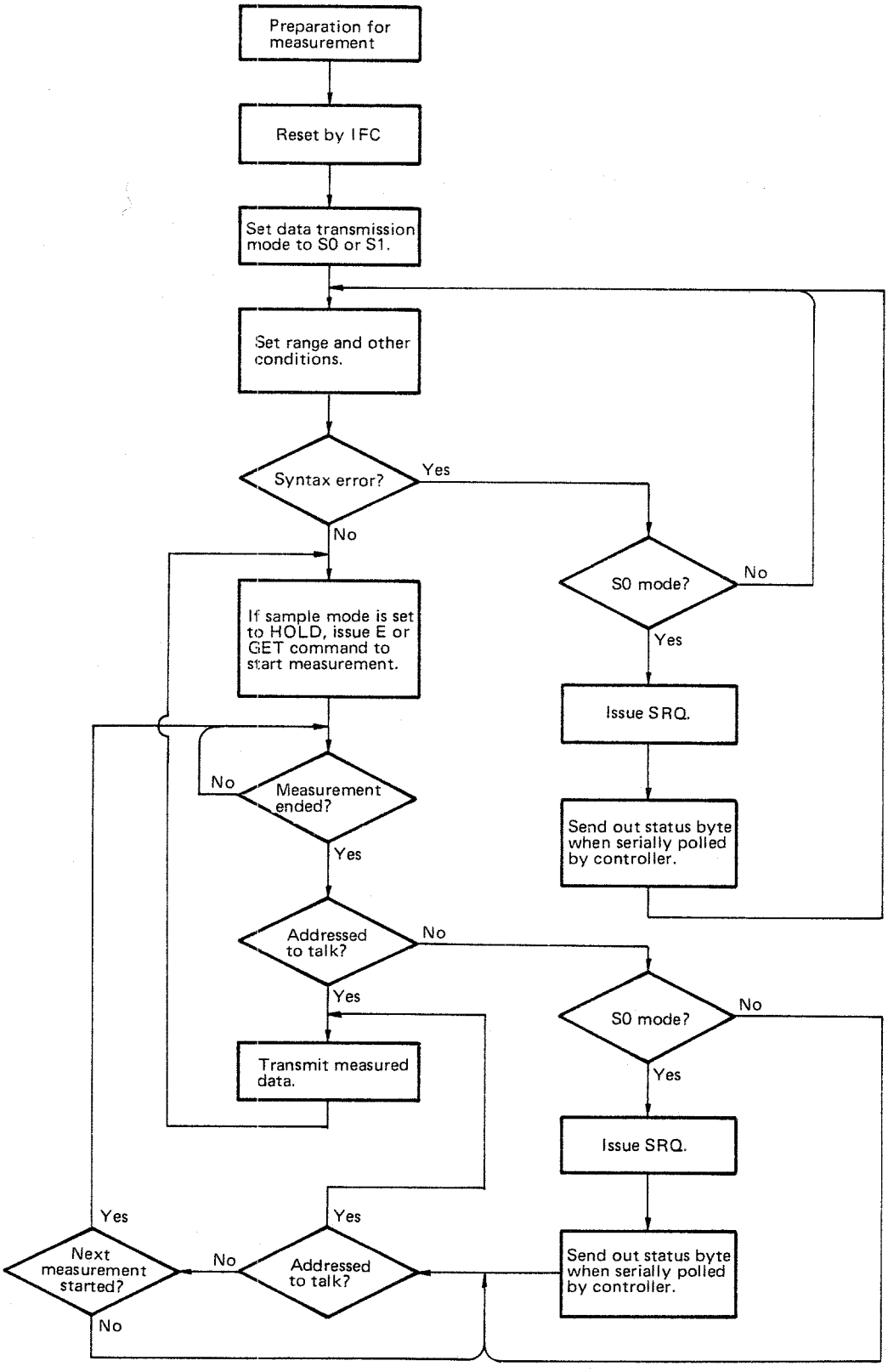


Fig. 8-4 GPIB operation flowchart

(6) Notes on operation

a. Operations during and after service requests

Figure 8-5 shows the operations that take place during and after a service request which follows the end of measurement or a syntax error (in S0 mode). Take these operations into consideration when generating programs.

b. Operations taking place when measurement is started by program code E or GET command

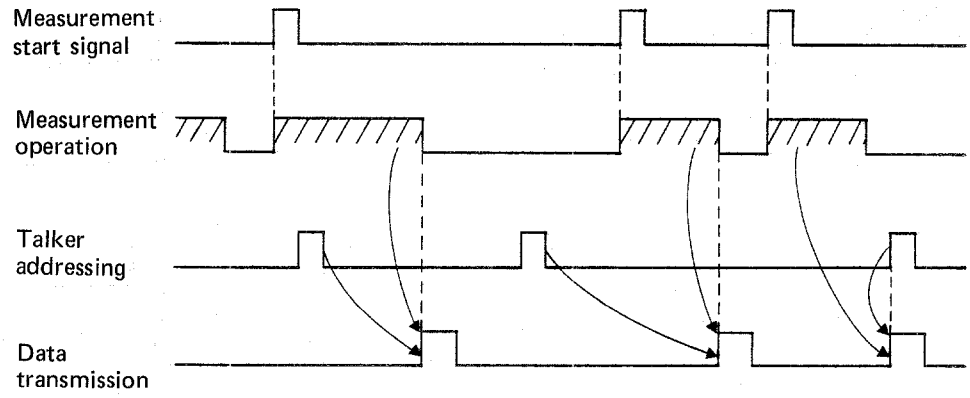
See Section 7-5-2 "Sampling Hold Mode" for the operations taking place when measurement is started by program code E or a GET command issued when the sample mode of the 2114H is set to HOLD.

Note: The print command signal for the TR13003 is equivalent to the service request at the end of measurement for the 13206A.

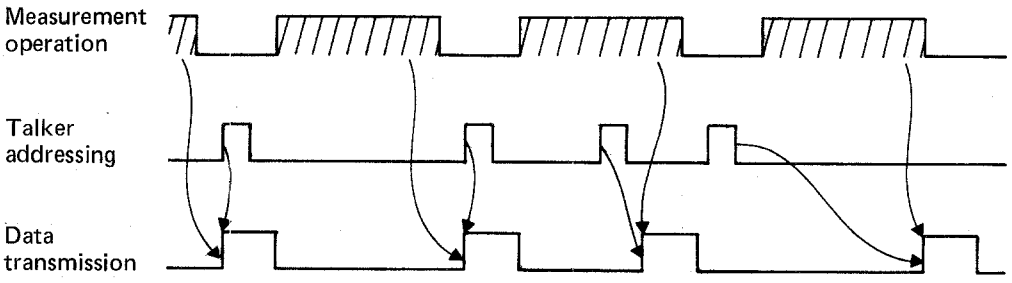
c. Transmit data difference caused by different timing of talker addressing

d. If a data read operation is made while the 19001 Auto Channel Selector is automatically scanning channels, scanning proceeds to the next channel after the data transmission is completed. Therefore, if the data read operation is suspended, channel scanning is left suspended.

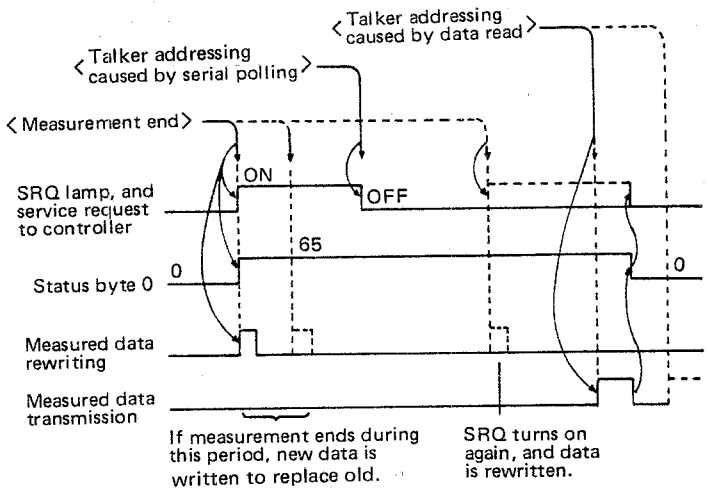
<Measurement started by program>



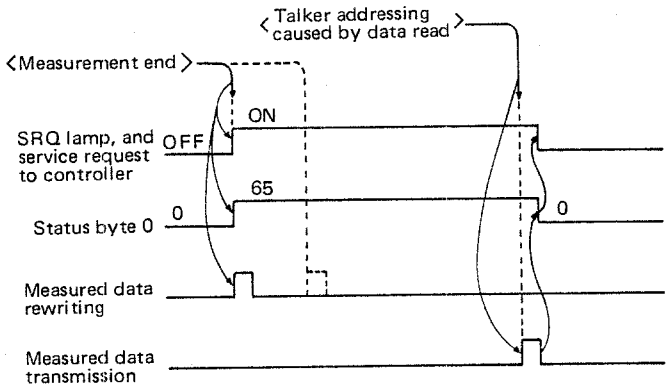
<Measurement in free-run mode>



a) When serial polling is performed



b) When serial polling is not performed



c) Timing following syntax error

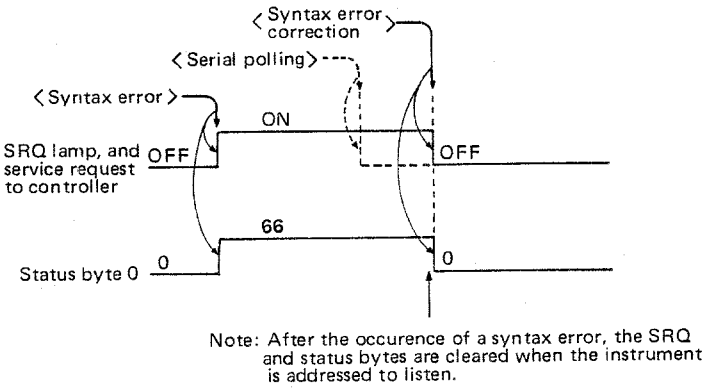


Fig. 8-5 Timing of operations carried out when service request is made

(7) Measurement timing

For the measurement timing, see Section 7-5 "MEASUREMENT TIMING". The total time required for output to a computer by the GP-IB consists of T3 (sampling cycle or total time) plus the handshake time.

