HIOKI

3191

DIGITAL POWER METER

INSTRUCTION MANUAL

HIOKI E.E. CORPORATION

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⚠ WARNING

This instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurement. Failure to follow directions can result in a serious or fatal accident.

Introduction

HIOKI wishes to thank you for purchasing this 3191 Digital Power Meter, and hope that your will contact either your vendor or us directly if you have any comments, suggestions or complaints regarding this or other HIOKI products.

To get the maximum performance from this meter, as well as assure the longest possible service life, please read this manual thoroughly before use. In addition, please observe the following precautions for safety and optimum application of the many functions provided.

Inspection

Once this product has been delivered, please inspect it carefully to ensure that it has not been damaged in transport. Examine the panel-mounted switches and terminals especially carefully. Contact your vendor or HIOKI at once if there is any damage, or if the unit does not function as it should.

Precautions in transport

If this equipment is transported, please pack it securely in the original shipping cartons. If the original material is no longer available, follow the procedure outlined below:

1. Wrap the unit well in vinyl.
2. Use a corrugated cardboard box at least 7mm. in thickness, and protect the equipment with cushioning material at least 100mm. thick on all sides.
3. After cushioning the equipment thoroughly, insert the accessories into the same carton, pack the remaining space with cushioning, and tape the carton shut. If required, the outside of the carton should be secured with packing rope.

Precautions in use

1. Never make any connections to the 3191 before verifying that the measurement line has no voltage present in it.
2. PT and CT input is supported, but DC cannot be transmitted. As a result, signals carrying DC components (full-wave rectified signals, half-wave rectified signals, etc.) cannot be measured with this equipment.
3. Values for reactive power (var), apparent power (VA), and power factor (PF) are calculated by the 3191 from voltage (V), current (A) and active power (W) using the equations given below. For this reason, equipment making measurements based on different principles or equations may display differing results.
4. Determinations of lead/delay for invalid power and power factor are handled by comparison of voltage and current phases, and accurate determination may be impossible for input waveforms with significant distortion.
5. Applying excessive input may damage the unit or cause malfunction.
6. This instruction manual applies to the 3191 version 2.10 , and includes descriptions of functions that do not operate with units of old versions. The version number is displayed on display block b during self-test.

1. Outline

The addition of input units to the 3191 will enable it to handle direct input of up to four lines, from single-phase to three-phase. Based on the fundamental measurements of voltage, current and power, the 3191 provides a wide array of calculated data (reactive power, apparent power, power factor calculations, voltage and current integration) and analog outputs.

The 3191 is also designed for system use, supporting GP-IB recording and management functions.

2. Special features

1. Measurement of various line types

Addition of input units can expand 3191 capabilities from a single channel to two or three channels, providing measurement support for single-phase two-wire, three-phase three-wire, and three-phase four-wire configurations. For unbalanced 3-phase 3-wire lines, more accurate apparent power and power factor can be obtained by using the 3V3A mode.

2. Simultaneous measurement of all measurement items

The voltage, current and active power values for each channel are captured with the sample hold circuit and A/D converted to ensure that simultaneous measurement of all parameters including reactive power, apparent power and power factor is possible without any time lag.

3. PT and CT ratio calculation

For measurement with an external PT or CT, the ratio can be specified in advance for direct reading of voltage, current, and active power.

4. Analog output of voltage, current and active power standard

Voltage, current and active power output for each channel is standard, supporting data recording.

5. True/mean voltage and current value select

Voltage and current displays may be set to either true value or mean value displays, enabling the user to adjust the rectification method depending on the exact application.

6. Average value display of voltage, current, and power

The measured values of voltage, current or power can be averaged according to the preset number of measurements or preset period of time. The apparent power, power factor and reactive power are calculated from these average values.

7. Realtime control

It is possible to start integration, averaging, and interval printing at a preset time.

8. Backup

The settings and integrated values will be held by the built-in battery when the power is turned off. If power failure occurs during integration, averaging, or interval printing, the operation will be resumed when the power is restored.

9. Rich array of internally-mounting options

- Input unit

  9484 Direct input unit (10Hz to 10kHz)
  9485 Broad band input unit (10Hz to 30kHz)
  9486 Clamp unit (5Hz to 50kHz)

These units can be selected and combined as necessary. Up to three of them can be built into the main unit (a clamp sensor is required for the 9486.)

- Clamp sensor

  9270 (Rated 20A 5Hz to 50kHz)
  9271 (Rated 200A 5Hz to 50kHz)
  9272 (Rated 20A/200A 5Hz to 10kHz)

These sensors offer excellent frequency characteristics (for use in combination with the 9486, or independently.)

9480 Printer unit - Enables printed output of any selected measurement items.

9482 GP-IB interface - Enables full remote control operation, with the exception of the power switch.

9483 Integrator interface - Enables simultaneous integration of any three current or active power values on specified channels.

9481 D/A output interface - Enables analog output of average voltage and current, and any three specified calculated data, including reactive power, apparent power, power factor and integrated values (integration requires the 9843 unit).

3. Specifications

The measurement range and accuracy are determined by optional equipment. Refer to the specifications in section [II. Options].

3-1 General specifications

Sampling rate	Approx. 2.5 times/sec
Resolution of A/D conversion	0.05% of the range (polarity + 11 bits)
Analog output	2 VDC full scale for V,A,W,W1+W2,W1+W2+W3 of each channel Monitor output 2 Vrms/f.s. for V and A of each channel
External control	Start and stop of integrator (with option added) A/D trigger (sampling start during hold) Printing start (with option added)
Operating environment	0°C to 40°C (Less than 80% RH; no condensation)
Power supply	85 to 250 VAC, 45 to 66 Hz
Power consumption Note 1)	Max. 80 VA, 100 V, 60 Hz (with full options) Approx. 42 VA at initial state
Dimensions	Approx. 133(H)×430(W)×400(D)mm(not including protrusions)
Weight Note 1)	Approx. 13 kg (with all input units and options)
Accessories	Instruction manual, power cable, 3A-250V midget fuses (5.2 dia. ×20), connector Note 2)
Realtime clock	Accuracy ±100 ppm (25°C)

Note 1) When the 9484 input unit is used.
Note 2) Connector type: ADS-B36LMR (manufactured by Honda-tushin kogyo)

3-2 Functions

Scaling: Displaying [PT ratio, CT ratio, or scaling constant] x [measured value]. Constant is 0.0001 to 10000.

Average: The number of samples (1 to 100) is set and arithmetic mean value is calculated and displayed.
The time of period (1 min. to 1000 hours) is set and values measured during that period are averaged and displayed.

RMS/MEAN: It is possible to select true effective value display and mean rectified value display.

Ranging: It is possible to select auto-range/manual range.

Overinput: The alarm LEDs (OVER V, OVER A) will light when the peak value of input reaches 2.5 times the range.

Sampling: Continuous and manual sampling (External triggering possible)

Realtime display: Displays the year,month and date, or time, minute and second.

Realtime control: Averaging and the operation of integrator (9483) and printer (9480) are controlled on realtime basis.

Battery backup: The settings displayed on the panel and measurement results of the integrator are backed up. When power failure occurs during averaging, integrating or printing, the operation will be resumed when the power is restored.

Load factor calculation and printing: When a printer is connected, the load factor is printed after averaging is completed.

Measurement items and equations

		voltage (V)	current (A)	power (W)	apparent power (VA)	reactive power (var)	power factor (PF)	# Integrator(see note) Wh	# Integrator(see note) Ah
CH i (i: 1 ~ 3)		V_i	A_i	W_i	V_iA_i	$s_i\sqrt{(V_iA_i)^2-W_i^2}$	$\frac{s_i\lvert W_i\rvert}{V_iA_i}$	W_ih	A_ih
SUM	1 ϕ	$\frac{1}{N}\Sigma V_i$ (N: No. of units)	$\frac{1}{N}\Sigma A_i$ (N: No. of units)	ΣW_i	ΣV_iA_i	$\Sigma s_i\sqrt{(V_iA_i)^2-W_i^2}$	$\frac{s_u\lvert\Sigma W_i\rvert}{\Sigma V_iA_i}$	ΣW_ih	ΣA_ih
	3 ϕ 3 W	$\frac{1}{2}(V_1+V_2)$	$\frac{1}{2}(A_1+A_2)$	W_1+W_2	$\frac{\sqrt{3}}{2}(V_1A_1+V_2A_2)$	$s_1\sqrt{(V_1A_1)^2-W_1^2}+s_2\sqrt{(V_2A_2)^2-W_2^2}$ (s_1, s_2: LEAD -1, LAG $+1$)	$\frac{s_u\lvert W_1+W_2\rvert}{\frac{\sqrt{3}}{2}(V_1A_1+V_2A_2)}$	$(W_1+W_2)h$ or W_1h+W_2h	A_1h+A_2h
	3 ϕ 3 W (3V 3A)	$\frac{1}{3}(V_1+V_2+V_3)$	$\frac{1}{3}(A_1+A_2+A_3)$	W_1+W_2	$\frac{\sqrt{3}}{3}\Sigma V_iA_i$ $=\frac{\sqrt{3}}{3}(V_1A_1+V_2A_2+V_3A_3)$	$s_1\sqrt{(V_1A_1)^2-W_1^2}+s_2\sqrt{(V_2A_2)^2-W_2^2}$ (s_1, s_2: LEAD -1, LAG $+1$)	$\frac{s_u\lvert W_1+W_2\rvert}{\frac{\sqrt{3}}{3}\Sigma V_iA_i}$	$(W_1+W_2)h$ or W_1h+W_2h	A_1h+A_2h
	3 ϕ 4 W	$\frac{1}{3}(V_1+V_2+V_3)$	$\frac{1}{3}(A_1+A_2+A_3)$	ΣW_i	ΣV_iA_i	$\Sigma s_i\sqrt{(V_iA_i)^2-W_i^2}$	$\frac{s_u\lvert\Sigma W_i\rvert}{\Sigma V_iA_i}$	$(W_1+W_2+W_3)h$ or $W_1h+W_2h+W_3h$	$A_1h+A_2h+A_3h$

Notes

- V_i, A_i and W_i are obtained by analog processing. See the general specifications for the degree of accuracy. Except for
- V_i, A_i, and W_i, accuracies indicated do not include a ±1 dgt display rounding factor. Values other than V_i, A_i, and W_i (which are determined by measurement) are obtained through digital signal processing. With these values, accuracy is within ±1 dgt of that calculated from measured values.
- The SUM value is accurate to within ±3 digits.
- si is -1 with LEAD and +1 with LAG, with the sign indicating the polarity.
- su is -1 when the var SUM value is negative and +1 when it is positive, with the sign indicating the polarity.

Note:

Optional integrator can display up to three items simultaneously for data input into integrator

- The sum of V and A values represents the average.
- Data are processed so that var = 0 and PF = 1 in case VA < | W | due to measurement error and / or unevenness of the load.

4. Internal configuration

The internal configuration of the 3191 is indicated in Fig. 4-1. The section enclosed by the dotted line is optional. Figure 4-2 shows the detailed flow of analog signals.

The voltage and current to be measured are applied to the input unit. The input unit outputs the dc voltage signal in proportion to the voltage, current and power. At the same time, the unit detects the advancing and delay of the phase between the voltage and current, and outputs it to 3191.

The signals from the input unit are all sampled, held and A/D converted at the A/D converter in the 3191. The digital values are then stored in memory temporarily. The apparent power, reactive power, and power factor are calculated based on this data. The polarity of the reactive power and power factor is determined by the phase detection signal from the input unit.

The power and current signals form the input unit is also fed to an integrator interface, selected with the multiplexer and converted into a pulse string with the V/F converter. The number of pulses is counted with the counter of the 3191 unit to convert data into integrated value and display it.

The D/A output interface has a 3-channel D/A converter, which selects three from the calculated apparent power, reactive power, power factor, ampere-hour and watt-hour to convert them into dc currents of 2 V f.s.

The 3191 has adders which add the power signals from the input units to obtain the power (W1+W2) of the 3-phase, 3-wire line and the power (W1+W2+W3) of the 3-phase, 4-wire line.

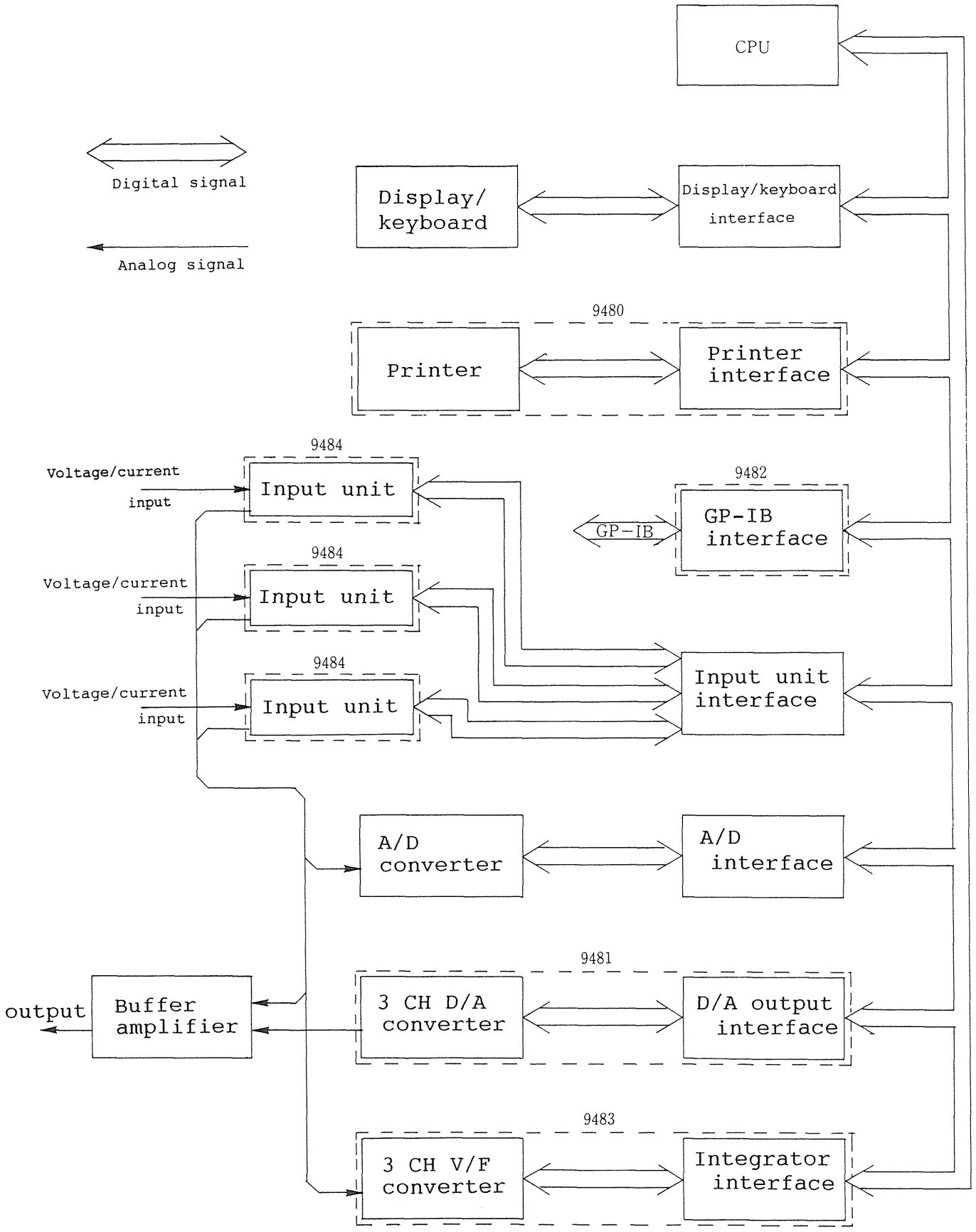


Figure 4-1 - 3191 Configuration and Block Diagram

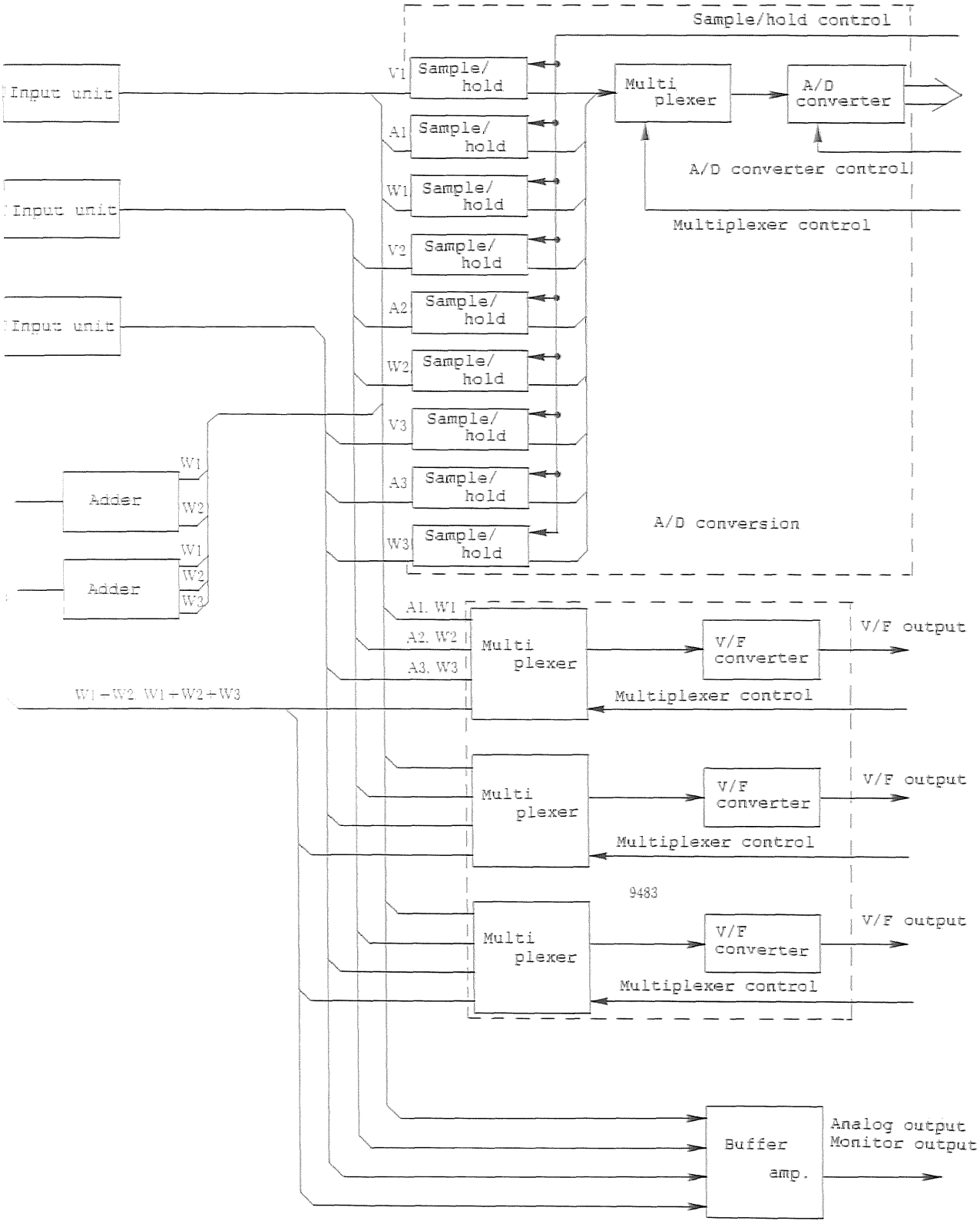


Fig. 4-2 Analog Signal Flow

5. Component names

Refer to the external drawing at the end of the manual for component names. For details on the operation methods, refer to the appropriate section in the text.

5.1 Front panel

1) Power switch

Turns the power to the 3191 on/off.

2) Shift key [SHIFT]

For keys with two functions, such as [MANUAL CONT], pressing the shift key selects the function written at the bottom (in orange). When the [SHIFT] key is pressed the lamp flashes to notify the user that the keyboard is in the shift mode. When the next key is pressed, that function will be selected and the shift mode canceled (the lamp will go out).

3) Filter key [FILTER]

This turns the phase detect circuit filter on/off. Pressing the [FILTER] key will cause the lamp to light and turn on the filter. Pressing a second time will turn both off.

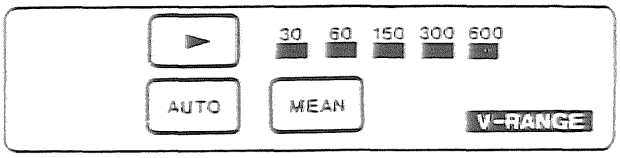
4) Mode key [MODE]

Pressing [SHIFT] and [MODE] keys will allow selection of single-phase tow-wire, three-phase three-wire or three-phase four-wire measurement. The lamp for the selected mode will light or start flashing intermittently.

5) Sampling hold key [MANUAL CONT]

Pressing the [MANUAL CONT] key will hold the data and allow manual measurement. In the data hold status, the HOLD lamp will light. Pressing [SHIFT] and [MANUAL CONT] keys will return the system from manual measurement to normal continuous measurement.

6) Voltage range set



7) Range key : [►]

Pressing [►] will increase the range setting by one, and light the selected range. Pressing [SHIFT] and [►] keys will lower the selected range by one.

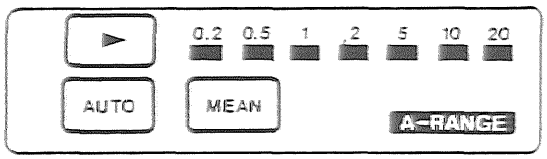
8) Autorange key : [AUTO]

Pressing the [AUTO] key will light the lamp, and set the V range automatically.

9) Mean/effective key : [MEAN]

Pressing the [MEAN] key will light the lamp and display the mean rectified effective voltage. When the lamp is out the true effective value is displayed.

10) Current range set



11) Range key [►]

Pressing [►] will increase the range setting by one, and light the selected range. Pressing [SHIFT] and [►] keys will lower the selected range by one.

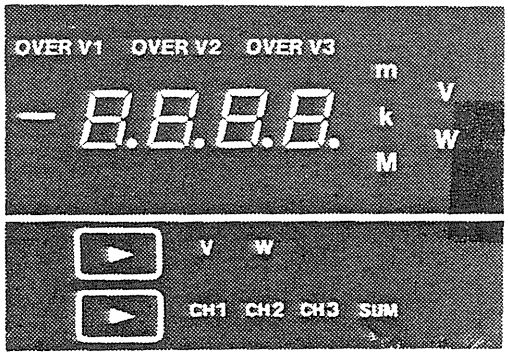
12) Autorange key : [AUTO]

Pressing the [AUTO] key will light the lamp, and set the A range automatically.

13) Mean/effective key : [MEAN]

Pressing the [MEAN] key will light the lamp and display the mean rectified effective current. When the lamp is out the true effective value is displayed.

14) Display block a

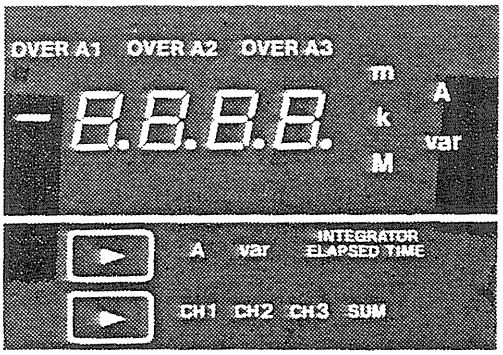


15) Function key a : ►

16) Channel key a : ►

Display block a can display either the voltage (V) or the power (W). The channels and functions indicated can be selected with this key. In the case of SUM for channels, (powers are summed and voltages are averaged when more than 2 channels are used) calculation is performed according to the equations stated in the specifications and the results are displayed.

17) Display block b

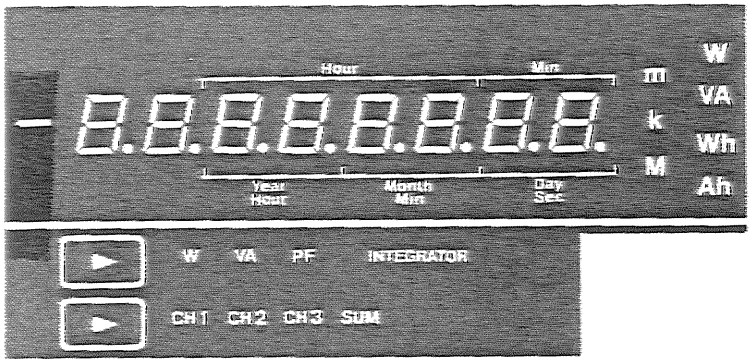


18) Function key b : ►

19) Channel key b : ►

Display block b can display either the current (A), reactive power (var) or the integration and averaging time.
The channels and functions indicated can be selected with this key. The SUM channel (the sum of multiple input channels) displays the average for current or sum for reactive power.

20) Display block c



21) Function key c : ►

22) Channel key c : ►

Display block a can display either the power (W), apparent power (VA) or integrator value. The channels and functions indicated can be selected with this key. The SUM channel (the sum of multiple input channels) will display the sum of all channels.
The display blocks a, b, and c are also used to set constants.

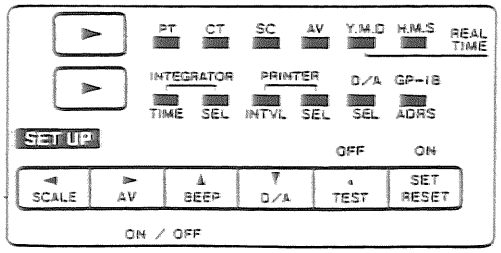
23) Constant set block

This term refers in general to the set up keys described below, key numbers 24 to 31.

24) Select key block a

These keys are used to select the following set up items.

1. PT: PT ratio
2. CT: CT ratio
3. SC: Scale
4. AV: Average
5. Y.M.D: Date (YEAR, MONTH, DAY), realtime control
6. HMS: Time (HOUR, MINUTE, SECOND)



25) Select key block b

These keys are used to select the following set up items.

1. INTEGRATOR~TIME: integrator time
2. INTEGRATOR~SEL: selects items to be integrated
3. PRINTER~INTVAL: printer time interval
4. PRINTER~SEL: selects items to be printed
5. D/A SEL: Selects items for D/A output
6. GP-IB ADRS: GP-IB address

26) Left shift key : [SCALE]

When values are set, pressing the [SCALE] key will shift the flashing digit to the left. Pressing the [SHIFT] and [SCALE] keys will turn the scaling function on/off.

27) Right shift key : [AV]

When values are set, pressing the [AV] key will shift the flashing digit to the right. Pressing the [SHIFT] and [AV] keys will turn the average function on/off.

28) Up key : [BEEP]

When values are set, pressing the [BEEP] key will increase the value of the flashing digit. Pressing the [SHIFT] and [BEEP] keys will turn the beeper on/off.

29) Down key : [D/A]

When values are set, pressing the [D/A] key will decrease the value of the flashing digit. Pressing the [SHIFT] and [D/A] keys will turn D/A output on/off.

30) Decimal point key : [TEST]

When values are set, pressing the [TEST] key will set the decimal to the right of the flashing digit. Pressing the [SHIFT] and [TEST] keys will activate the self-test.

31) Set key : [SET RESET]

When values are set, pressing the [SET RESET] key will end the set process. Pressing the [SHIFT] and [SET RESET] keys will reset the 3191 itself.

32) GP-IB interface

The GP-IB control status (remote=RMT, service request=SRQ, talk=TLK, listen=LTN) is displayed.

33) Local key : [LOCAL KEYLOCK]

Pressing the [SHIFT] and [LOCAL KEYLOCK] keys disables the panel key operations. To release this keylock, press the [LOCAL KEYLOCK] key. Likewise, press it to release GP-IB remote status and return to local control. However, when the 3191 is in keylock [LOCAL KEYLOCK] status through the GP-IB, this key is also disabled.

34) Integrator start key [START STOP]

Pressing the [START STOP] key starts integration, and pressing the [SHIFT] and [START STOP] keys stops integration.

35) Hold key : [HOLD CONT]

Pressing the [HOLD CONT] key holds the displayed integrator value. Pressing the [HOLD CONT] key again returns the display to the start of integration. This key does not require the shift key.

36) Printer unit

This prints out measurement data and panel settings.

37) Printer start key : [START STOP]

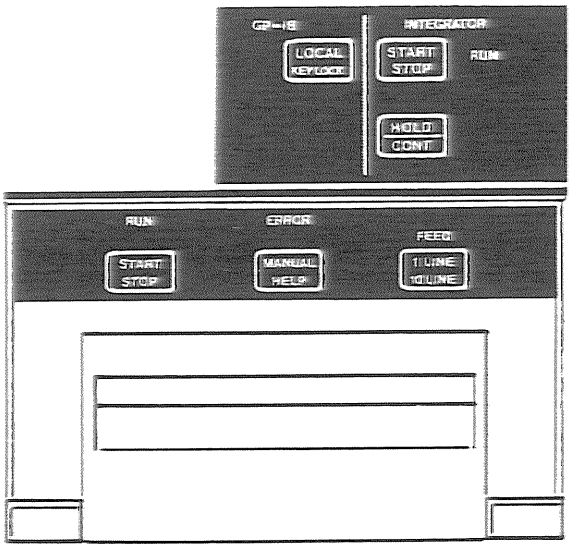
Pressing the [START STOP] key starts the printer. Pressing the [SHIFT] and [START STOP] keys will turn off the RUN display, release the interval print, and stop printing.

38) Manual print key : [MANUAL HELP]

Pressing the [MANUAL HELP] key will print out the preset items one time. Pressing the [SHIFT] and [MANUAL HELP] keys will print out the panel settings.

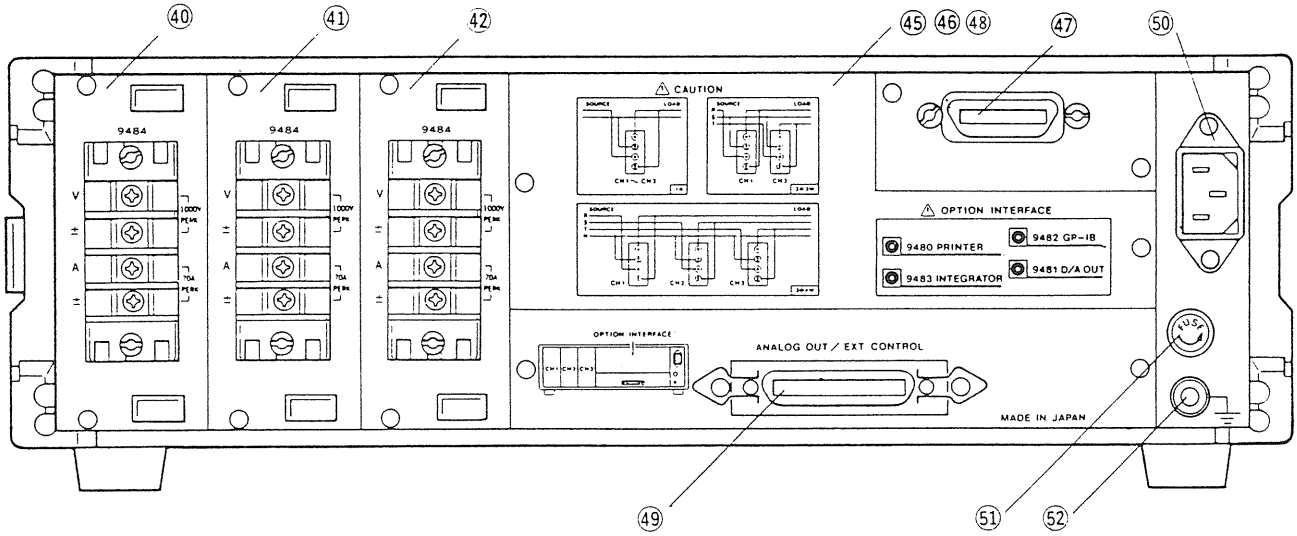
39) Line feed key : [1 LINE 10 LINE]

Pressing the [1 LINE 10 LINE] key will advance the paper one line, and pressing the [SHIFT] and [1 LINE 10 LINE] keys will advance the paper 10 lines.



5.2 Rear panel

Refer to the exterior drawing at the end of the manual.