8-8. PROGRAM EXAMPLES

Program examples to be run by the HP-9825A and HP-9845B are shown in the following. They are generated on the assumption that the device address of the 13206A is 1.

(1) Externally setting the measuring range of the 2114H from the HP-9825A, externally starting the 2114H to make measurements about every 10 seconds, and reading data without using any SRQ. (On the panel of the 2114H, the function is set to DCV, sampling to HOLD, and range to AUTO.)

- Sample program

```
0: dim A$[20]
1: clr 701
2: wrt 701,"S1DL
 0F1R0"
3: trg 701
4: red 701,A$
5: dsp A$
6: prt A$
7: wait 10000
8: gto 3
9: end
```

- Sample data

```
DV +00.897E-3
DV +01.158E-3
DV +00.825E-3
DV +00.838E-3
DV +01.183E-3
DV +00.786E-3
DV +00.767E-3
DV +01.018E-3
DV +01.044E-3
DV +00.787E-3
DV +00.792E-3
DV +01.068E-3
DV +00.755E-3
DV +00.830E-3
DV +00.924E-3
DV +01.103E-3
DV +00.770E-3
DV +00.889E-3
DV +03.102E-3
DV +01.186E-3
```

- Explanation

  0: The data area is defined.

  1: The 13206A is initialized.

2: The data transmission mode is set to S1, the 2-byte delimiter, CR LF, is set, and the function and range are set to DCV and AUTO, respectively.

3: An external start is made.

4: Data is read.

5: The data is indicated.

6: The data is printed.

7: A wait time of about 10 seconds (10,000 ms) is inserted.

8: Processing returns to line 3.

(2) Externally setting the measuring range of the 2114H from the HP-9845B, externally starting measurement about every 10 seconds, and reading data without using any SRQ.

● Sample program

```
10      DIM A$[20]
20      CLEAR 701
30      OUTPUT 701;"S1DL0F1R0M1"
40      TRIGGER 701
50      ENTER 701;A$
60      PRINT A$
70      WAIT 10000
80      GOTO 40
90      END
```

● Sample data

```
DV -00.003E-3
DV -00.003E-3
DV -00.003E-3
DV +00.000E-3
DV -00.002E-3
DV -00.003E-3
DV -00.005E-3
DV +00.001E-3
DV -00.000E-3
DV -00.000E-3
```

● Explanation

10: The data area is defined.

20: The 13206A is initialized.

30: The data transmission mode is set to S1, the 2-byte delimiter, CR LF, is set, and the function, range, and sampling are set to DCV, AUTO, and HOLD, respectively.

40: An external start is made.

50: Data is read.

60: The data is indicated (printed).

70: A wait time of about 10 seconds is inserted.

80: Processing returns to line 40.

(3) Externally setting the measuring range of the 2114H from the HP-9825A, externally starting measurement about every second, and reading data using a SRQ.

- Sample program

```
0: dim A$[20]
1: clr 701
2: oni 7,"SRQ"
3: wrt 701,"S0F2
 R0"
4: trg 701
5: eir 7
6: "MAIN TRANSAC
 TION WRITE
  HERE !!":
7: jmp -1
8: "SRQ":rds(7)→
 S:if bit(7,S)=0
 :gto 18
9: if bit(6,rds(
 701)):gto 11
10: gto 18
11: red 701,A$
12: prt A$
13: dsp A$
14: wait 1000
15: trg 701
16: eir 7
17: iret
18: "TRANSACTION
  FOR OTHER INST
 RUMENT!!":
```

- Sample data

```
R    170.49E+3
R    170.50E+3
R    170.50E+3
R    170.50E+3
R    170.50E+3
R    170.51E+3
R    170.50E+3
R    170.50E+3
R    170.50E+3
R    170.50E+3
R    170.49E+3
R    170.50E+3
R    170.48E+3
R    170.49E+3
R    170.50E+3
R    170.49E+3
R    170.48E+3
R    170.48E+3
R    170.51E+3
R    170.51E+3
R    170.50E+3
R    170.49E+3
```

- Explanation

0: The data area is defined.

1: The 13206A is initialized.

2: An interrupt processing routine is defined.

3: The data transmission mode, function, and range are set to S0, OHM, and AUTO, respectively.

4: An external start is made.

5: An interrupt is enabled.

6 to 7: The main routine is inserted.

8: Whether the interrupt is from port 7 to which the 13206A is connected is checked. If it is from port 7, processing advances to the next line; otherwise processing branches to line 18.

9: Whether the interrupt is from the 13206A is checked. If it is from the 13206A, processing jumps to line 11; otherwise processing advances to the next line.

10: Processing branches to line 18.

11: Data is read.

12: The data is printed.

13: The data is indicated.

14: A wait time of about 1 second is inserted.

15: An external start is made.

16: An interrupt is enabled.

17: Processing returns to the main routine.

18: Interrupts from other devices are processed.

(4) Externally setting the measuring function and measuring range of the 2114H from the HP-9845B, externally starting measurement about every 0.1 second, and reading data using an SRQ.

● Sample program

```
10    DIM A$[20]
20    ON INT #7 GOSUB Srq
30    CLEAR 701
40    OUTPUT 701;"S0F2R0"
50    CONTROL MASK 7;128
60    TRIGGER 701
70    CARD ENABLE 7
80    ! MAIN TRANSACTION WRITE HERE!!"
90    GOTO 80
100 Srq:  STATUS 701;S
110   IF S<>65 THEN 180
120   ENTER 701;A$
130   PRINT A$
140   WAIT 100
150   TRIGGER 701
160   CARD ENABLE 7
170   RETURN
180   !  TRANSACTION FOR OTHER INSTURUMENT!!"
190   RETURN
200   END
```

● Sample data

```
R    170.49E+3
R    170.50E+3
R    170.50E+3
R    170.48E+3
R    170.49E+3
R    170.50E+3
R    170.49E+3
R    170.49E+3
R    170.47E+3
R    170.49E+3
```

● Explanation

10: The data area is defined.

20: An interrupt processing routine is defined.

30: The 13206A is initialized.

40: The data transmission mode, function, and range are set to S0, OHM, and AUTO, respectively.

50: An interrupt by a SRQ signal is enabled.

60: An external start is made.

70: An interrupt from the GPIB is enabled.

80 to 90: The main routine is inserted.

100: The interrupt routine name, 13206A, is polled, and the status is read.

110: If the interrupt is not from the 13206A , processing branches to line 180.

120: Data is read.

130: The data is indicated (printed).

140: A wait time of about 0.1 second is inserted.

150: An external start is made.

160: An interrupt from the GPIB is enabled.

170: Processing returns to the main routine.

180: Interrupts from devices other than the 13206A are processed.

190: Processing returns to the main routine.

Note: See Section 8-5 "Remote Programming" for the program codes.

(5) When the measurement function, sensor type, unit, standard contact, scan channel, and GPIB output format are set externally by HP-9845B and data are read

● Sample program

```
10    CLEAR 701
20    OUTPUT 701;"S1DL0F3M1A1"
30    OUTPUT 701;"P3,3,0,0,0"
40    OUTPUT 701;"P6,1,10"
50    OUTPUT 701;"P7,1"
60    TRIGGER 701
70    FOR N=1 TO 10
80    ENTER 701;A$
90    PRINT A$
100   NEXT N
110   GOTO 60
120   END
```

● Sample data

```
N 01,TC +0030.0E+0
N 02,TC +0030.0E+0
N 03,TC +0030.0E+0
N 04,TC +0030.0E+0
N 05,TC +0030.0E+0
N 06,TC +0030.0E+0
N 07,TC +0030.0E+0
N 08,TC +0030.1E+0
N 09,TC +0030.0E+0
N 10,TC +0030.1E+0
N 01,TC +0029.9E+0
N 02,TC +0030.0E+0
N 03,TC +0030.0E+0
N 04,TC +0029.9E+0
N 05,TC +0030.0E+0
N 06,TC +0030.0E+0
N 07,TC +0030.0E+0
N 08,TC +0030.0E+0
```

● Program description

10: 13206A is initialized.

20: The data sending mode is set to "S1", the delimiter to a two-byte "CR LF", the function to "TC", and the sampling to "HOLD". The auto-scan mode is also set.

30: The TC function (P3) sensor is set to K (3), the unit to ^{o}C (0), and the standard contact to the internal standard contact (0). No computation (0) is also set.

40: The 19001 scan channel (P6) is set to channels 1 to 10.

50: The presence of channel data is set in the GPIB output format (P7).

60: The external start is made.

70: Processing is repeated from here to "NEXT N" ten times.

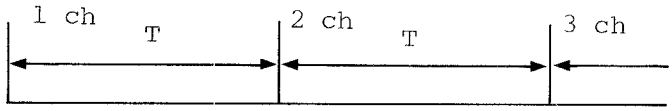
80: Data is read.

90: Data is printed.

100: Processing returns to 70 before 10 repetitions are completed. When 10 repetitions are completed, processing returns to the next line.

110: Processing returns to 60.

● Measurement timing



T: 110 to 230 ms

T is longer by about 1 second at the time of the internal calibration cycle.

SECTION 9

21141 INPUT BLOCK

9-1. INTRODUCTION

The 21141 Input Block is an input terminal block incorporated in the 2114H as a standard accessory for normal measurements. It is a binding post type terminal which permits the use of banana plugs, arrow tips, wires, etc. This input block also enables resistance measurements by the 3- and 4-wire methods.

9-2. SPECIFICATIONS

Maximum voltage appliable between input terminals: 220 Vdc, 220Vrms ac
Insulation resistance: 2000 MΩ or more
Operating temperature: 0 to +50°C
Weight: Less than 160 g

9-3. OPERATING PROCEDURE

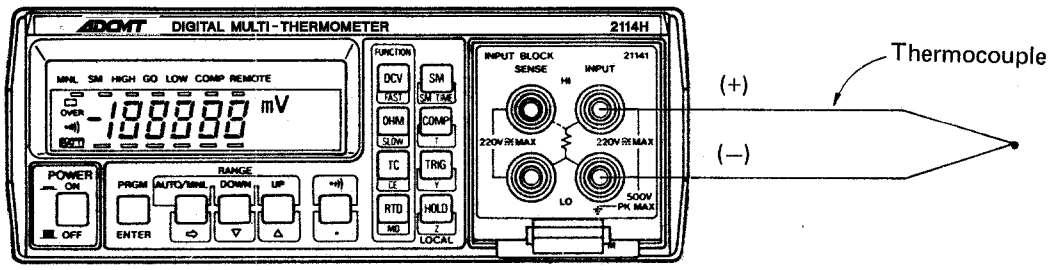


Fig. 9-1 Connection example with 21141

Install the 21141 in the 2114H, and turn the POWER switch on. For normal measurements, connect the input cables (for example, from a temperature sensor) to the HI and LO terminals on the INPUT side (see Figure 9-1). For resistance measurements or temperature measurements (to be made using an RTD) by the 3-wire method, connect the input cables to the HI and LO terminals on the INPUT side, and the LO terminal on the SENSE side. If the 4-wire method is to be used, connect the input cables to the HI and LO terminals on both the INPUT and SENSE sides. (See Figure 3-7.) To remove the input block, turn the POWER switch off, then pull the input block out by its bottom catch.

Note: At the time of shipping, this epuipment has been calibrated by connecting to input cable A01007. When using a different type cable for two-wire resistance measurement, the difference between these two cable resistances will affect measured values.

SECTION 10

21142 INPUT BLOCK

10-1. INTRODUCTION

The 21142 Input Block is a high-accuracy input terminal for temperature measurement. This input block can also be used as a 2-channel selector to measure the potential difference or temperature difference between two channels.

10-2. SPECIFICATIONS

Input terminals: Two terminals for two-wires; fixed with horizontal screws (M4)

Functions: 2-channel measurement; difference measurement

CH A:

DC voltage measurement: 20 mV, 200 mV, and 2000 mV ranges

Temperature measurement using a thermocouple

CH B:

DC voltage measurement: 20 mV, 200 mV, 2000 mV, 20 V, and 200 V ranges

Temperature measurement using a thermocouple

Resistance measurement, and temperature measurement using an RTD (2-wire method only)

A-B:

DC voltage measurement: 20 mV, 200 mV, and 2000 mV ranges

Indication of voltage difference between CH A and CH B in the same range.

Thermocouple temperature: Measurement of temperature difference between two thermocouples of the same type.

Weight: Less than 120 g

10-3. OPERATING PROCEDURE

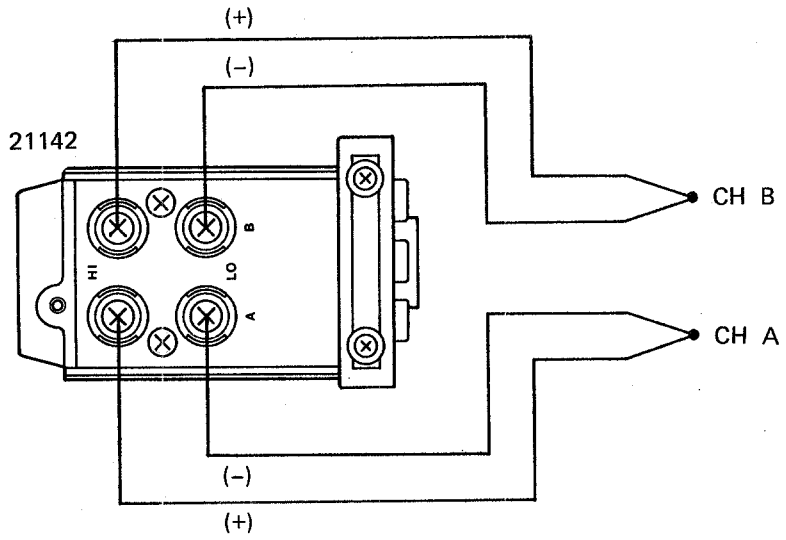


Fig. 10-1 Connection example with 21142

Connect the input cables to the HI and LO terminals of the 21142 through the hole in the front. Install the 21142 to which the input cables have been connected in the 2114H, and turn the POWER switch on. Press the desired channel key and the value measured on the channel is indicated.

10-4. NOTES ON OPERATION

(1) If the 20 or 200 V range is set for channel A or A-B, an error indication is given, and the channel setting is automatically switched to B.

(2) Channel A-B is used to indicate the difference between the values measured on channels A and B. Automatic range shifting is performed according to the input to channel B.

(3) The LO inputs to channels A and B are internally connected.

(4) If the value obtained in measurement on channel A-B exceeds the maximum value, 19999, an OVER indication is given.

(5) Since this equipment for two-wire resistance measurement has been calibrated by using 21141, the maximum 0.3Ω, internal resistance must be added to the resistance values measured.

SECTION 11

19001 AUTO CHANNEL SELECTOR AND 21143 INPUT BLOCK

11-1. INTRODUCTION

The 19001 Auto Channel Selector is a channel selector which enables voltage measurement, resistance measurement, and temperature measurement (using a thermocouple or an RTD) on up to 10 channels. The 21143 Input Block is an input terminal block used to connect the 19001 to the 2114H. Since up to four 19001 units can be connected to the 2114H, channel switching can be performed between up to 40 channels.

11-2. SPECIFICATIONS

19001 Auto Channel Selector

Number of channels: 10 (5 for 3- and 4-wire method)
Up to four units can be connected to use a total of up to 40 channels.

Channel specification: Shifting is possible using the UP and DOWN keys.
When the 13206A is used, the channel specification can be controlled externally.
When automatic scanning is performed, the specified channels are scanned to make measurements in the specified sampling period.

Input signal:

DC voltage: ±20 mV, ±200 mV, ±2000 mV, and ±20 V ranges

Resistance: 200 Ω, 2000 Ω, 20 kΩ, 200 kΩ, and 2000 kΩ ranges using 2-, 3-, or 4-wire method

Thermocouple: Dependent on the 2114H
(Internal reference junction compensation is possible.)

Resistance temperature detector: Using 2-, 3-, or 4-wire method

Interchannel error: 3 μV or less

Maximum voltage appliable between input terminals: 120 Vdc,
120 Vrms ac
Insulation resistance: 100 MΩ or more between channels
Signal path resistance: 1 Ω or less per unit
Reference junction temperature compensation: Temperature measurement compensation at the terminal section based on the specification of the internal reference junction compensation for measurement using a thermocouple (Compensation accuracy: ±1.0°C including temperature distribution in the terminal strip)
External dimensions: About 185 (W) x 42 (H) x 257 (D) mm
Weight: Less than 1.4 kg

21143 Input Block

This is an input terminal block to be installed in the 2114H to connect the 19001 Auto Channel Selector to the 2114H.
Weight: Less than 110 g

11-3. PRECAUTIONS

Since the measurement of temperatures and very small voltages is affected by thermoelectromotive forces, avoid using these instruments in places exposed to strong heat radiation or the direct wind. Do not apply a voltage exceeding 20 V; inputting such a high voltage may cause a malfunction or failure.