40-42 Input units (9484), channels 1 to 3
Channel 1 (40) only for single-phase two-wire.
Channels 1 (40) and 2 (41) for three-phase three-wire.
Channels 1 (40), 2 (41) and 3 (42) for three-phase three-wire (3V3A) and three-phase four-lead

43 Voltage input terminal

44 Current input terminal

45 Printer interface (9480)

46 Integrator interface (9483)

47 GP-IB interface connector (9482)

48 D/A output interface (9481)

49 Analog output/external control connector
Analog output - V, A, and W for each channel and W1+W2, W1+W2+W3.
Monitor output - V and A for each channel.
D/A output - averages of V and A, and any three of var, VA, PF, Wh and Ah for each channel (requires option).
External control - enables external control of integration

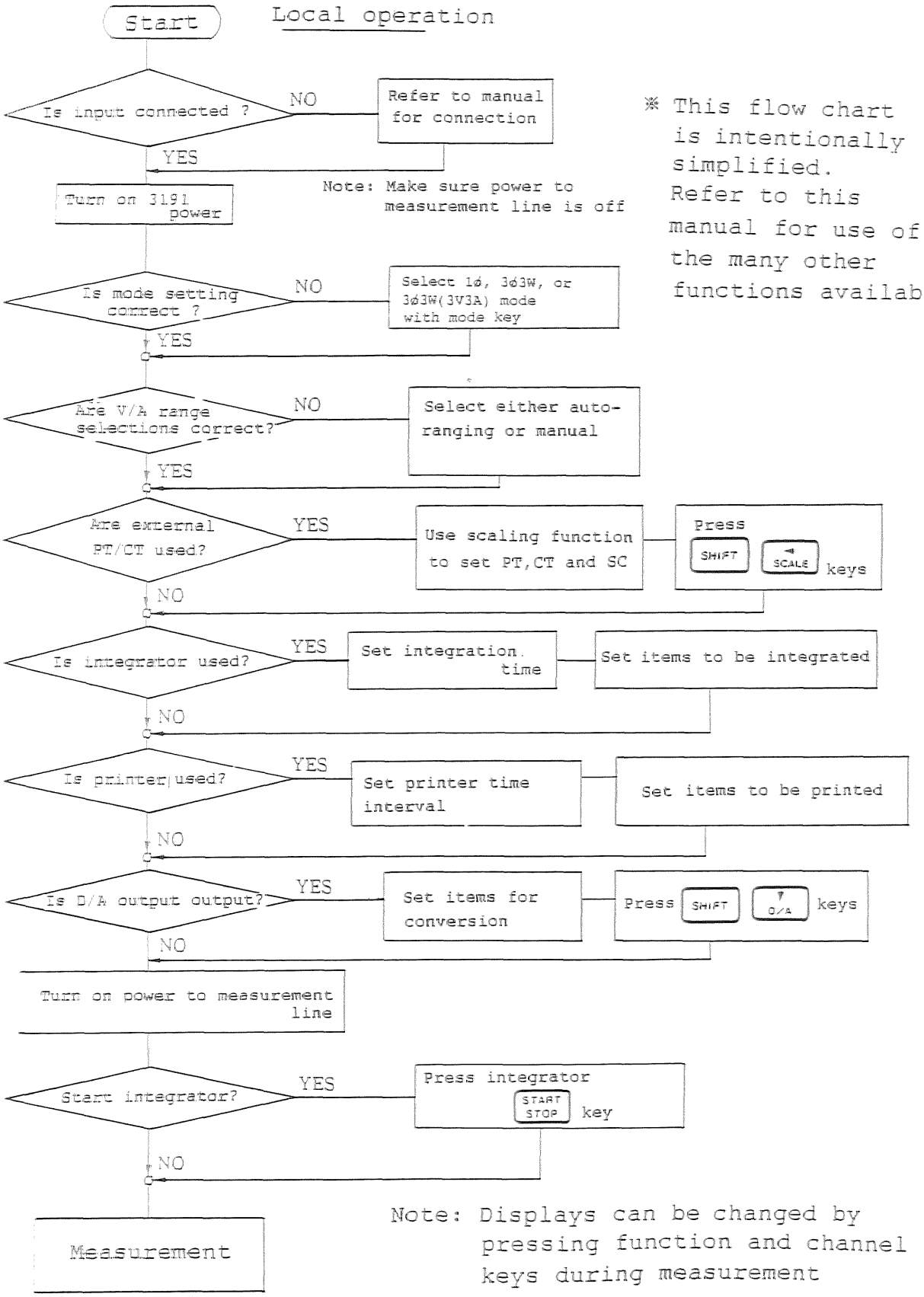
50 AC power in
Automatically responds to AC85-250V input.

51 Power supply fuse
Rated 3A, 250V fuse. Always remove power cord before changing fuses.

52 Ground terminal
Always ground the unit securely for measurement.

6. Operation

General 3191 operation



※ This flow chart is intentionally simplified. Refer to this manual for use of the many other functions available.

Note: Displays can be changed by pressing function and channel keys during measurement

6.1 Connection

Up to a maximum of three input channels can be used with the 3191, enabling connection methods to suit the items to be measured.

Caution

1. Power measurement is affected by polarity (phase) of V and A, so ensure correct connection.
2. To avoid shocks and shorts, always verify that the power to the measurement line is off before making connections. Always attach the protective cover before applying power.
3. Always securely ground the 3191 to ensure safety and correct operation.
4. If the V or A of the equipment being measured exceeds the measurement range of the 3191, use an externally-connected PT or CT. Use of the scaling function will enable direct reading (see Section 6.9.1).
5. Where externally-connected PT or CT are used, note that their phase difference will exercise a great effect on power measurement. Observe care where accurate power measurement is required.

6.1.1 Connection for single-phase two-wire

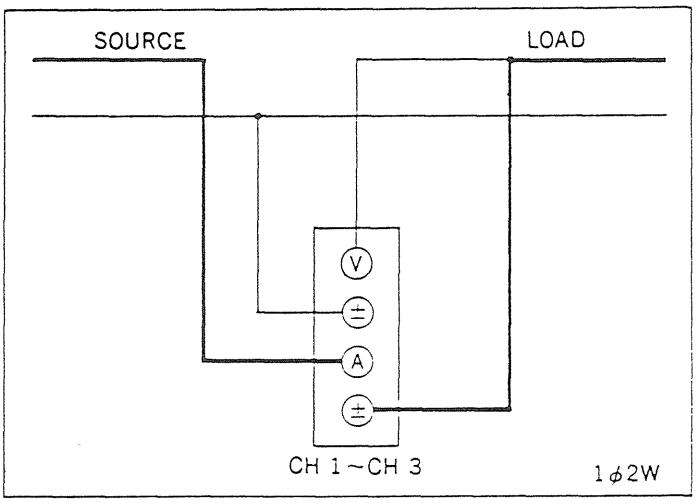


Fig. 6-1

1) Direct connection of measured line to 3191

As shown in Fig. 6-1 and on the rear panel, connect SOURCE and LOAD sides correctly. If there are 2 or 3 input units, this can be used as 2 or 3 power meters, respectively.

2) Connection though external PT or CT

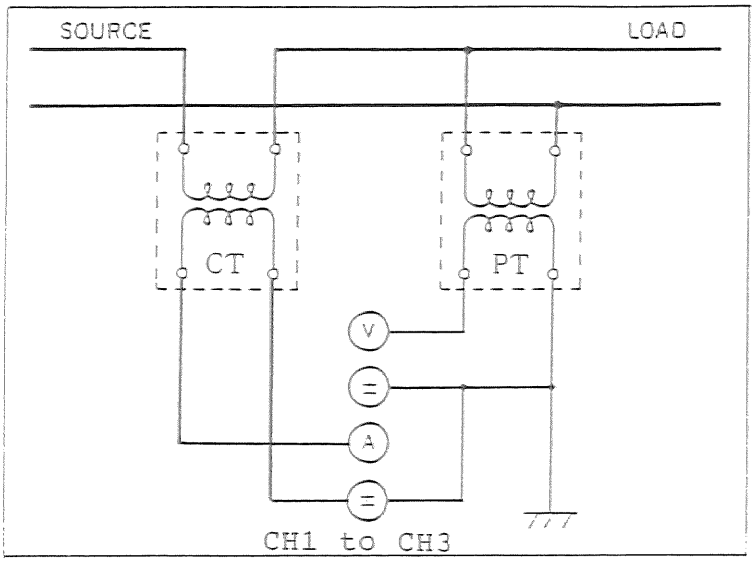


Fig.6-2

a) V measurement (3191 displayed reading × PT ratio)= Vn × Kp

PT ratio = Kp = (primary voltage) / (secondary voltage)

Example: Displayed reading V1 = 100.0V
PT ratio Kp = 2200V/110V = 20
Actual voltage V1× Kp = 100V × 20 = 2kV

b) A measurement (3191 displayed reading × CT ratio)= An × Kc

CT ratio = Kc = (primary current) / (secondary current)

Example: Displayed reading A1 = 4.00A
CT ratio Kc = 30A/5A = 6
Actual current A1× Kc = 4A × 6 = 24A

c) W measurement (3191 displayed reading × PT × CT)= Wn×Kp×Kc

Example: Displayed reading W1 = 320W
PT ratio Kp = 20
CT ratio Kc = 6
Actual power W1×Kp×Kc = 38.4kW

After the V, A and W for all channels are determined, the total sum of the power for all channels is determined by:

SigmaW = W1 × Kp × Kc + W2 × Kp × Kc + W3 × Kp × Kc

6.1.2 Three-phase three-wire

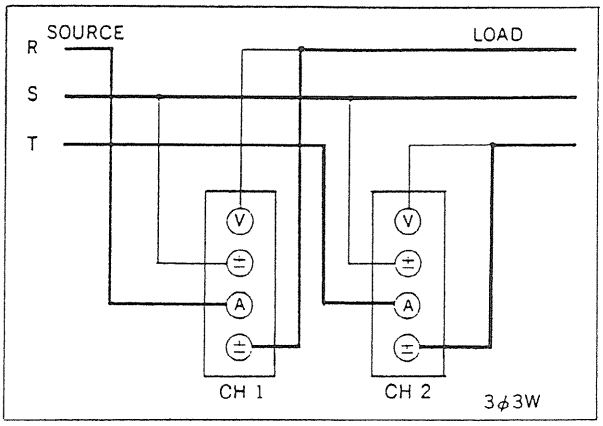


Fig. 6-3

1) Direct connection of line to be measured

When multiple input units are used it is possible to measure three-phase three-wire configurations. Connect channel 1 and 2 input units as shown in Fig. 6-3.

Caution: Other input unit combinations (i.e., 2 and 3, or 1 and 3) cannot be used.

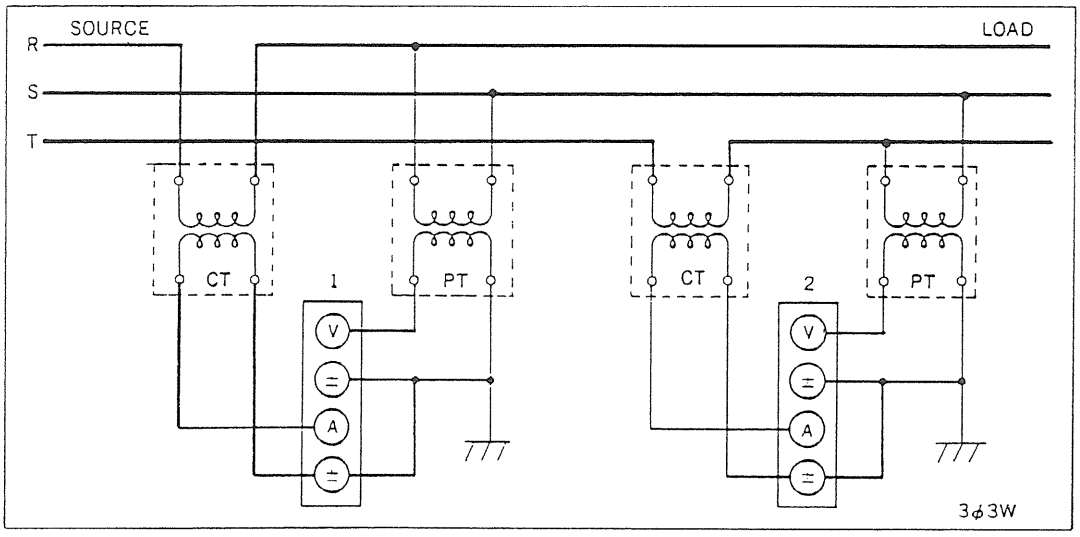


Fig. 6-4

2) **Using external voltage transformer (PT) and current transformer (CT) connected as shown in Fig. 6-4.**

Calculation example using PT/CT

First determine the V, A and W for each channel as given in Section 6.1.1 2) above. The three-phase power can be determined from these values as:

$$SigmaW = W1 + W2 = W1 \times Kp \times Kc + W2 \times Kp \times Kc$$

6.1.3 Three-voltage three-current connection with three-phase three-wire line (3ø3W,3V3A)

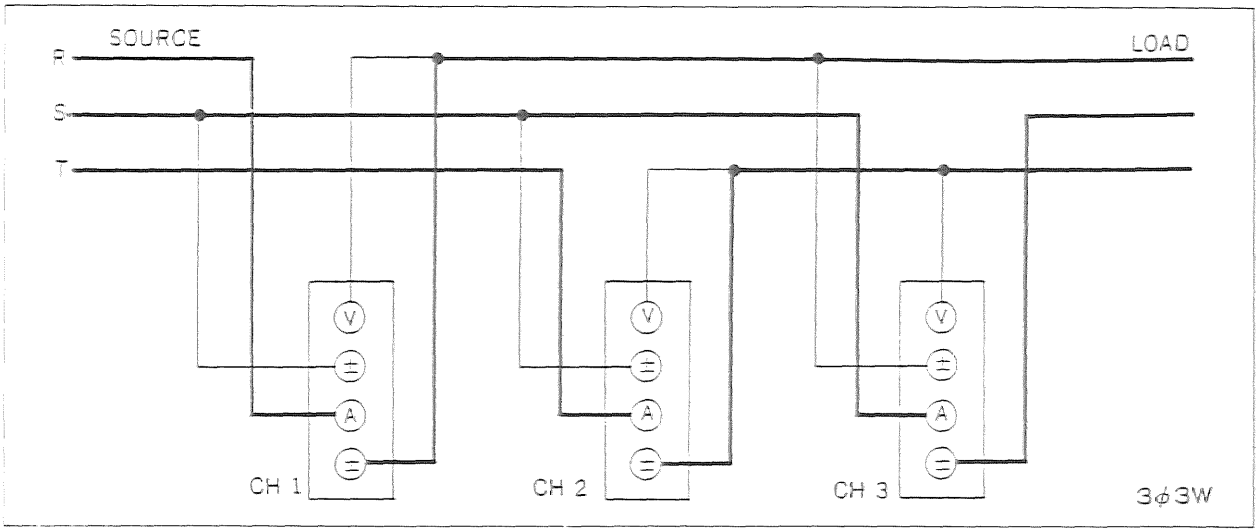


Fig. 6-5

(1)When connecting the line to be measured to the 3191 directly
When three input units are used, measurement using 3 voltages and 3 currents of the three-phase three-wire line is possible. Connect as shown in Fig. 6-5