11-4. OPERATING PROCEDURE

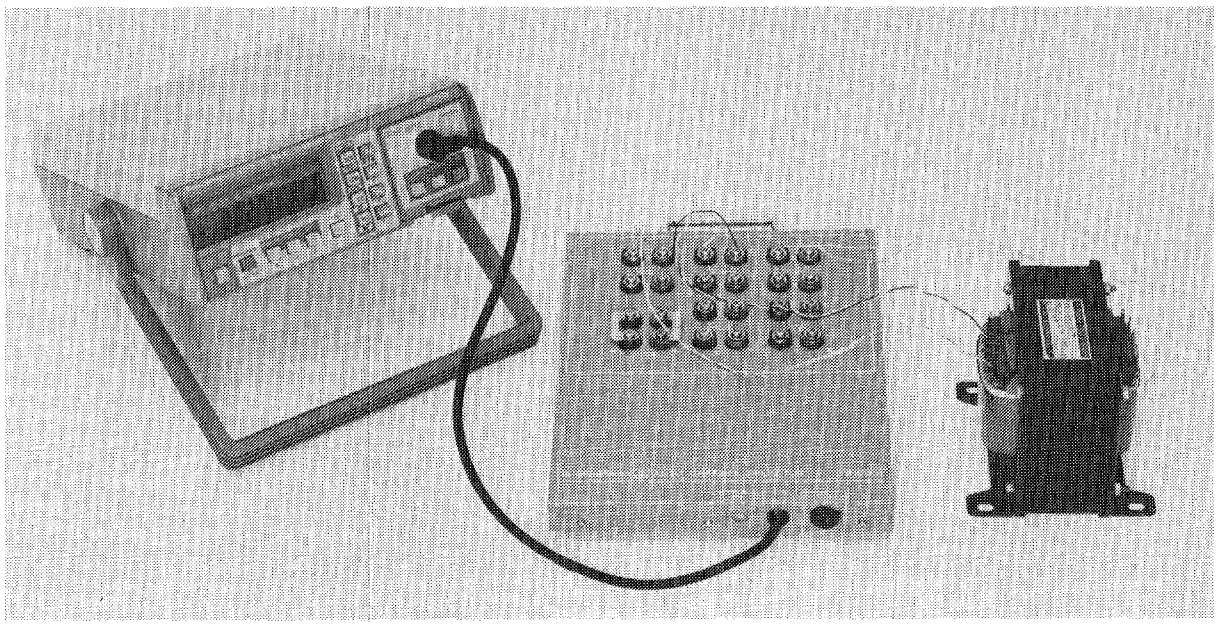


Fig. 11-1 Connection example with 19001 and 21143

① Install the 21143 in the 2114H, and connect the 19001 connection cable to the 21143.

② Interconnect the + terminals of AD IN. and MPX OUT., and also interconnect their - terminals with short bars.

③ Set the TERMINAL NO. switch of the 19001 to a number between 0 and 3 according to the number of channels. (See the table below.)

TERMINAL No.	Scan channel DCV,TC,OHM(2W),RTD(2W)	Scan channel OHM(3W,4W),RTD(3W,4W)
0	1 to 10	1 to 5
1	11 to 20	11 to 15
2	21 to 30	21 to 25
3	31 to 40	31 to 35

Note: Two or more 19001 units cannot be operated together with their TERMINAL NO. switches set to the same number. The maximum of four 19001 units can be connected to one 2114H.

④ Connect the input cable to the terminal of the selected channel. When using a thermocouple, be sure to observe the correct polarity. When measurement is made by the 3- or 4-wire method, the maximum of five channels can be handled by one 19001 unit.

⑤ Specify the channels to be scanned on the 2114H.

⑥ Press the AUTO key of the 21143 to start scanning.
Pressing it again stops the scanning.
See Section 3-9-12 for the procedures for setting the first and last channels to be scanned.
To make measurements on a fixed channel, set the channel using the UP or DOWN key.
Channel selection cyclically changes through the channels set on the 2114H.

⑦ When the preceding steps are taken, measuring starts.

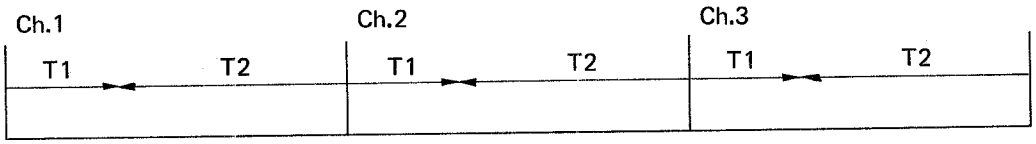
Note: The channel sequence is not guaranteed, if function or range is set during automatic scanning.

⑧ With automatic scanning, smoothing is not performed.

⑨ When setting the TERMINAL NO. switch, make sure that the unit is not powered.

Figure 11-2 shows the timing of measurements made with the 19001 connected.

a. DCV (MNL range), or TC measurement in AUTO scan mode (with 2114H set to FAST mode)



Channel relay operation (T1): 40 ms
Measurement operation (T2): 50 to 80 ms
Scanning interval: 90 to 120 ms

b. AUTO range operation in AUTO scan mode (with 2114H set to FAST mode)
Input to channels 1 and 2: 10 mV
Input to channel 3: 18 V

( ): Measuring range

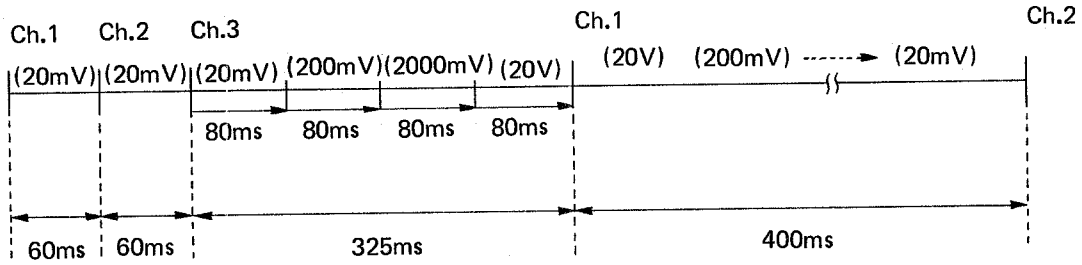
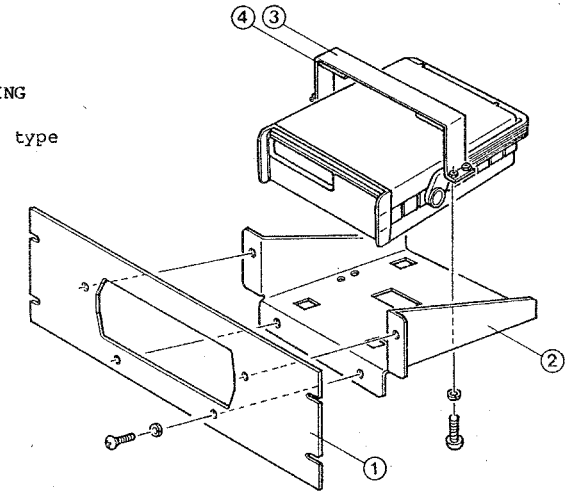


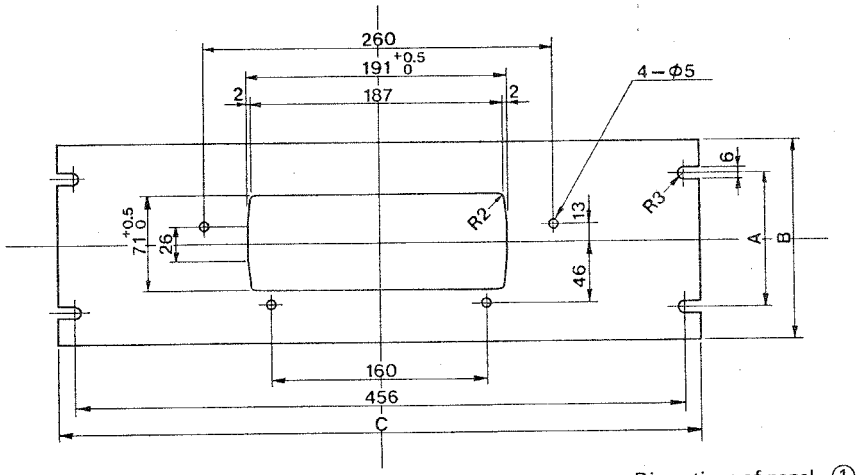
Fig. 11-2 Timing of measurements made with 19001 connected