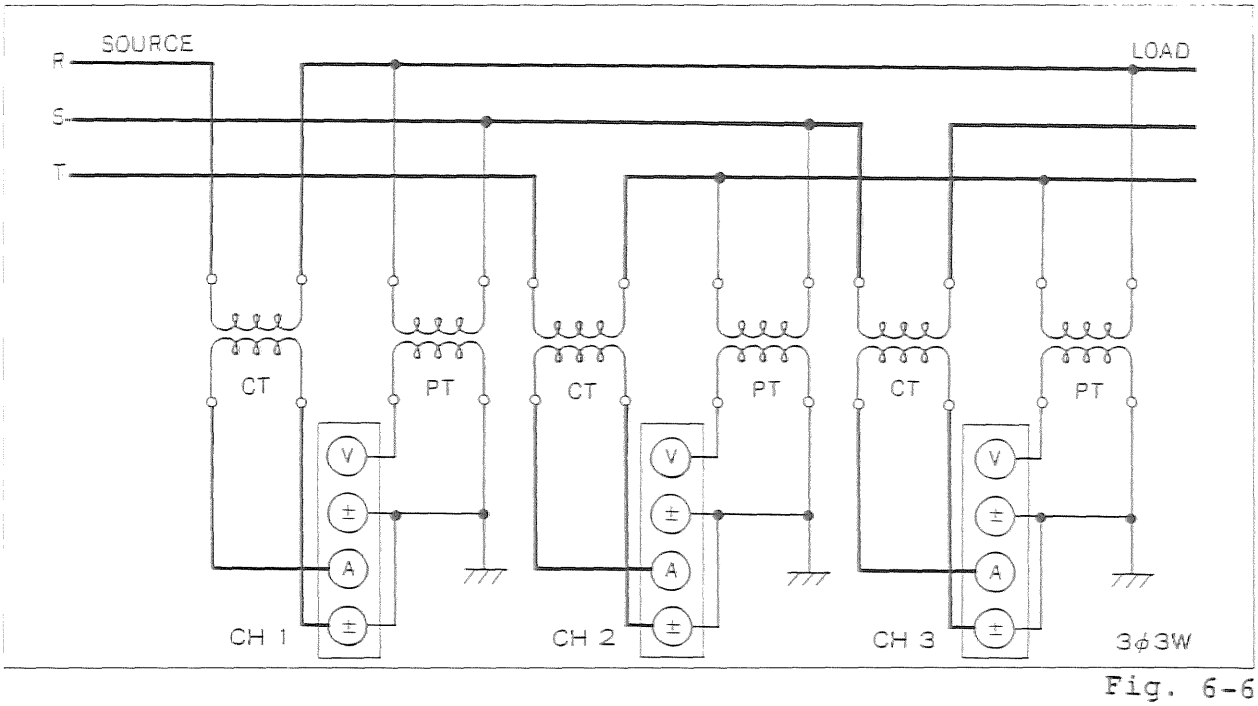
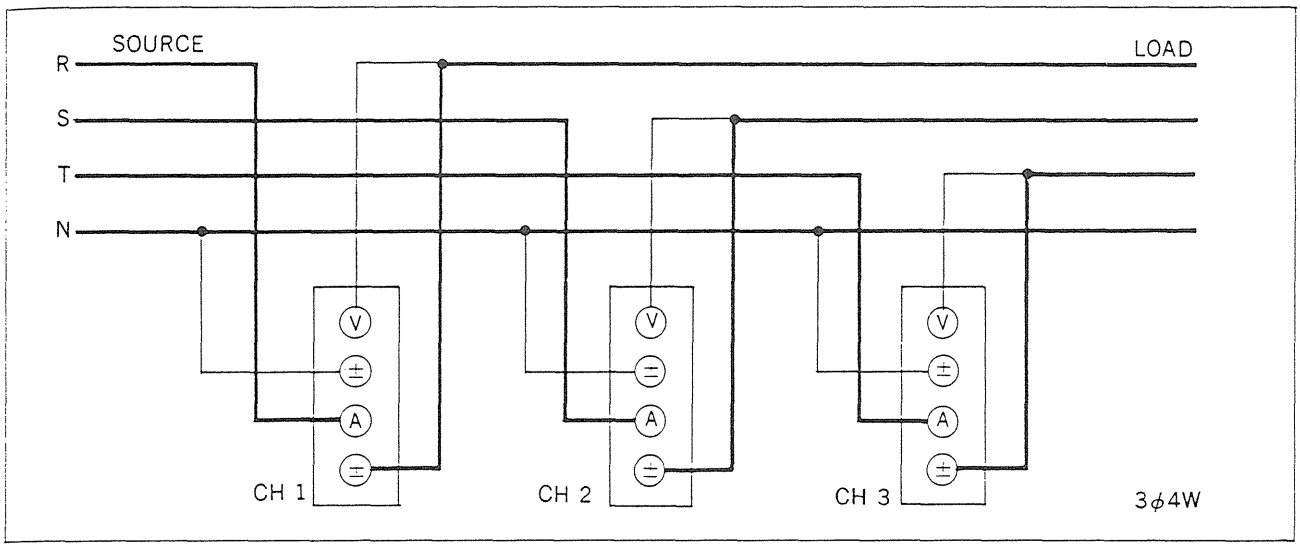


Fig. 6-6

Note: When measuring apparent power, reactive power, or power-factor of an asymmetrical or unbalanced power line, this method of connection provides more accurate measurements than can be obtained through the usual three-phase, three-wire connection.
The accuracy of power measured with this connection method is equal to that measured with three-phase, three-wire connection. Values of W, var and PF measured from CH3 are meaningless.

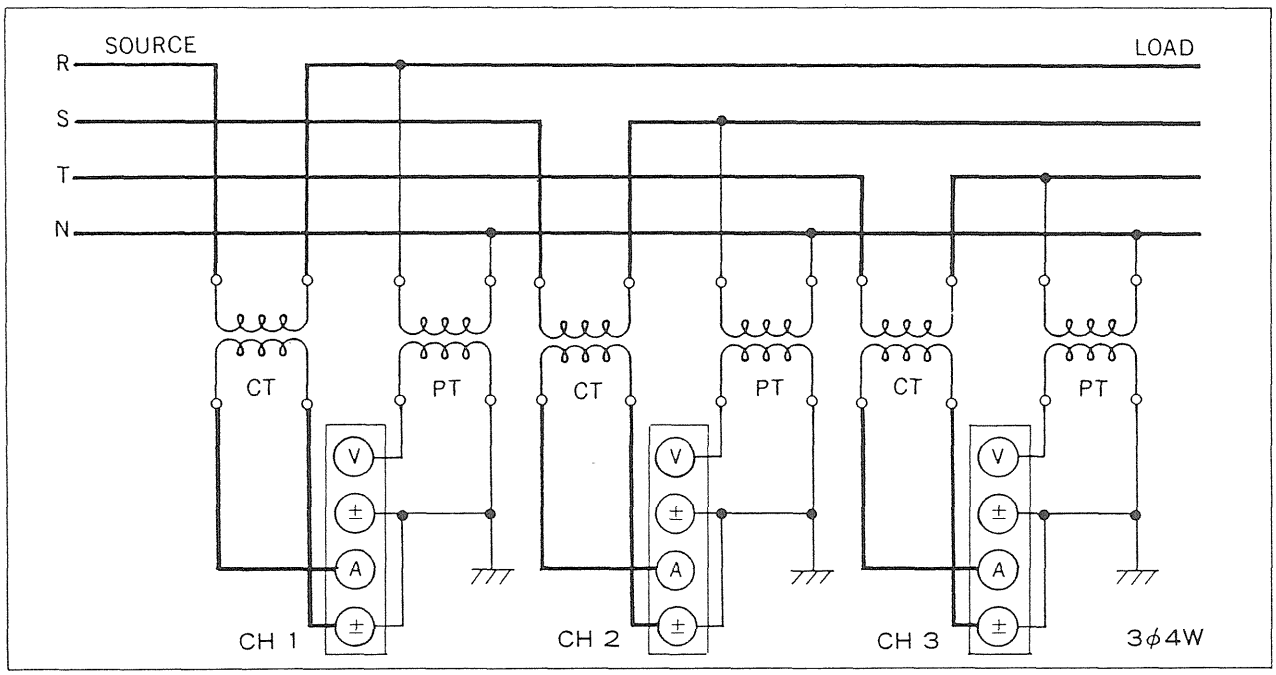
(2) Using external voltage transformer (PT) and current transformer (CT)
Connect as shown in Fig. 6-6

6.1.4 Three-phase four-wire connection



1) Direct connection of line to be measured

With three input units it is possible to measure power for three-phase four-wire configurations. Connect the leads as shown in Fig. 6-7.



2) Using external voltage transformer (PT) and current transformer (CT) connected as shown in Fig. 6-8.

Calculation example using PT/CT

First determine the V, A and W for each channel as given in Section 6.1.1 2) above. The three-phase power can be determined from these values as:

$$SigmaW = W1 + W2 + W3 = W1 \times Kp \times Kc + W2 \times Kp \times Kc + W3 \times Kp \times Kc$$

6.1.5 Notes on Connection

This power meter can be connected either by connecting the load to the voltage measurement terminal as shown in Figs. 6-1 to 8, or to the current measurement terminal as in Fig. 6-9. If the load is connected to the voltage measurement terminal as ib Fig. 6-10, the power reading will include loss due to the input resistance of the voltage measurement terminal. On the other hand, if the load is connected to the current measurement terminal as in Fig. 6-11, the power reading will include loss due to the input resistance of the current measurement terminal.
The connection method must be selected according to the voltage or current level. For example, when measuring a single-phase 30-V 20-A line with the 9484,

Loss= $(30(v))^2 \div 1(M\Omega) = 0.0009(VA)$ in Fig. 6-10, and
Loss= $(20(A))^2 \times 3(m\Omega) = 1.2(VA)$ in Fig. 6-11.

Therefore, in this case the method in Fig. 6-10 will give more accurate results.
For a single-phase 600-V 0.2-A line, however,

Loss= $(600(v))^2 \div 1(M\Omega) = 0.36(VA)$ in Fig. 6-10, and
Loss= $(0.2(A))^2 \times 3(m\Omega) = 0.00012(VA)$ in Fig. 6-11.

In this case, the method in Fig. 6-11 is advisable.

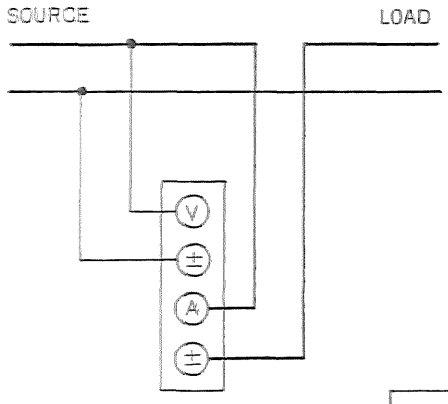


Fig. 6-9

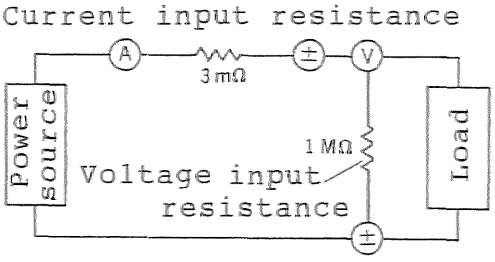


Fig. 6-10 (corresponds to Fig. 6-1)

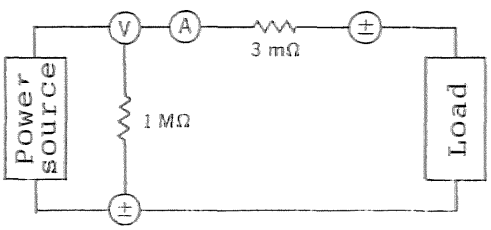


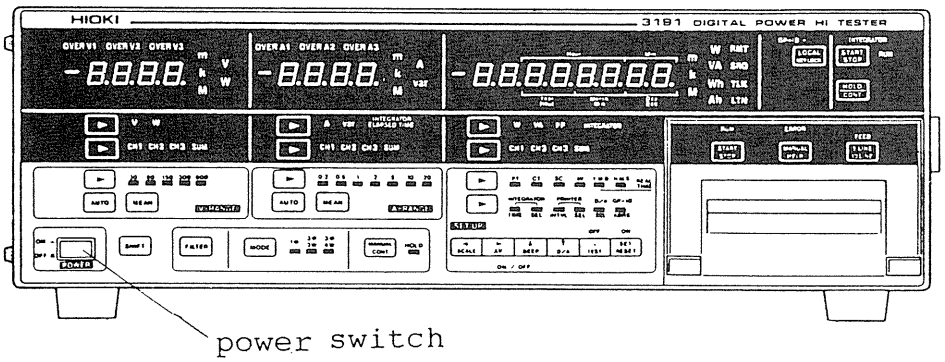
Fig. 6-11 (corresponds to Fig. 6-9)

6.2 Turning on the power

Connect the AC power input line to the connect provided on the rear panel of the 3191. The 3191 power switch is located on the front panel, at the lower left.

Caution

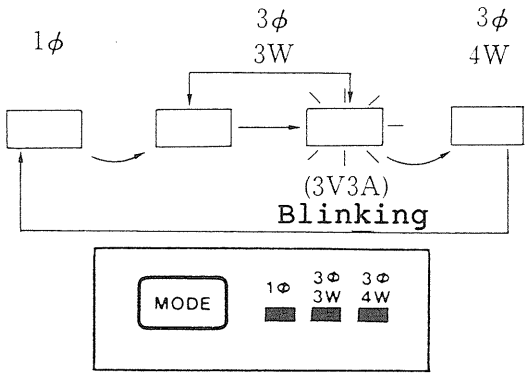
1. The 3191 settings will remain the same as they were when the power was turned off.
2. When the power is turned on, the 3191 will execute a self-test. Do not press any keys during this period. Refer to Section 6.14 for details.
3. When 3191 power is off, avoid inputting any A or V into the input units.
4. Allow a 10-minute warmup period before using the 3191.



6.3 Mode selection

A single 3191 unit can measure power for single-phase two-wire, three-phase three-wire and three-phase four-wire configurations. Before measurement, be sure to set the mode to be measured.

Pressing the SHIFT and MODE keys will shift the mode in the order shown below.

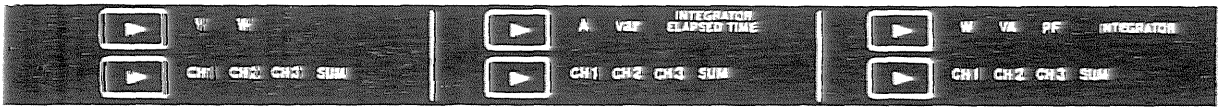


Caution

1. The arithmetic procedures used for each mode are different, so always use the correct mode for measurement.
2. If there is only one channel, only single-phase measurement is possible, and if there are only two channels that only single-phase and three-phase three-wire measurement will be possible.
3. Changing the mode will change the settings of the range, rms/average value, and scaling values (PT, CT, SC) as follows. For integration, A1 is input to channel 1, W1 to channel 2 and A1 to channel 3.
   1) 1 - 3 3W: Settings of CH2 are set to those of CH1.
   2) 3 3W - 3 3W(3V3A): Settings of CH3 are set to those of CH1.

6.4 Display selection

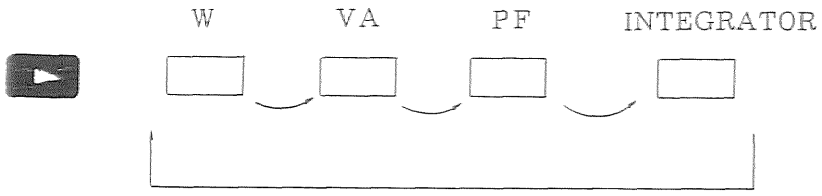
The 3191 is capable of displaying any three selected values, whether measured or calculated. The display selection is made with the function and channel keys. Refer to Table 6-① for the functions that may be displayed in each display block.



Caution

Unless the optional integrator is used, INTEGRATOR function is disabled. Refer to Appendix D for details.

Function and channel selection consists of pressing the key. Each time it is pressed, the selected function will shift one to the right, as shown below. The selection after the right-most one is the one on the left side. The selected function will be indicated with an indicator lamp.



Caution

The 3191 will automatically determine the number of units installed, and therefore in channel selection the 3191 will jump over selections that cannot be supported with that particular equipment configuration.

Functions that can be displayed in each display

Function \ Display	a	b	c
Voltage V_1	o		
V_2	o		
V_3	o		
V_{SUM}	o		
Current A_1		o	
A_2		o	
A_3		o	
A_{SUM}		o	
Effective power W_1	o		o
W_2	o		o
W_3	o		o
W_{SUM}	o		o
Apparent power VA_1			o
VA_2			o
VA_3			o
VA_{SUM}			o
Reactive power var_1		o	
var_2		o	
var_3		o	
var_{SUM}		o	
Power factor PF_1			o
PF_2			o
PF_3			o
PF_{SUM}			o
# Integrator $INTEGRATOR_1$			o
$INTEGRATOR_2$			o
$INTEGRATOR_3$			o
$INTEGRATOR_{SUM}$			*o
ELAPSED TIME		o	

* May not be displayed for certain combinations of functions selected for other displays.

Table 6-①

6.5 Range selection

Range selection is handled with the range keys for V and A measurement. Refer to Table 6-② for ranges.

6.5.1 Auto-ranging

When the auto-ranging key lamp is lit it indicates that the 3191 will automatically adjust the V and A ranges to suit the input levels.

Range switch levels are as follow:

1) Switch to a higher range
   a. When value exceeds 102% of the current range
   b. When OVER Vi or OVER Ai lamp lights (i=1~3)

2) Switch to a lower range
   a. When value drops below 30% of current range

To release auto-ranging either of the following methods may be used:

1) Press the auto-ranging key [AUTO] again.

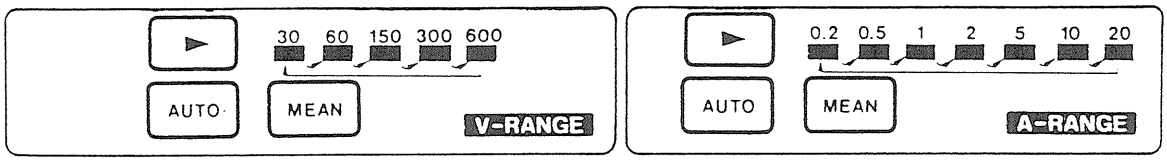
2) Press the [►] range key.

Method 1) will leave the 3191 in the current range, while method 2) will increase the range. Both will switch to manual ranging selection.

Note: The range may not be selected for some input waveform or level.

6.5.2 Manual ranging

When the auto-ranging lamp is not lit the 3191 is in manual ranging. The range will rise one level each time the key is pressed, and return to the left side from the highest range. It is also possible to reduce the range with the SHIFT and ► keys.