APPENDIX

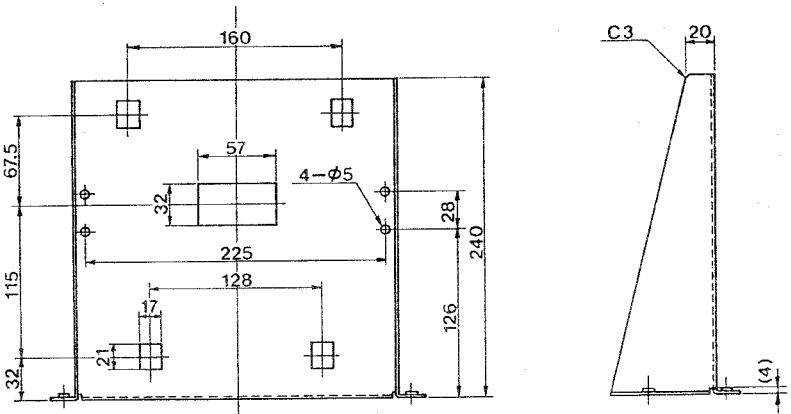
A.1 RACKMOUNTING

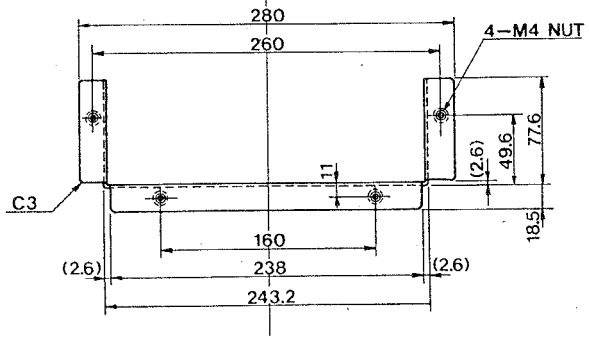
(1) For single type



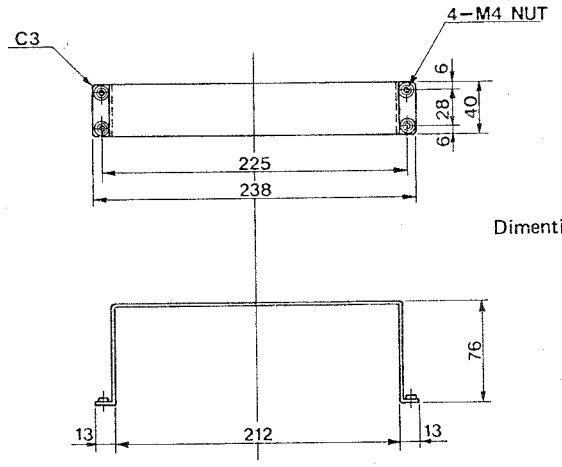


Dimentions of panel ①





Dimentions of chassis ②

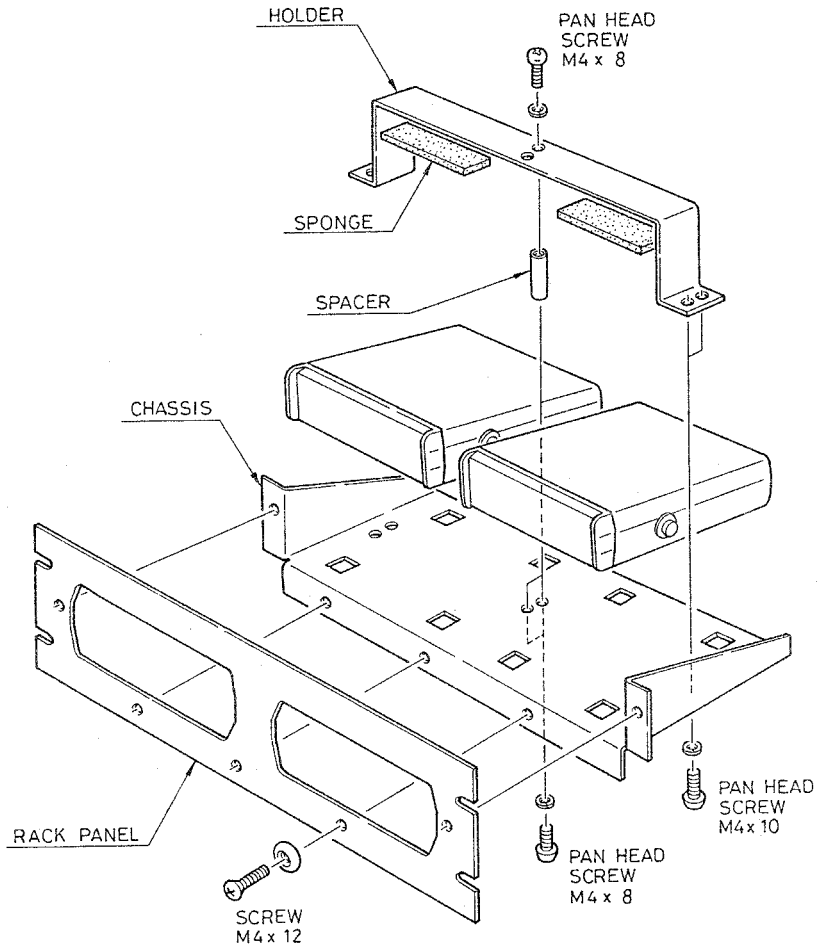


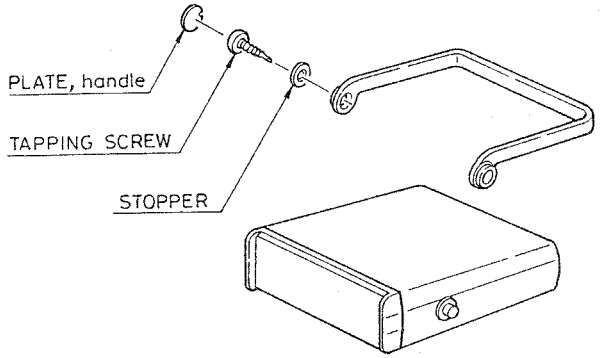
Dimentions of holder ③

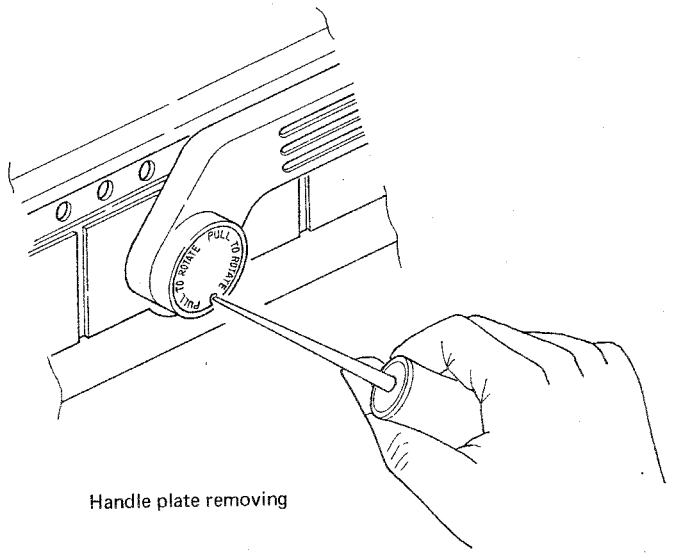
All dimentions in mm

Name	Stock No.	A	B	C
Chassis	9992−062			
Rackmounting panel (EIA specifications)	9992−182	89	132	482
Rackmounting panel (JIS specifications)	9992−183	100	149	480

(2) For double type

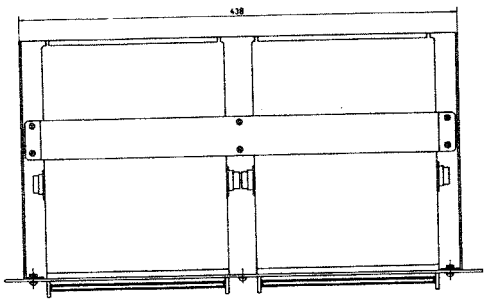




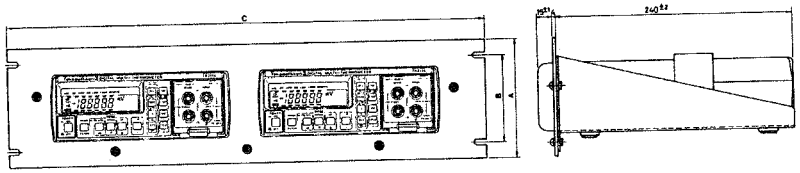


Handle plate removing

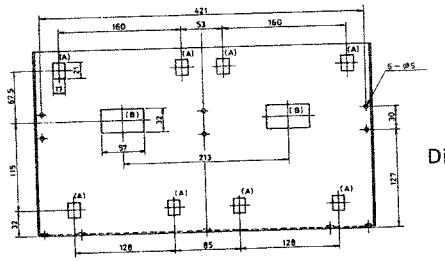
A.2 DIMENTIONS

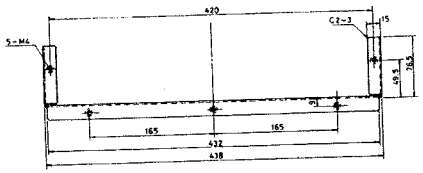


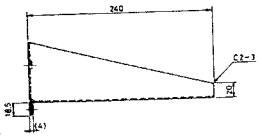
External view of
twin type rack mount



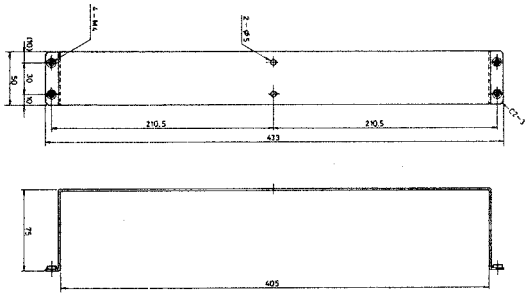
Dimentions of chassis ②



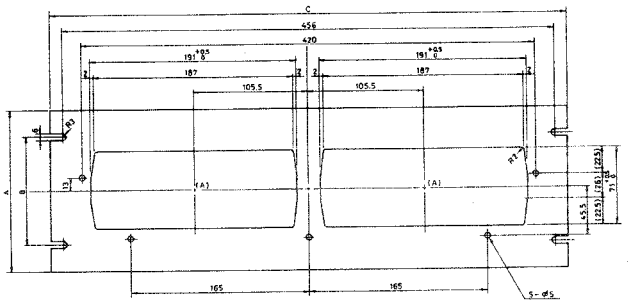




Dimentions of holder ③

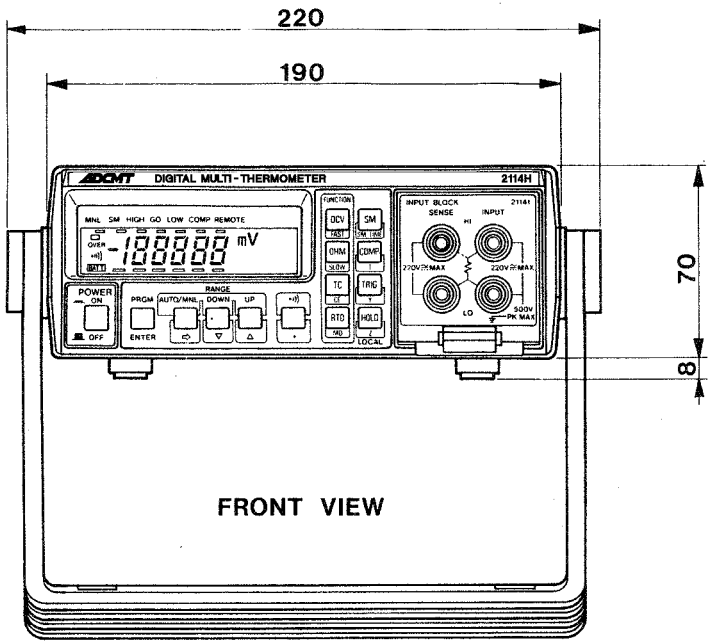


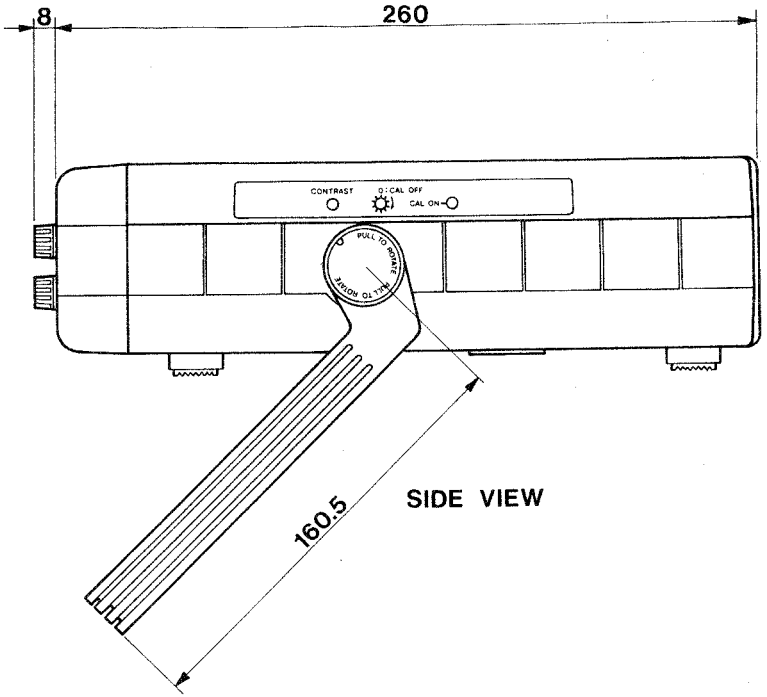
Dimentions of panel ①

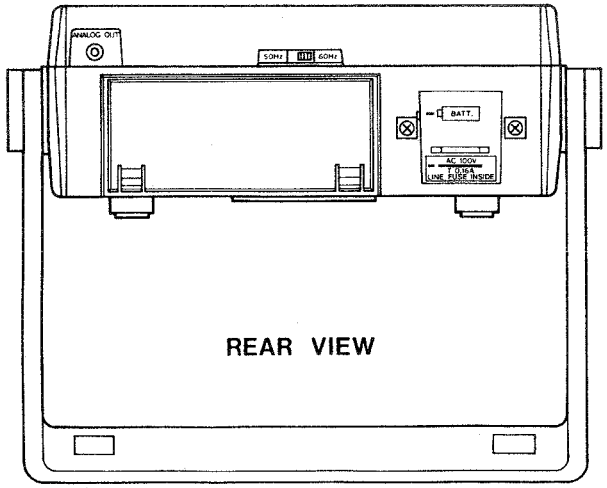


All dimentions in mm

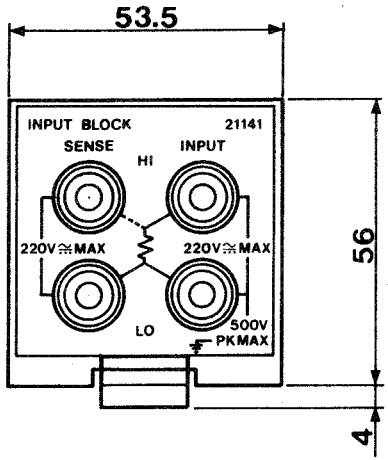
Name	Stock No.	A	B	C
Panel mounting **kit** ① + ②	A02018			
Rackmounting **kit** ① + ② + ③ (EIA specifications)	A02425	132	89	482
Rackmounting **kit** ① + ② + ③ (JIS specifications)	A02228	149	100	480