Caution

1. For three-phase three-wire measurement channels 1 and 2 are set to the same range, and for three-phase three-wire (3V3A) and three-phase four-wire measurement all channels are set to the same range.
2. OVER V and OVER A lamps light when the peak input value exceeds 2.5 times the range limit (i.e. if the range is 1A, then a 2.5A peak current). In this case accurate measurement is not possible, and the range should be raised when in manual ranging operation.

Range Chart

In the chart, items with 2 ranges (such as 120.0/99.99 in the 2A, 30V column), the ranges are automatically switched over. The analog output has a full scale of 2 VDC for the power range determined by [voltage range]×[current range].

V \ A		200.0mA	500.0mA	1.000A	2.000A	5.000A	10.00A	20.00A
30.00V	1φ	6.000W	15.00W	30.00W	60.00W	150.0W	300.0W	600.0W
	※3φ3W	12.00/9.999	30.00	60.00	120.0/99.99	300.0	600.0	1.200k/999.9W
	3φ4W	18.00/9.999	45.00	90.00	180.0/99.99	450.0	900.0	1.800k/999.9
60.00V	1φ	12.00W	30.00W	60.00W	120.0W	300.0W	600.0W	1.200kW
	3φ3W	24.00	60.00	120.0/99.99	240.0	600.0	1.200k/999.9W	2.400
	3φ4W	36.00	90.00	180.0/99.99	360.0	900.0	1.800k/999.9	3.600
150.0V	1φ	30.00W	75.00W	150.0W	300.0W	750.0W	1.500kW	3.000kW
	3φ3W	60.00	150.0/99.99	300.0	600.0	1.500k/999.9W	3.000	6.000
	3φ4W	90.00	225.0/99.99	450.0	900.0	2.250k/999.9	4.500	9.000
300.0V	1φ	60.00W	150.0W	300.0W	600.0W	1.500kW	3.000kW	6.000kW
	3φ3W	120.0/99.99	300.0	600.0	1.200k/999.9W	3.000	6.000	12.00/9.999
	3φ4W	180.0/99.99	450.0	900.0	1.800k/999.9	4.500	9.000	18.00/9.999
600.0V	1φ	120.0W	300.0W	600.0W	1.200kW	3.000kW	6.000kW	12.00kW
	3φ3W	240.0	600.0	1.200k/999.9W	2.400	6.000	12.00/9.999	24.00
	3φ4W	360.0	900.0	1.800k/999.9	3.600	9.000	18.00/9.999	36.00

* 3φ3W includes 3φ3W(3V3A).

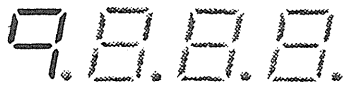
Table 6-②

6.5.3 Power range

The relation of the power range to the V and A ranges, modes and unit configuration is given in Table 6-②. This range is the same for active power, reactive power and apparent power.

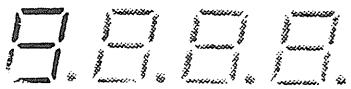
6.5.4 Overflow display for measured and calculated value

When the measured value exceeds 102% of range, the following overflow display will appear:



Only first digit lights.

In scaling, if the calculated value exceeds the maximum that can be displayed (9999M), the following overflow display will be used:

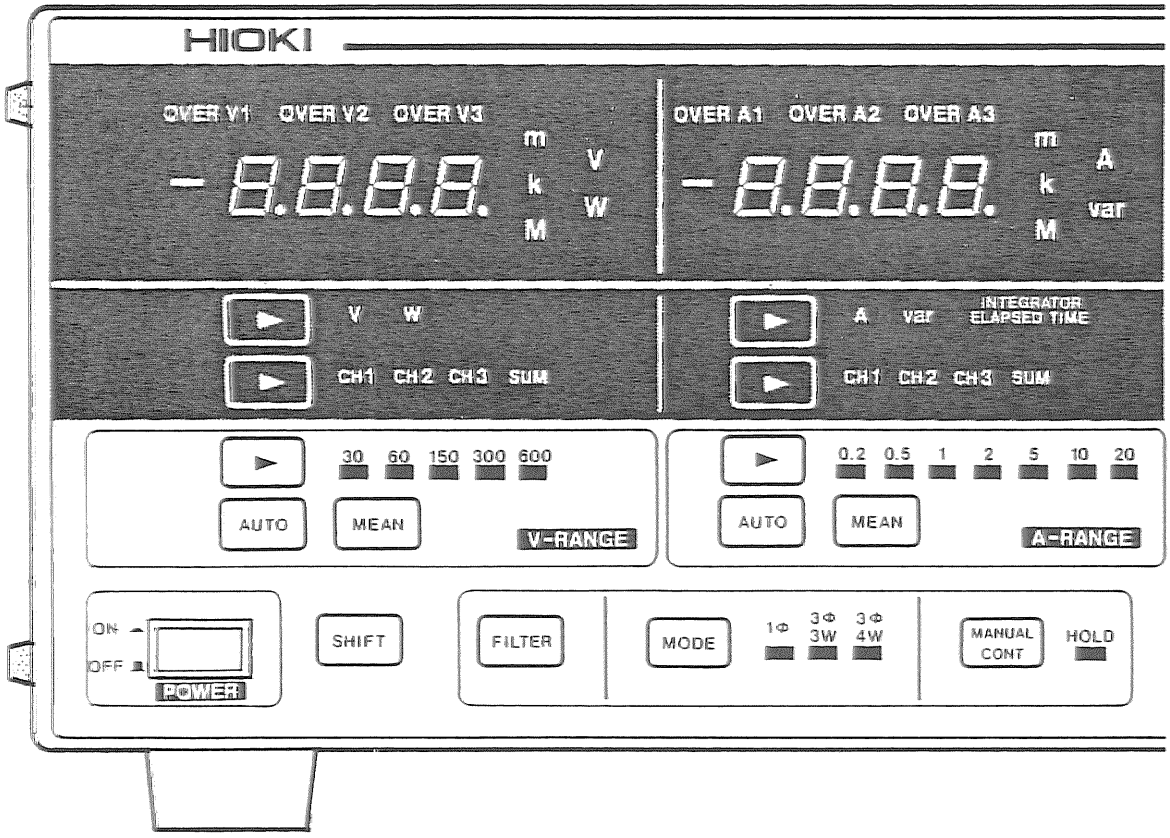


Only first digit lights.

The apparent power display will overflow if either A or V overflows.

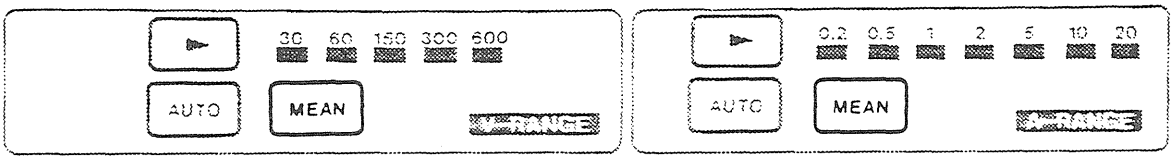
The power factor will overflow when A or V is 0, or when A, V or active power overflows.

Reactive power will overflow if any of V, A, or active power overflows.



6.6 True/mean value selection

Pressing the [MEAN] key on the 3191 can be used to select either true value or mean value display for V or A measurement. When the lamp lights the display will be the mean rectified effective value, and when the lamp is off the value will be the true value.



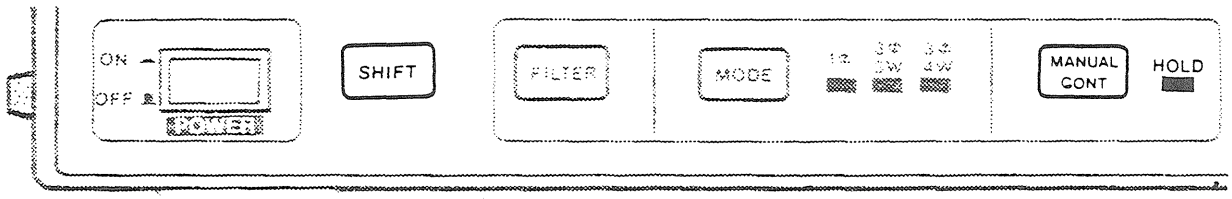
6.7 Sampling selection

The sampling hold key [MANUAL CONT] and shift key [SHIFT] can be used to select either continuous sampling (the usual setting), display hold, or manual sampling.

Pressing the sampling hold key will cause the HOLD lamp to light, and the 3191 to enter the hold status. In the HOLD status, each time the sampling hold key is pressed the data will be sampled and displayed. To release the hold status, press the [SHIFT] and [MANUAL CONT] keys. The HOLD lamp will go out, and continuous sampling will start again at about 2.5 times/sec.

Caution

1. In the hold status it is possible to control sampling with an external signal. Refer to Chapter 7.



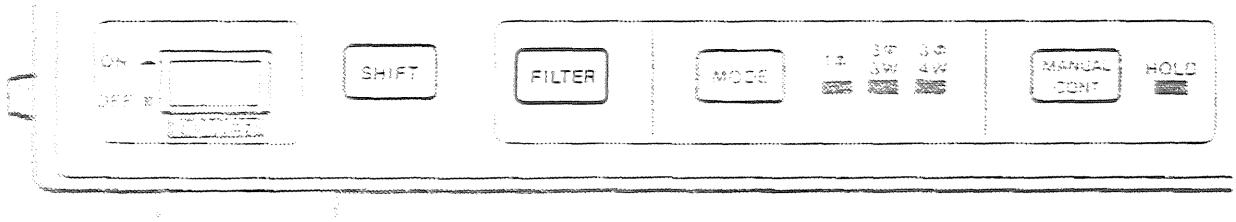
6.8 Filter selection

The 3191 detects the phase difference of the V and A waveforms to determine polarity for active and reactive power values. As a result, waveform detection may be impossible where there is extreme distortion, leading to an unstable polarity display. When the filter is turned on the phase detector filter is switched into the circuit to cut out high-frequency components of 500Hz or higher.

When the filter key [FILTER] lamp is lit, the filter is operating. Pressing the key will turn the filter on/off.

Caution

1. There is no effect for frequencies under 500Hz, and therefore switching in the filter may not stabilize the polarity display in certain cases.



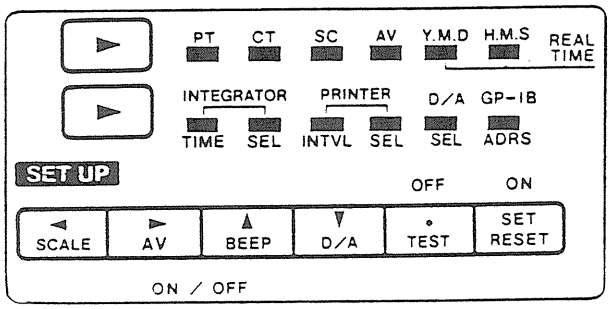
6.9 Scaling function

Before explaining the scaling function it is necessary to explain how to set values and decimal points. The methods used for digit increase/decrease and digit movement are common to the following items:

1. PT ratio
2. CT ratio
3. **Scaling function**
4. Averaging count
5. Realtime display and realtime control
6. Integration time
7. Printer time interval
8. GP-IB address

Note: Numbers 6 and 8 require options.

Select key a



The set method is as follows:

1) Press the [►] key to specify which item is to be set. For the PT/CT ratios and scaling constant, the channel lamp will light to show which channel the values are set for.

2) For numerals the digit can be moved with the [◄ SCALE] and [► AV] keys, and increased/decreased with the [▲ BEEP] and [▼ D/A] keys.

3) The decimal point is set to the right of the flashing digit. It can be moved with the [◄ SCALE] and [► AV] keys, and fixed with the [• TEST] key. The decimal is not displayed if located to the right of the last digit.

4) After numeral and decimal point setting, set is completed by pressing the [SET RESET] key. Pressing the key again will enable PT/CT ratio and scaling constant setting for the next channel.

6.9.1 Setting scaling constants

The 3191 scaling function enables the use of external transformers (PT and CT) to enable direct reading for all functions.

Scaling constant	Panel symbol	Range
PT ratio (Kp)	PT	0.0001-10000
CT ratio (Kc)	CT	0.0001-10000
Scaling constant (Ksc)	SC	0.0001-10000

Function	Arithmetic operation
Voltage V	V×Kp
Amperage A	A×Kc
Active power W	W×Kp×Kc×Ksc
Inactive power var	var×Kp×Kc×Ksc
Phased power VA	VA×Kp×Kc×Ksc
Integrated power(option) Wh	Wh×Kp×Kc×Ksc
Integrated amperage (option) Ah	Ah×Kc

First press the select key [►] to specify which item is to be set. The constant for the flashing lamp will be displayed in display block c, and at the same time the lamps for the functions and channels scaled will flash.

In display block c the digit that may be set will flash. The set procedure is given below. The set-up mode will be canceled by pressing any key other than those used in set-up.

Press the [SHIFT] and [◄ SCALE] keys to flash the panel PT, CT and SC lamps and display the values set for each constant.

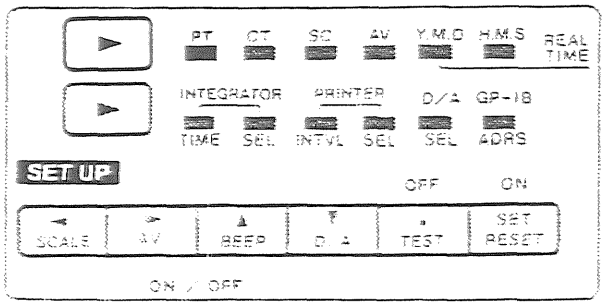
Press them again to cancel the constant display and return to the normal display.

Caution

1. The scaling constant Ksc is common to W, var, VA and Wh.
2. In the single-phase mode, different constant may be set for each channel used.
3. In the three-phase three-wire mode the same constant is set for both channels.
4. In the three-phase three-wire (3V3A) or three-phase four-wire mode the same constant is set for all channels.
5. A setting of 0 cannot be made (the default value is 1).
6. The initial setting is 1.0000.

6.9.2 Setting example

The example provided here is for a three-phase four-wire measurement of the primary side, using a 2200/110V PT and a 30/5A CT for direct reading.



$$\text{PT ratio} = KP = \frac{2200}{110} = 20$$

$$\text{CT ratio} = KP = \frac{30}{5} = 6$$

1) Set the PT ratio to 20.

a. Press the [►] key and cause the PT lamp to flash.

b. Move the flashing digit to the first position with the [► AV] key.

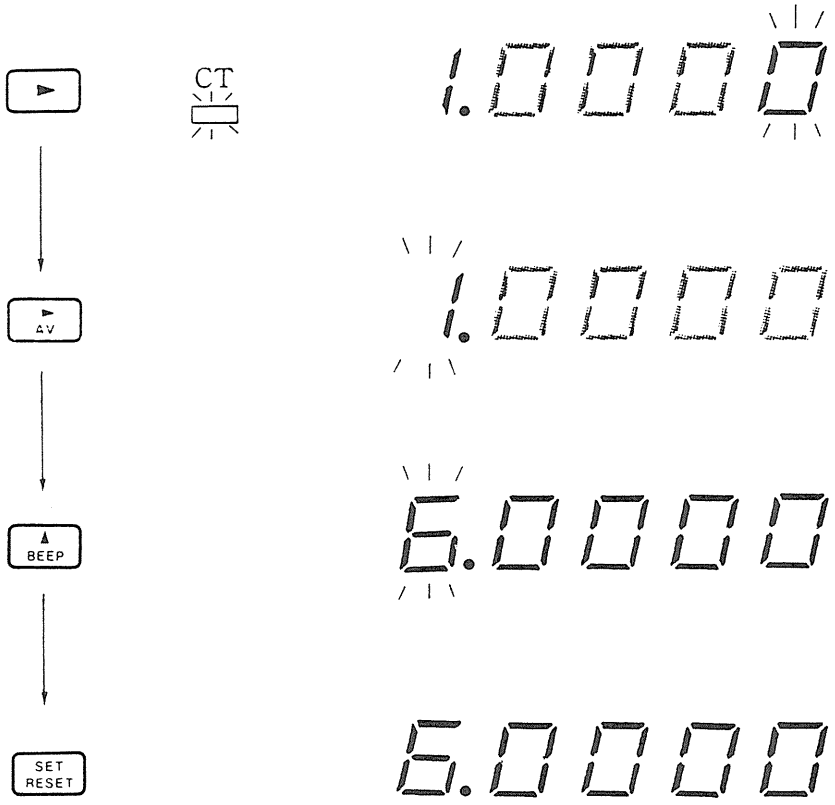
c. Press the [▲ BEEP] key once to increase the value to 2.

d. Use the [► AV] key to cause the second digit to flash.

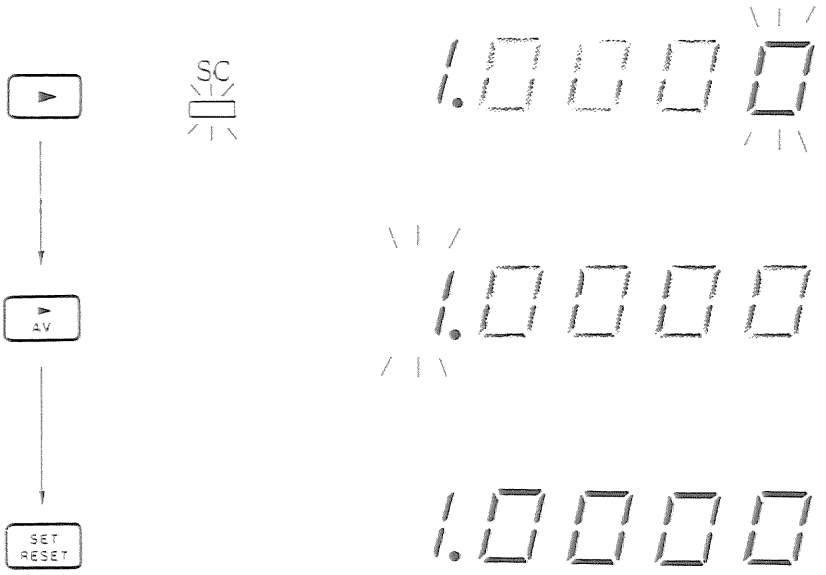
e. Press the [• TEST] key to move the decimal point.

f. Press the [SET RESET] key to complete the setting.

2) Next, set the CT ratio to 6. First press the select key [►] again to cause the CT ratio lamp to flash.



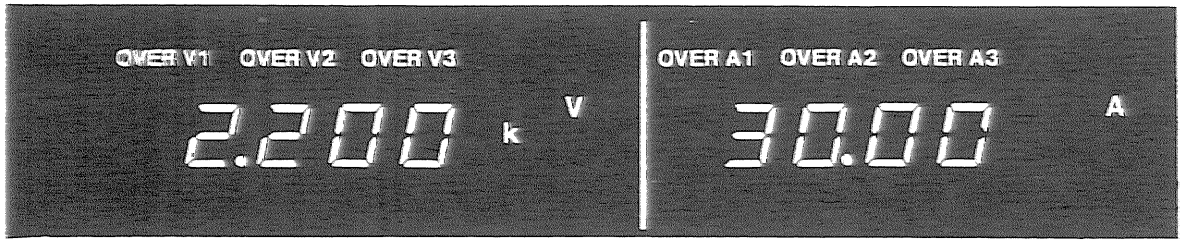
3) Press the [►] key again to cause the SC (scaling constant) lamp to flash.



This example is a setting to read directly the values for the primary side, so the scaling constant is input as 1.0000 as shown above.

Once the constants are set, press any key not used for set-up to return to normal 3191 operation status. Pressing the [SCALE] and [SHIFT] keys after that point will cause the panel PT, CT and SC lamps to light, indicating that scaling is enabled. The values shown will be those for the primary side.

Where scaling is used and SC is not 1, units for W, VA, var and Wh will not be displayed.



6.10 Averaging function

The 3191 has two averaging modes: the counter mode in which the specified number of measured values are averaged; the timer mode in which data measured during the specified time is averaged.

6.10.1 Counter mode

The number of measurements can be specified from 1 to 100 and the simple average for 1 to 100 samples is calculated. The display value is calculated as follows:

$$\text{Display value} = \frac{1}{N} \sum_{K=1}^{N} D_K$$

where Dk is instantaneous value of V, A, or W. Values for var, VA and PF are calculated based on the average values for V, A and W.

Sample rates for average calculation are as follows:
Average number of times N = 10 ····· Approx. 1 time/s
Average number of times N = 100 ····· Approx. 0.1 time/s

6.10.2 Timer mode

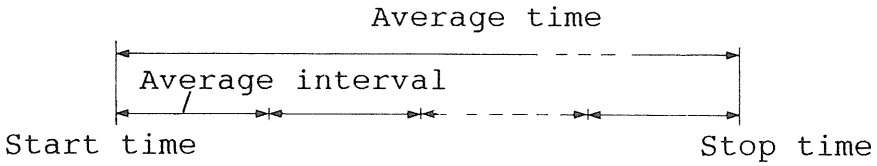
The period of time for averaging is specified from 1 minute to 1000 hours, and data measured during this period is averaged. The display value of average is calculated with the following equation:

$$\text{Display value} = \frac{1}{T} \sum_{K=1}^{T} D_K$$

where Dk is instantaneous value of V, A, or W. Values for var, VA and PF are calculated based on the average values for V, A and W.

Average time and average interval are the parameters for the timer mode. They are defined as follows:

Average time: Time range of the timer mode
Average interval: Time range where averaging is done



CAUTION

With the reactive power meter function, average values of V, A and W are used for calculating reactive power; the line polarity is are ignored. Therefore, reactive power cannot be measured with a three-phase, three-wire or three-phase, four-wire line.

6.10.3 Setting averaging count

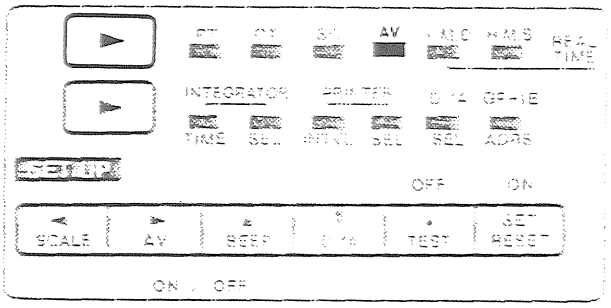
Each of the averaging modes requires the following parameters:
Counter mode: Number of samples used for averaging
Timer mode: Average time, Average interval
These parameters are set with the display block c in the following sequence:

1. Averaging mode and number of samples
2. Average time
3. Average interval

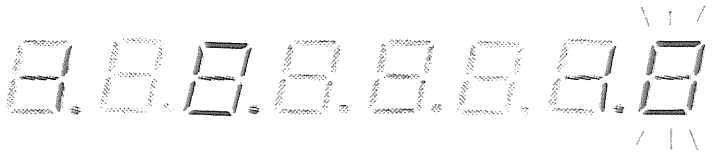
Which parameters are set is indicated with the most significant digit of the display block c by displaying a number 1, 2, or 3.

(1) Setting the average mode and number of samples

1) First press the select a key [►] to flash the AV lamp.



The display block c displays "1", average mode and number of samples.



Average mode Number of samples

Use the [◄ SCALE] , [► AV] , [▲ BEEP] , and [▼ 0/A] keys to input the count from 1~100.

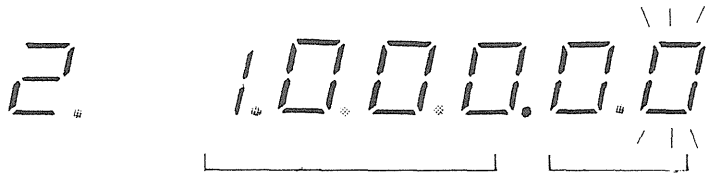
2) The average mode is 0 (counter mode) or 1 (timer mode). Make the average mode digit blink and enter 0 or 1.

3) Press the [SET RESET] key, then blinking stops and setting is completed.

Note: The number of samples cannot be set to 0.

(2) Setting the average time and average interval

1) Press the [SET RESET] key after performing step 3) of (1), and the display block c displays 2 and the average time. The right end digit blinks.



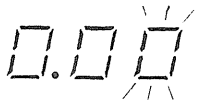
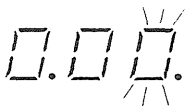
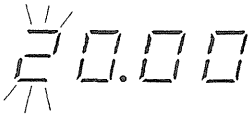
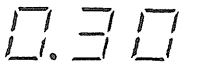
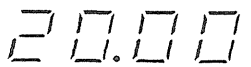
Hour Minute
Average time

Move the blinking digit with the [SCALE] and [AV] keys and change the value with the [BEEP] and [D/A] keys.

The average time can be set to 1 minute to 1000 hours. Figure up and figure down are performed automatically.

2) Press the [SET RESET] key to set the average time. Pressing the [SET RESET] key again changes display to "3" followed by the display interval.

Example of setting

30 minutes	20 hours
	
	
	
	

3) Set the average interval in the same manner as the average time.

4) After pressing the [SET RESET] key to set the average interval, press it again. Then, display returns to the average mode and the number of samples.

5) Press any key other than the setup key exits the setup mode.

6.10.4 Description of operation

(1) Counter mode

Press the [SHIFT] and [AV] keys, then the AV lamp lights and the averaged value is displayed.

Press the [SHIFT] and [AV] keys again, then the AV lamp goes off and the instantaneous input is displayed.

Caution

1. The averaging function is effective for all channels and functions.
2. Even during averaging, the result of a manual sampling are not averaged.
3. The absolute values of var and PF are calculated by using the averaged values of V, A, and W. The polarity displayed is that of the sample taken last.
4. The setup mode cannot be entered during averaging.

(2) Timer mode

1) Start/stop
Pressing the [SHIFT] and [AV] keys will start the averaging operation, with the AV lamp lit. In the realtime control mode, the 3191 enters the waiting state and the AV lamp blinks. (For the realtime control mode, refer to "6.12 Realtime Control".) Pressing the [SHIFT] and [AV] keys again terminates the average function and "3) displaying the total average value" starts.

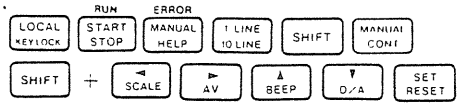
2) Displaying the interval average value
In the continuous sampling state (with HOLD lamp off), the average value during the time between the beginning of the interval and the current point of time will be displayed at approx. 2.5 times/sec.
When the HOLD lamp is lit, the average value during an average interval is displayed each time the average interval ends.

3) Displaying the total average value
When the average time ends or forcibly terminated, the average value from the previous display, with the HOLD lamp blinking. Pressing the [MANUAL CONT] key in this state will change display to the total average value (average during the entire average time), with the HOLD lamp lit.
Pressing the [MANUAL CONT] key or the [SHIFT] and [MANUAL CONT] keys will return display to the instantaneous value, terminating the averaging function.

CAUTION

1. The averaging function is canceled when the average time ends even if the average interval is longer than the average time.
2. The polarity will not be attached to PF and var (as well as VA) since the average value is not calculated using instantaneous values.
3. During interval printing, the 3191 displays the total average value and holds it at the end of the averaging function without displaying the interval average value.

4. At the moment when excessive input is applied, the 3191 displays "over" indication only and displays the average value calculated assuming the full scale input is applied for the interval average value and total average value.
5. When the averaging function starts, the auto-range function for voltage and current is canceled. The keys other than those shown below will be disabled:
-Keys used to change the functions and channels displayed on display block c.



That is,
i. Scaling: ON/OFF
ii. Average: OFF
iii. BEEP: ON/OFF
iv. D/A output: ON/OFF
v. RESET

6. By pressing the [MANUAL CONT] key while the interval average value is displayed, the 3191 samples the instantaneous value at that time and displays it.
7. When the setting of the range, etc. is changed while the HOLD lamp is blinking after terminating the averaging function, the 3191 moves to the normal operation without displaying the TOTAL average value.
8. For the operation when a power failure occurs, refer to 6.16 Backup.

4) Displaying average elapsed time

Setting the function on the display block c to INTEGRATOR ELAPSED TIME will display the average elapsed time.

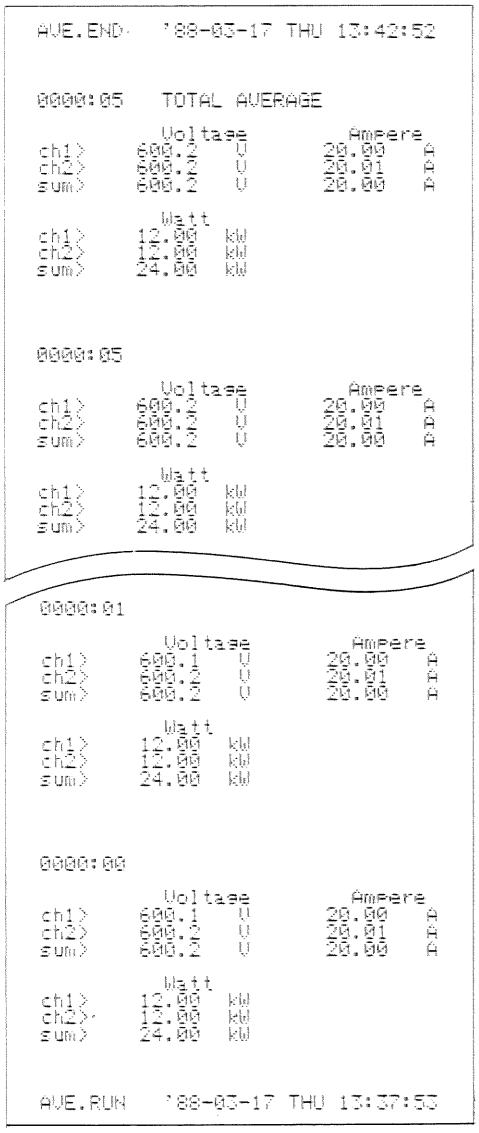
	Display block c
1 minute to 99 hours and 59 minutes	xx.xx hour minute
100 hours to 999 hours and 59 minutes	xxx.x hour tens minute
1000 hours	1000 hour

CAUTION

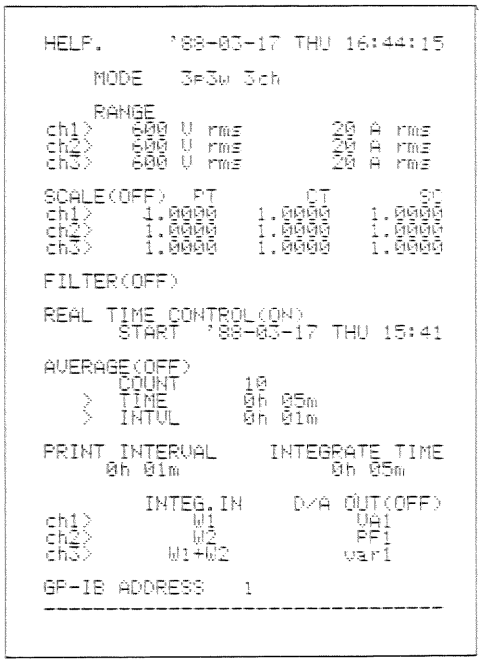
The INTEGRATOR ELAPSED TIME on the display block b also serves to display the integrator elapsed time. The display shows the elapsed time that has measured last when averaging and integrator are stopped.

5) Printing data

When the printer unit (9480) is built in, the 3191 starts printing at the same time the averaging function starts. Then, the printer prints the measured data at the printer time interval. The printer prints the total average value, then stops printing when the averaging function ends. (Print example 1)
Further, it is possible to print the settings of the averaging function with HELP PRINT. When ">" is attached to "COUNT", the 3191 is in the counter mode; otherwise, in the timer mode. (Print example 2)



```
AVE.END    '88-03-17 THU 13:42:52

0000:05    TOTAL AVERAGE

              Voltage          Ampere
ch1>       600.2    V        20.00    A
ch2>       600.2    V        20.01    A
sum>       600.2    V        20.00    A

              Watt
ch1>       12.00    kW
ch2>       12.00    kW
sum>       24.00    kW


0000:05

              Voltage          Ampere
ch1>       600.2    V        20.00    A
ch2>       600.2    V        20.01    A
sum>       600.2    V        20.00    A

              Watt
ch1>       12.00    kW
ch2>       12.00    kW
sum>       24.00    kW

0000:01

              Voltage          Ampere
ch1>       600.1    V        20.00    A
ch2>       600.2    V        20.01    A
sum>       600.2    V        20.00    A

              Watt
ch1>       12.00    kW
ch2>       12.00    kW
sum>       24.00    kW


0000:00

              Voltage          Ampere
ch1>       600.1    V        20.00    A
ch2>       600.2    V        20.01    A
sum>       600.2    V        20.00    A

              Watt
ch1>       12.00    kW
ch2>       12.00    kW
sum>       24.00    kW


AVE.RUN    '88-03-17 THU 13:37:53
```



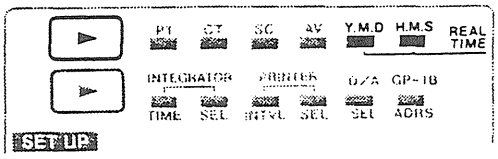
```
HELP.      '88-03-17 THU 16:44:15

    MODE    3P3W 3ch

    RANGE
ch1>     600 V rms          20 A rms
ch2>     600 V rms          20 A rms
ch3>     600 V rms          20 A rms

SCALE(OFF)   PT         CT         SC
ch1>      1.0000     1.0000     1.0000
ch2>      1.0000     1.0000     1.0000
ch3>      1.0000     1.0000     1.0000

FILTER(OFF)

REAL TIME CONTROL(ON)
     START   '88-03-17 THU 15:41

AVERAGE(OFF)
      COUNT      10
    > TIME       0h 05m
    > INTVL      0h 01m

PRINT INTERVAL     INTEGRATE TIME
     0h 01m             0h 05m

        INTEG.IN     D/A OUT(OFF)
ch1>          W1             VA1
ch2>          W2             PF1
ch3>       W1+W2            var1

GP-IB ADDRESS    1
--------------------------------
```

6.11 Realtime display and set

The 3191 is equipped with a calendar/clock, so that the printer and optional GP-IB unit can be used in realtime.