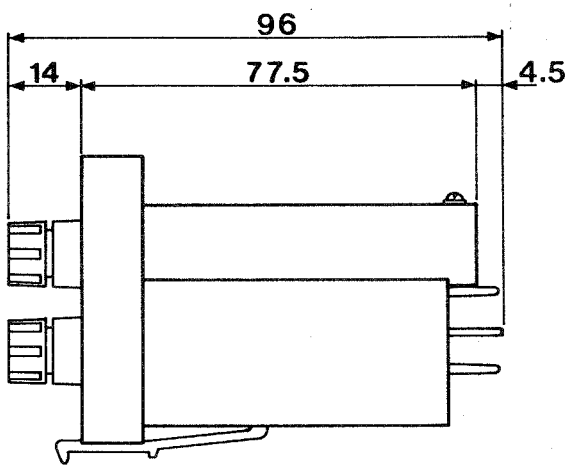




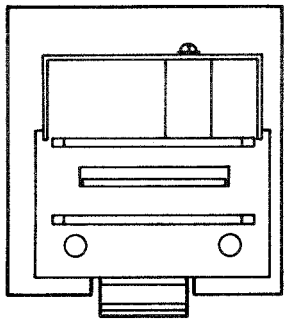
2114H
EXTERNAL VIEW



FRONT VIEW

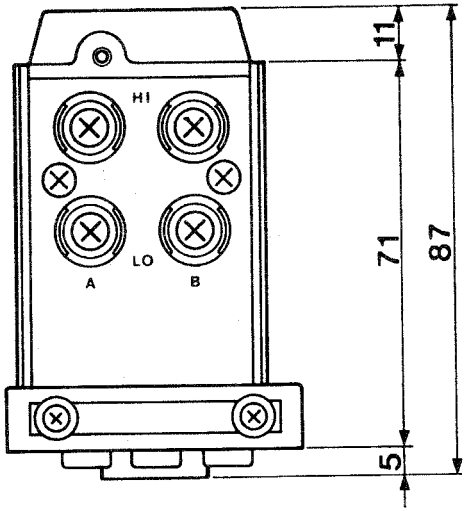


SIDE VIEW

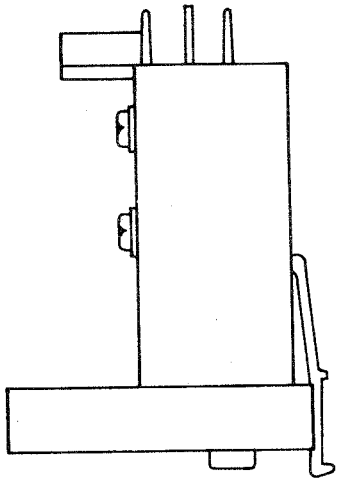


REAR VIEW

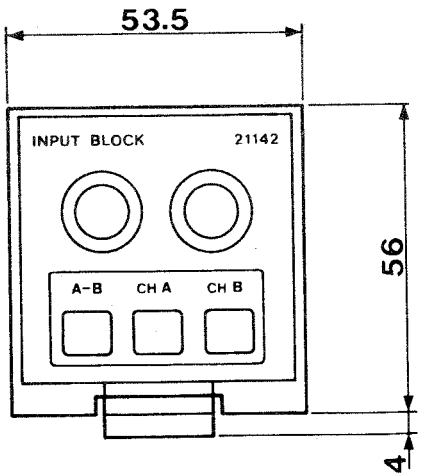
21141
EXTERNAL VIEW



TOP VIEW

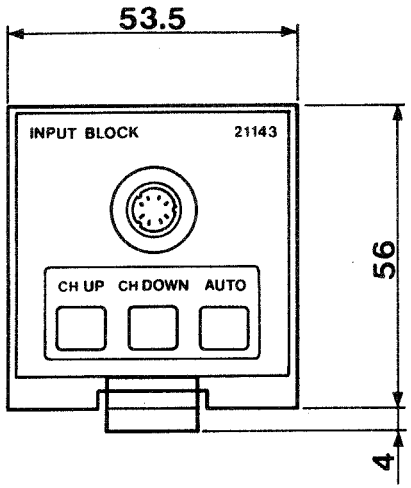


SIDE VIEW

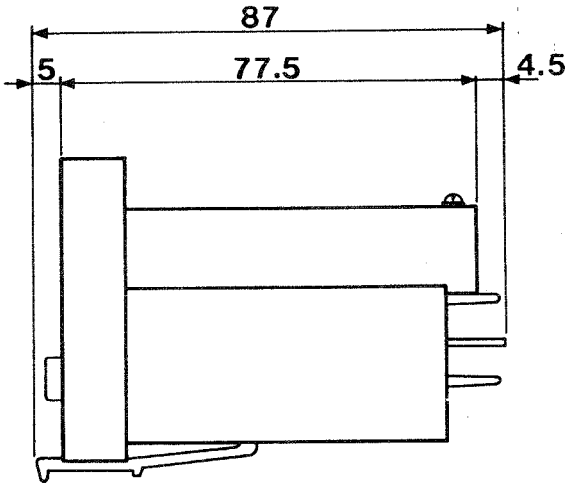


FRONT VIEW

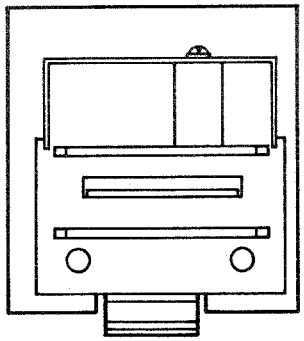
21142
EXTERNAL VIEW



FRONT VIEW



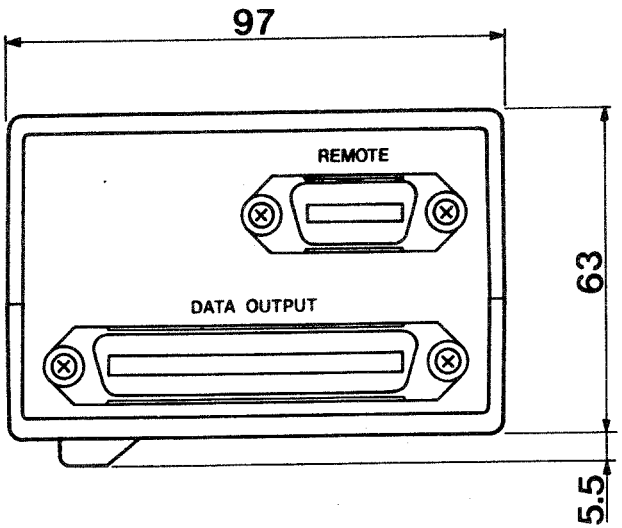
SIDE VIEW



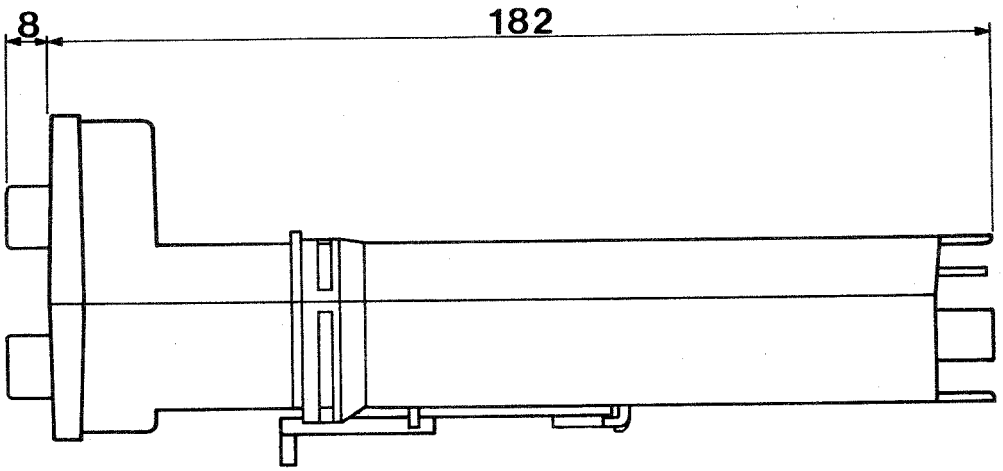
REAR VIEW

21143

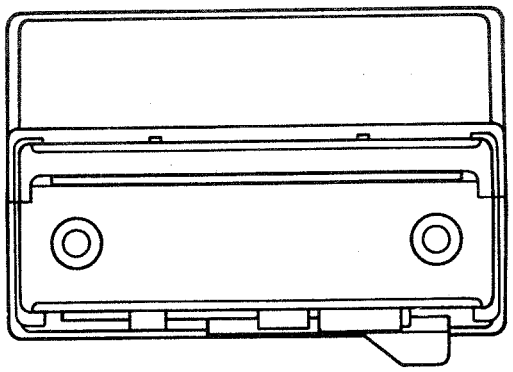
EXTERNAL VIEW



FRONT VIEW

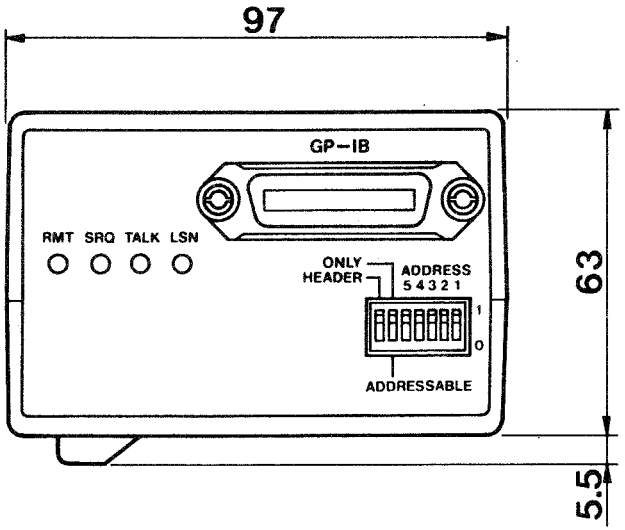


SIDE VIEW

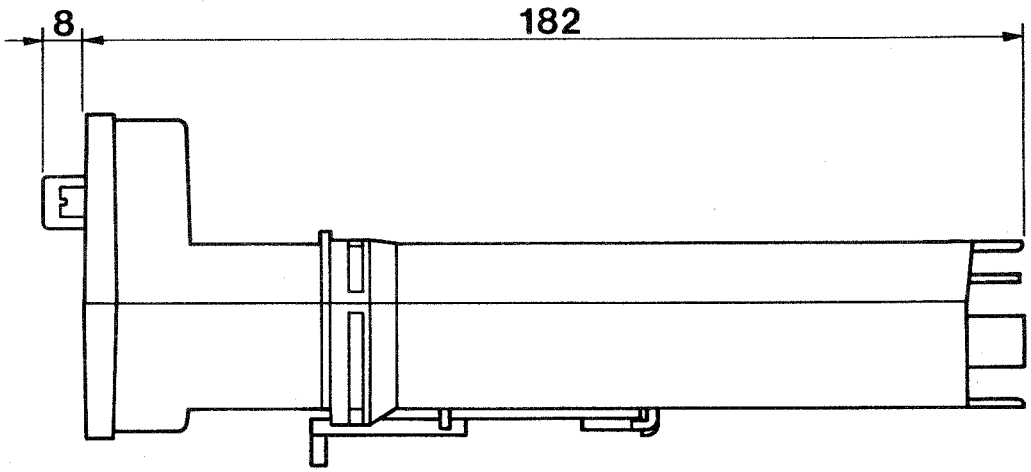


REAR VIEW

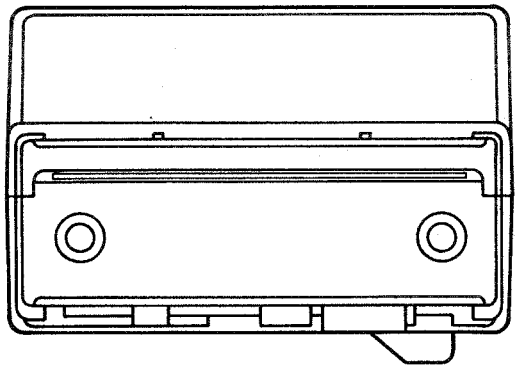
TR13003
EXTERNAL VIEW



FRONT VIEW

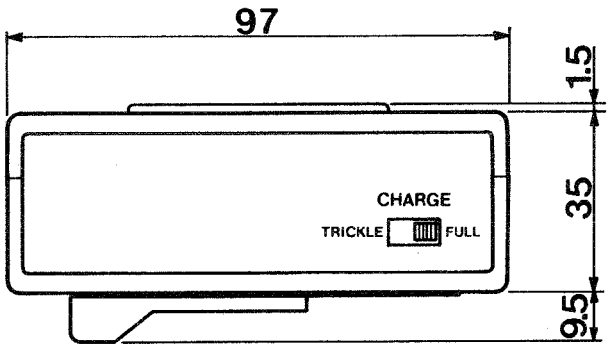


SIDE VIEW

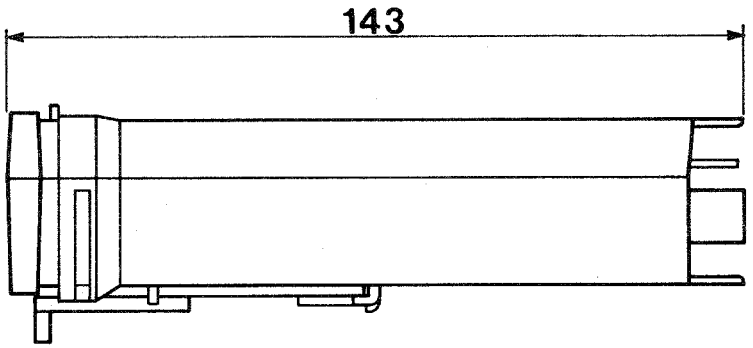


REAR VIEW

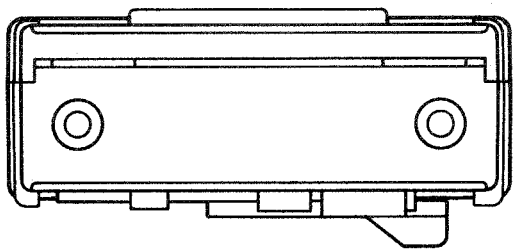
13206A
EXTERNAL VIEW



FRONT VIEW

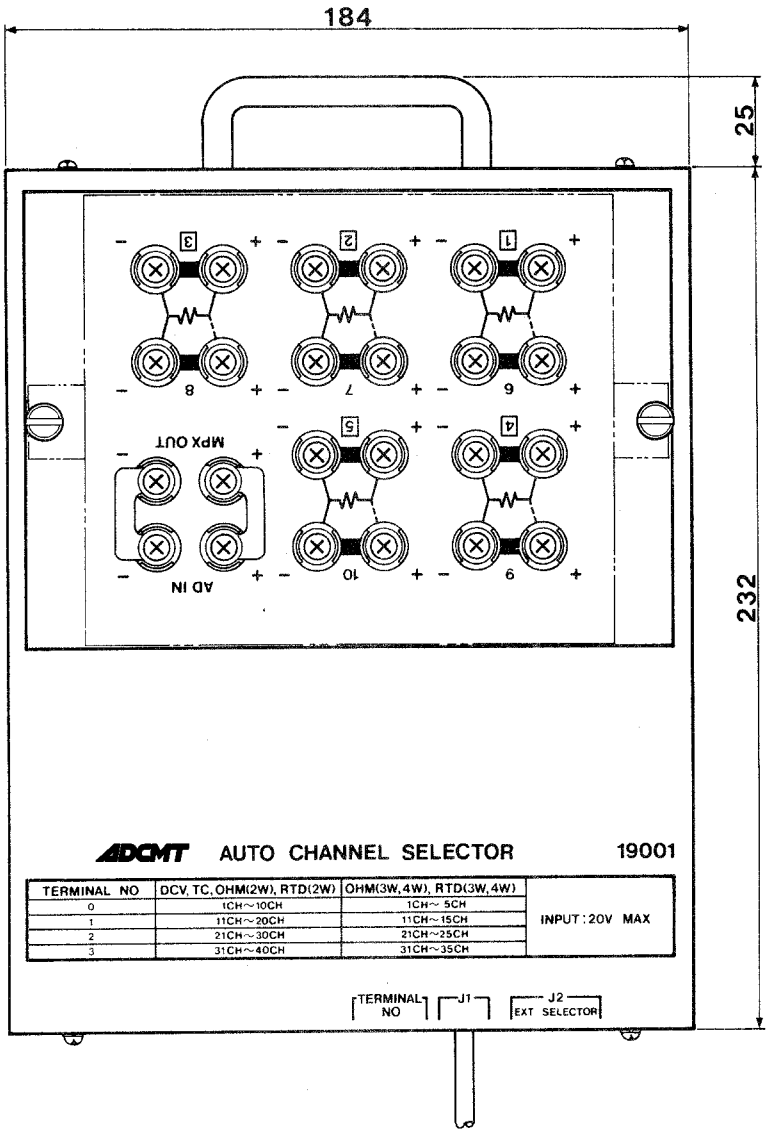


SIDE VIEW



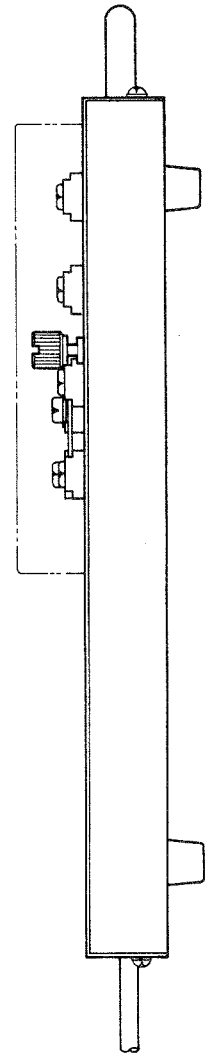
REAR VIEW

TR15802
EXTERNAL VIEW

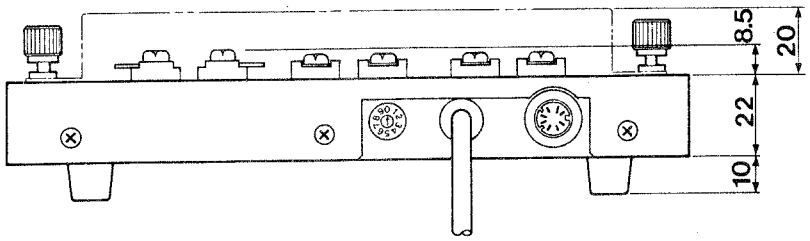


TERMINAL NO	DCV, TC, OHM(2W), RTD(2W)	OHM(3W,4W), RTD(3W,4W)	
0	1CH~10CH	1CH~ 5CH	INPUT : 20V MAX
1	11CH~20CH	11CH~15CH	
2	21CH~30CH	21CH~25CH	
3	31CH~40CH	31CH~35CH	

TOP VIEW



SIDE VIEW



FRONT VIEW

19001
EXTERNAL VIEW

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2. The warranty period for the Product (the "Warranty Period") will be a period of one year commencing on the delivery date of the Product.

3. If the Product is found to be defective during the Warranty Period, ADC CORPORATION will, at its option and in its sole and absolute discretion, either (a) repair the defective Product or part or component thereof or (b) replace the defective Product or part or component thereof, in either case at ADC CORPORATION's sole cost and expense.

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   (b) any improper or inadequate handling, carriage or storage of the Product by the Purchaser or any third party (other than ADC CORPORATION or its agents);

   (c) use of the Product under operating conditions or environments different than those specified in the Operation Manual or recommended by ADC CORPORATION, including, without limitation, (i) instances where the Product has been subjected to physical stress or electrical voltage exceeding the permissible range and (ii) instances where the corrosion of electrical circuits or other deterioration was accelerated by exposure to corrosive gases or dusty environments;

   (d) use of the Product in connection with software, interfaces, products or parts other than software, interfaces, products or parts supplied or recommended by ADC CORPORATION;

   (e) the occurrence of an event of force majeure, including, without limitation, fire, explosion, geological change, storm, flood, earthquake, tidal wave, lightning or act of war;

   (f) any negligent act or omission of the Purchaser or any third party other than ADC CORPORATION; or

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

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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.

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(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

77-1, Miyako, Namegawa-machi, Hiki-gun, Saitama 355-0812, Japan