6.11.1 Realtime display

Press select key a [►] to light either the YMD or HMS lamp.



YMD stands for Year Month Date, and HMS for Hour Minute Second. These are displayed in display block c.

1. Sample YMD Display

2. Sample HMS display

Fig p33:

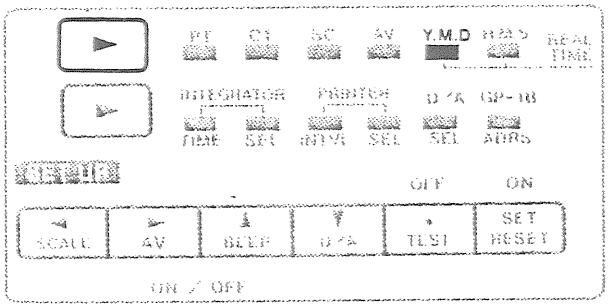
Caution

1. The year display is only the last two digits of the year.
2. A 24-hour clock is used.

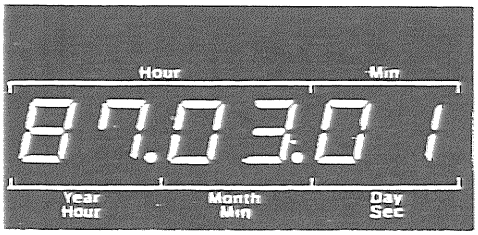
6.11.2 Realtime set

1) YMD display set

Press the [►] key to light the YMD lamp.



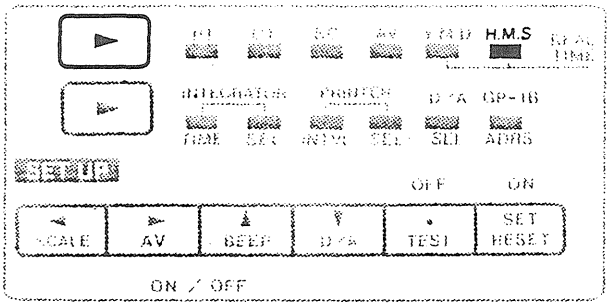
The date will be displayed in display block c.



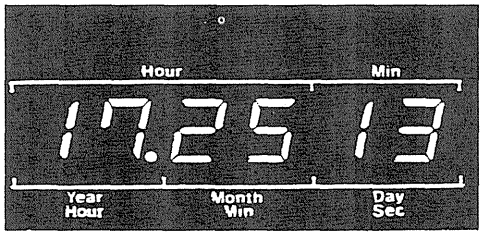
Use the [SCALE] and [AV] keys to move the digit, and then use the [BEEP] and [D/A] keys to set the date. Press the [SET RESET] key to complete the sequence. See Section 6.9 for the detailed set sequence.

2) HMS display set

Press the [►] key to light the HMS lamp.



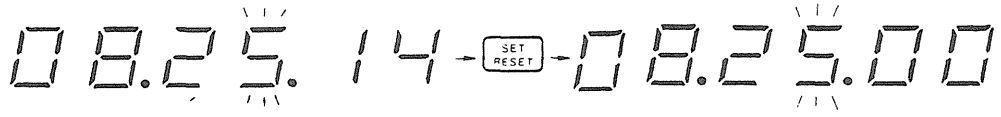
The time will be displayed in display block c.

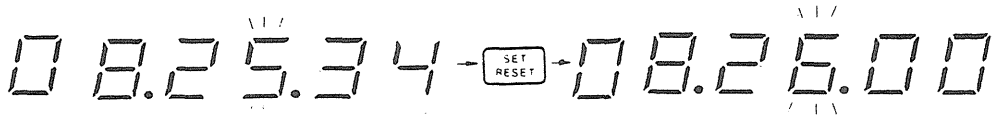


Use the [▲ BEEP] and [▼ D/A] keys to move the digit, and then use the [▲ BEEP] and [▼ D/A] keys to set the time. Pressing the set key when the second count is less than 30 will set the second display to 00, and pressing the [SET RESET] key will input the displayed time.

If the second display is 30 or more, pressing the [SET RESET] key will set the seconds to 00 and increase the minute display by one.

Example:





See Section 6.9 for the detailed set sequence.

Cautions

1. Each of the settings has a restricted range of values.

Y (year)	00~99
M (month)	01~12
D (date)	01~31
H (hour)	00~23
M (minute)	00~59

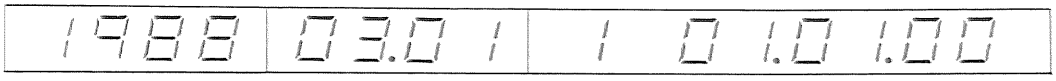
6.12 Realtime control

The 3191 can set the starting time for the average function, printer (9480) and integrator (9483) to an arbitrary time.

6.12.1 Realtime control setting

Press the select a key [►] to turn the Y.M.D lamp on. Pressing the [SET RESET] key will display the year on the display block a, the month and date on the display block b, and the numeric value indicating the realtime control mode, hour, minute, and second on the display block c.

Display block a Display block b Display block c



Year Month Date Realtime control mode Hour Minute Second Blinking

(1) Setting the year

Move the blinking digit to the display block a with the [◄ SCALE] and [► ΔV] keys. Change the value with [▲ BEEP] and [▼ D/A] keys.

It is possible to change only lower 2 digits of the year, with the upper 2 digits fixed as shown below.

Upper 2 digits	Lower 2 digits
19	87 to 99
20	00 to 86

(2) Setting the date

Move the blinking digit to the display block b and change the setting as described in (1).

(3) Setting the hour

Move the blinking digit to the hour setting section of the display block c and change the setting as described in (1). It is possible to change the hour and minute with the second fixed to 00.

(4) Setting the realtime control mode

Move the blinking digit to the setting control section of the display block c and change the setting with [▲ BEEP] and [▼ D/A] keys.

Setting "0" turns the realtime control mode OFF.
Setting "1" turns the realtime control mode ON.

To complete each setting, be sure to press the [SET RESET] key.
In the realtime control mode, the Y.M.D lamp lights when constant setting is finished.

CAUTION

1. Resetting the 3191 by pressing the [SHIFT] and [SET RESET] keys will set the starting time for the realtime control to the time of resetting.
2. It is not possible to set the date that does not exist (e.g., Feb. 30). The date will be set to Jan. 1.

6.12.2 Starting by means of realtime control

To start operation at the specified time, set the realtime control mode to ON. Pressing any start keys for the integrator, printer or averaging function in this state will set the unit in the waiting state for starting, with the LED blinking on the constant setting section corresponding to each function.

	Start key	Constant setting section
Average	[SHIFT] [▶ AV]	AV lamp
Printer	[RUN START STOP]	PRINTER INTVL lamp
Integrator	[START STOP]	INTEGRATOR TIME lamp

If the set time has been passed when the start key is pressed, the 3191 starts operation immediately.

The printer will start operation synchronized with the averaging function and the integrator even if the start key is not pressed. If there is no need to print out data, set the time interval to 0. (For the setting of time interval, refer to the 9480 Printer Unit Instruction Manual.)

6.13 Silenced operation

Every time a key is pressed on the 3191, a beep will sound. To turn off this beep, press the [SHIFT] and [▲ BEEP] keys. Pressing them again will turn it back on.

6.14 Self test

The self test function (self diagnosis) determines the status of the 3191 unit, checking that all LEDs, ROM and RAM are operating normally.

Pressing the [SHIFT] and [TEST] keys activates the self test. All display segments will light for about 1 second, and if there is no problem then the system will return to the previous status. If a fault is detected, an error message will be displayed in display block c.

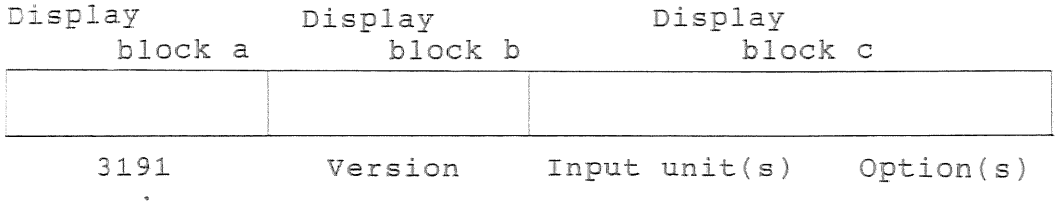
Error message

i)	0x	0 ≦ x ≦ 7 ROM fault
ii)	10	RAM fault
iii)	20	Either channel 1 unit not connected or only channel 1 and 3 unit inserted.
iv)	30	A/D board fault
v)	40	Unit interface fault
vi)	50	Display board fault
vii)	60	Backup error

Caution

1. The tester requires repair if error messages i), ii), iv), v), or vi) are displayed.
2. If error message iii) is displayed, turn off the power momentarily, then turn it back on after correctly reinserting the unit. If the message still appears, repair is required.
3. If error message vii) is displayed, the tester can be used without any problem but should be left on for a while to recharge the backup battery. (complete recharge for about 15 hours.)
4. Note that the GP-IB status lamp will not light during the self test execution.

When power is turned on or a self-test is performed, all indications light for approx. 1 second, then the software version and indications for any installed options are shown on displays a, b and c.



Display block a: Shows "3191".
Display block b: Indicates the software version.
Display block c: Indicates any installed options. The upper three digits stand for input units, representing channels 1, 2 and 3, respectively. Codes are as follows.

0 ..... 9484 or 9485
2 ..... 9486 with a 20-A sensor
3 ..... 9486 with a 200-A sensor
7 ..... 9486 without sensor

The lower four digits indicate the presence of units 9480 to 9483. They represent, from the top down, the 9483 integrator, the 9480 printer, the 9481 D/A output device, and the 9482 GP-IB. A one (1) means that the corresponding option is installed, and a zero (0) that it is not.

6.15 Reset

Pressing the [SHIFT] and [SET RESET] keys will reset all settings except realtime and GP-IB address, returning the system to the initial state.

Initial settings

Setting	Set status
PT ratio (PT)	1.0000
CT ratio (CT)	1.0000
Scaling constant (SC)	1.0000
Averaging (AV)	10
Mode	0
No. of samples	10
Time	1000 hours (Hour 1000, Min 00)
Interval	1 min. (Hour 0, Min 01)
Realtime control (Y.M.D)	
Mode	0
Start time	Reset time
Integrator time* (INTEGRATOR TIME)	Continuous (Hour 0, Min 0)
Integrator input* (INTEGRATOR SEL)	1channel A1, 2 channel W1, 3 channel A1
Printer interval* TER (INTVL)	1minute (Hour 0, Min 01)
Printer data* (PRINTER SEL)	Print all
D/A output data* (D/A SEL)	1 channel VA1, 2 channel PF1, 3 channel var1
GP-IB address* (GP-IB ADRS)	Previously set address (no initialization)
Display block a (function)	V
(channel)	CH1
(range)	600V
(autoranging)	OFF
(MEAN)	OFF

Setting	Set status
Display block b (function)	A
(channel)	CH1
(range)	20A
(autoranging)	OFF
(MEAN)	OFF
Display block c (function)	W
(channel)	CH1
(range)	12.00kW
Shift	OFF
Filter	OFF
Sampling	Continuous
Mode: Channel 1 inserted	1φ
Channels 1 and 2 inserted	3φ3W
Channels 1~3 inserted	3φ4W

* marks options

6.16 Backup

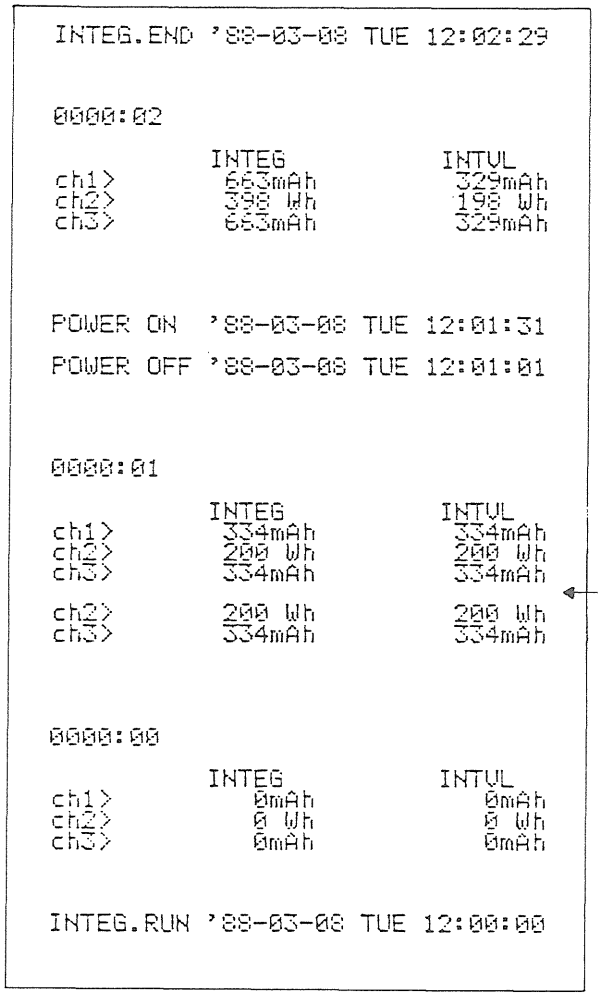
This 3191 maintains the setting conditions and measurement results of the integrator by means of a built-in battery when the power is off.

if power failure occurs during execution of integration, interval printing or averaging, operation is resumed when the power is restored. At this time, the printer (9480 option) will print the time of the power failure and the time of restoration of the power.

If power failure occurs while the printer is operating, the same data will be printed again when the power is restored (refer to the print example).

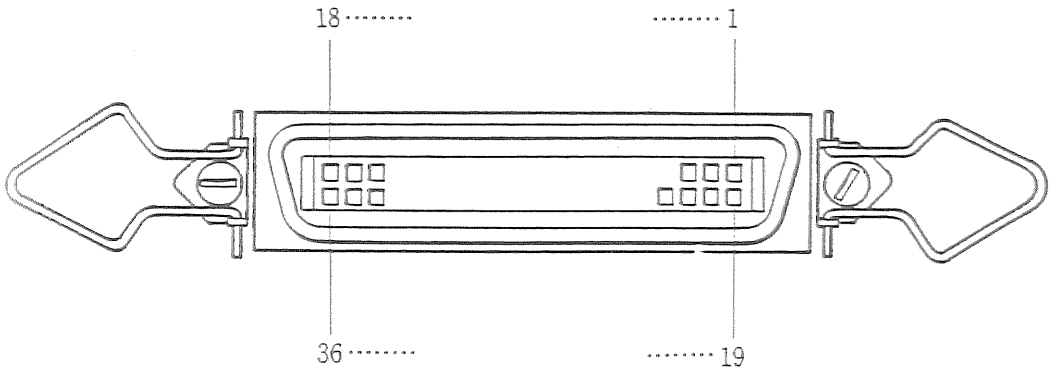
CAUTION

1. The settings are initialized when backup is not properly done or the optional equipment is replaced.
2. The measured data may not be printed in some case of power failure. (For example, in the case where power failure occurs just before printing starts.)
3. When power failure occurs while the HOLD lamp is blinking or lit after the termination of averaging, the TOTAL average value is displayed and the hold state is entered at the time of restoration of the power.



7. Connector usage

7.1 Pin array



Connector: ADS-B36LMR (Honda Tushin Kogyo) or equivalent

V 1	1	19	INTEG. EXT. CONT
A 1	2	20	D. GND
W 1	3	21	PRINTER EXT. PRINT
V 1 monit	4	22	D. GND
A 1 monit	5	23	EXT. A/D START
A. GND	6	24	D. GND
V 2	7	25	
A 2	8	26	
W 2	9	27	
V 2 monit	10	28	
A 2 monit	11	29	
A. GND	12	30	D/A OUT 1
V 3	13	31	D/A OUT 2
A 3	14	32	D/A OUT 3
W 3	15	33	A. GND
V 3 monit	16	34	W1+W2
A 3 monit	17	35	W1+W2+W3
A. GND	18	36	A. GND

7.2 Signal functions

1) Analog output (level output)

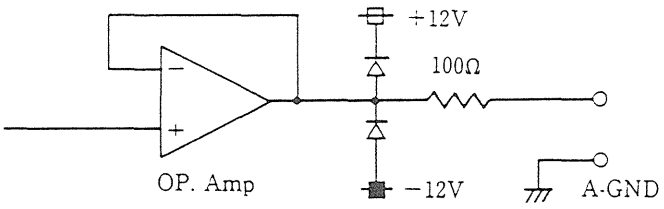
V1, A1, W1	V2, A2, W2	V3, A3, W3	#1
W1+W2	W1+W2+W3		
D/A OUT1	D/A OUT2	D/A OUT3	#2

2) Waveform output (monitor output)

V1monit, A1monit, V2monit, A2monit, V3monit, A3monit #1

3) Output circuit

The analog output and waveform output circuits are as shown below.



Analog output: ±2V full scale for each range.
Waveform output: 2Vrms f.s. for each range.

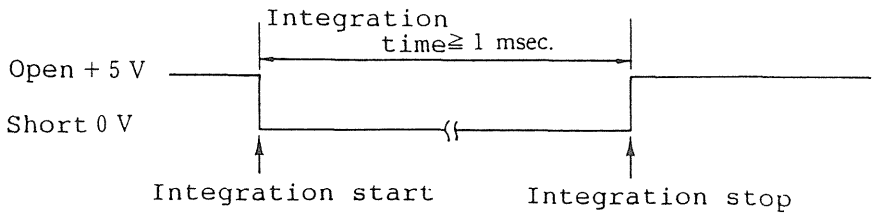
Caution

1. The numbers 1, 2 and 3 correspond to input unit channels. There is not output is the corresponding input unit is not installed (output is 0V).
2. These outputs are not valid if different ranges are used for each channel.
3. If the optional 9481 D/A output interface is installed in the 3191, then the values allocated to the panel displays will be output in analog.

4) External control

a. INTEG.EXT.CONT.

If the 9483 integrator interface is mounted in the 3191 then integrator start/stop is possible through external control.

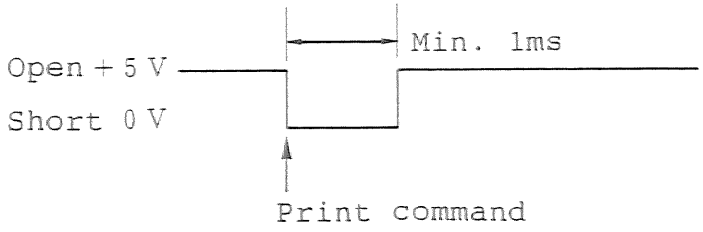


Caution

1. In principle the integration time can be controlled in 1ms units, but in fact this time will be extended as required to input the set number of data. For example, for a rated input 180msec, or for a 1/40th rated input 7.2 seconds, is required to change the lowest digit. Take this point into consideration.
2. Actual integrator start/stop may be delayed slightly by 3191 status, such as whether it is printing out or using GP-IB output.

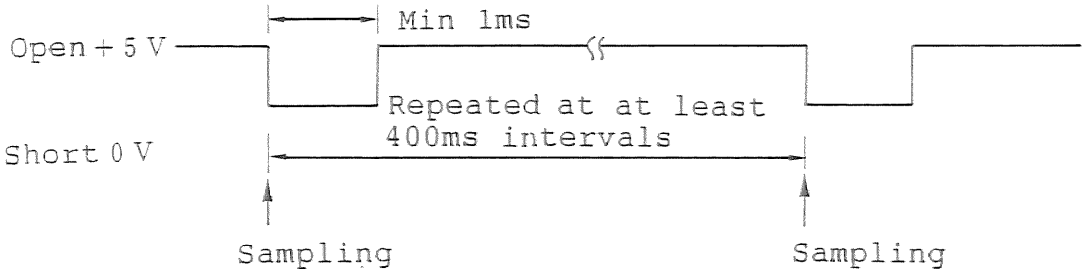
b. PRINTER EXT.PRINT

If the 9480 printer unit (option) is mounted in the 3191, then a print (the same as a manual print of the panel) is possible with an external signal.



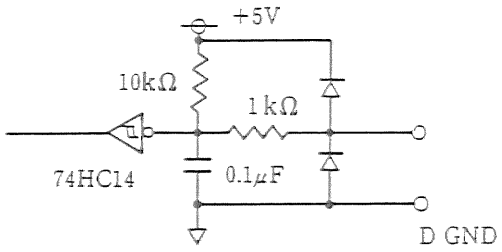
c. EXT. A/D START

In the sampling hold status, an external signal can be used to trigger sampling.



5) Input circuit

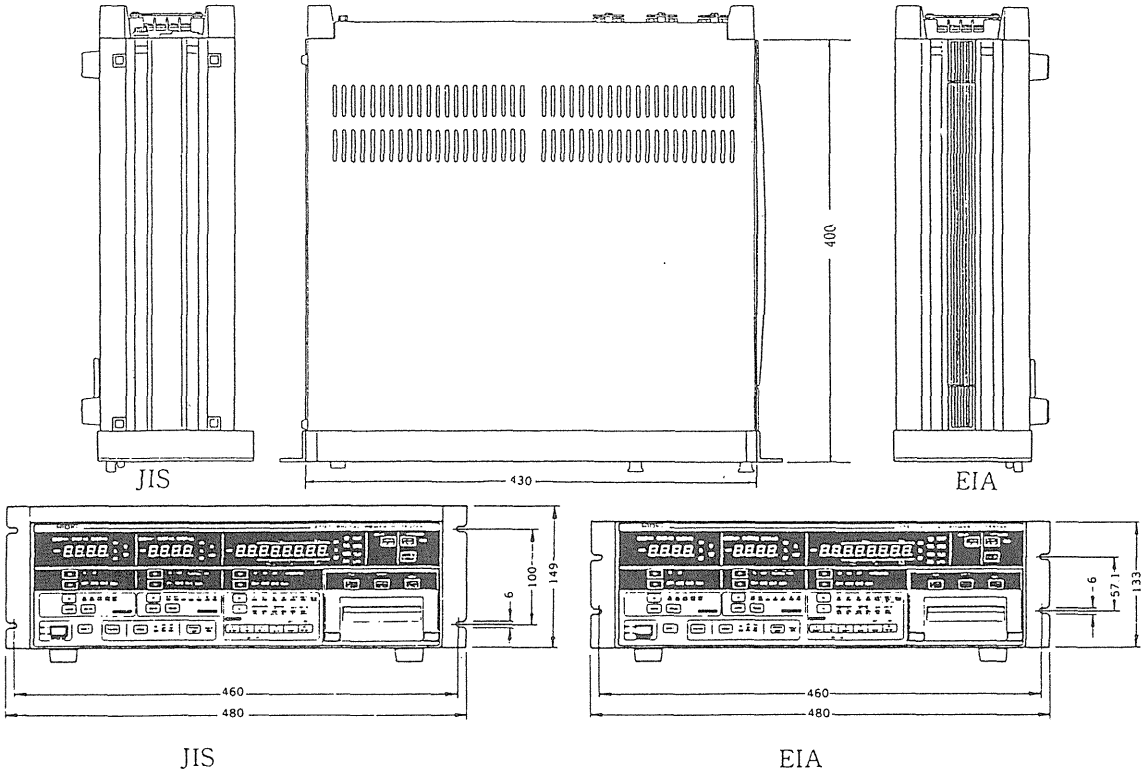
The external control input circuit is given below.



8. Rack mount

8.1 For rack mounting, attach a rack mounting brackets on the basis of the Fig.8-6 to 9.

8.1.1 Dimensions



JIS EIA

8.1.2 Mounting method

(1) Tear off the sheets from the both side of the tester.

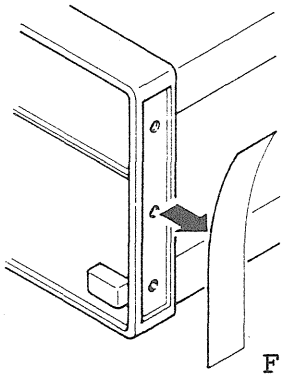


Fig. 8-1

(2) For EIA racks, attach a rack mounting brackets as shown in FIg. 8-2.

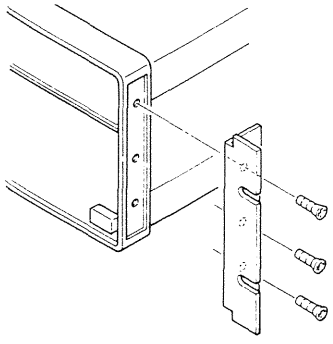


Fig. 8-2

For JIS racks, attach a rack mounting brackets as shown in Fig. 8-3.

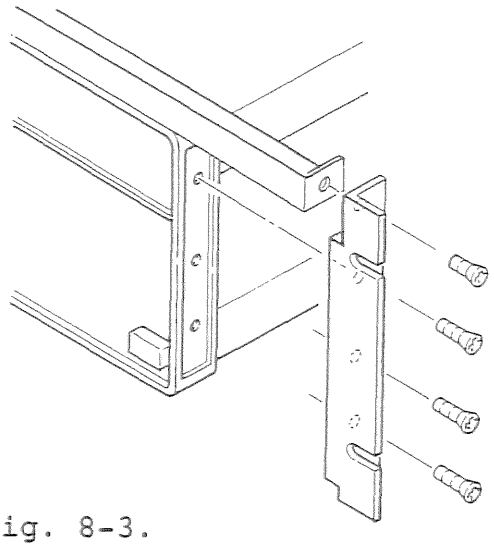
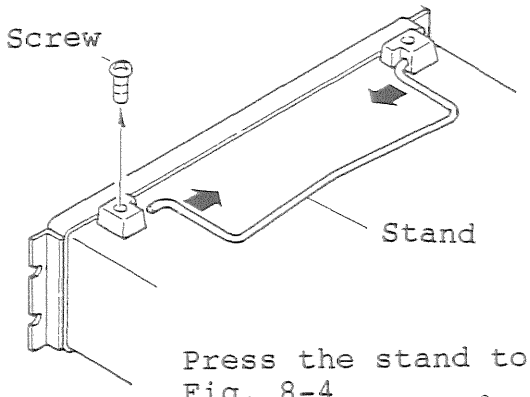


Fig. 8-3.

(3) Attache a rack mounting bracket to the other side of the tester.

(4) To install the tester into the rack, remove the 4 feet from the bottom of the tester as shown below.
1) remove the stand and screws as shown in Fig. 8-4.

> ⚠ WARNING
> If the feet are removed and then fasten the screws, short may occur inside.



Press the stand to remove it.
Fig. 8-4

2) Remove each foot as folows:

i) Slide the hook in the direction of arrow 1 to bend the flexible tab.

ii) Lift the foot in the direction of arrow 2 to unhook the other tab.

iii) Remove the foot by pulling and twisting the foot in the direction of arrow 3.

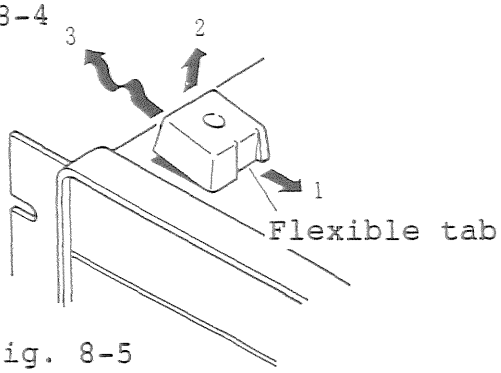


Fig. 8-5

3) Two back feet are adhered to the tester by the adhesive double couted tapes. Use any release agent to remove the tape.

Note: Use any mount support frame if the rack mounting brackets cannot support the tester steady.

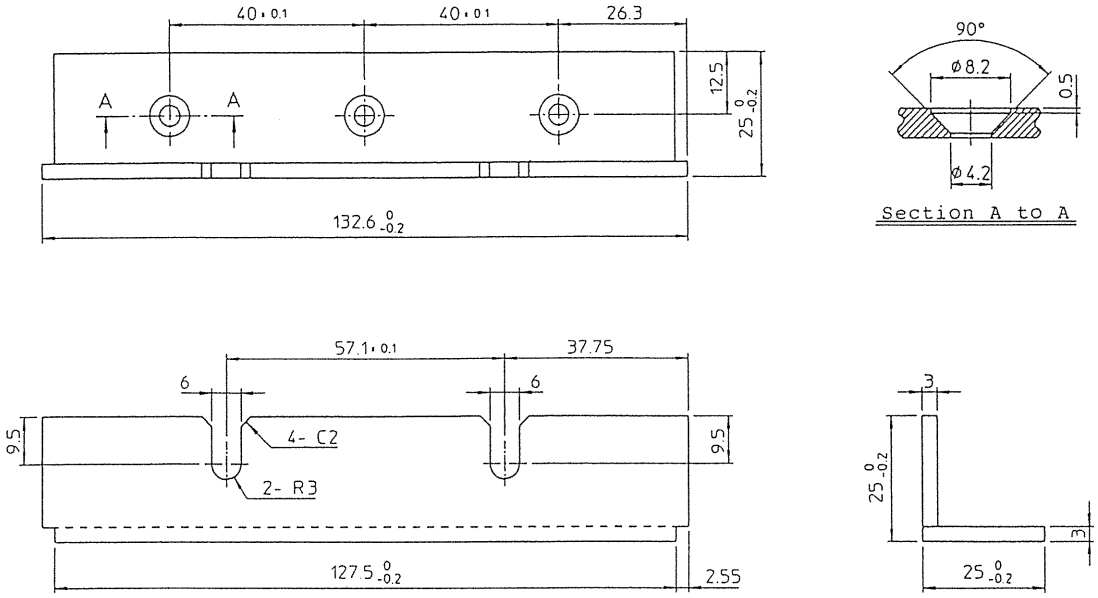


Fig. 8-6 Bracket for EIA Brackets are required each sides.
(Screw··· M4×8 six)

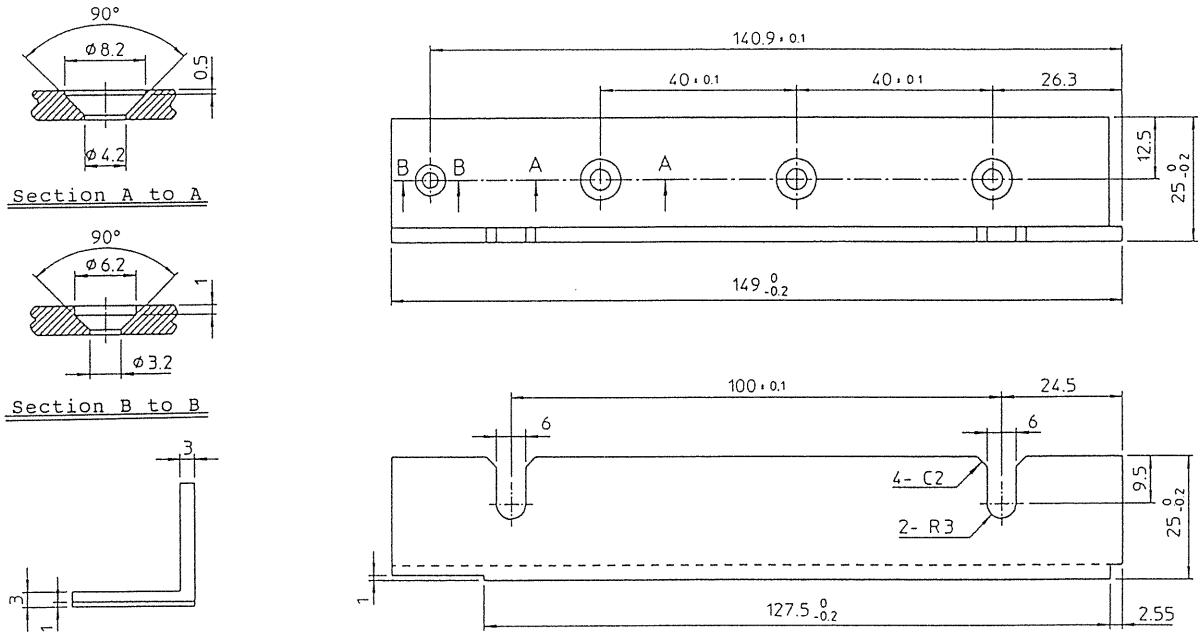


Fig. 8-7 Bracket for JIS A bracket is required at right side.
(Screw··· M4×8 six, M3×5 two)

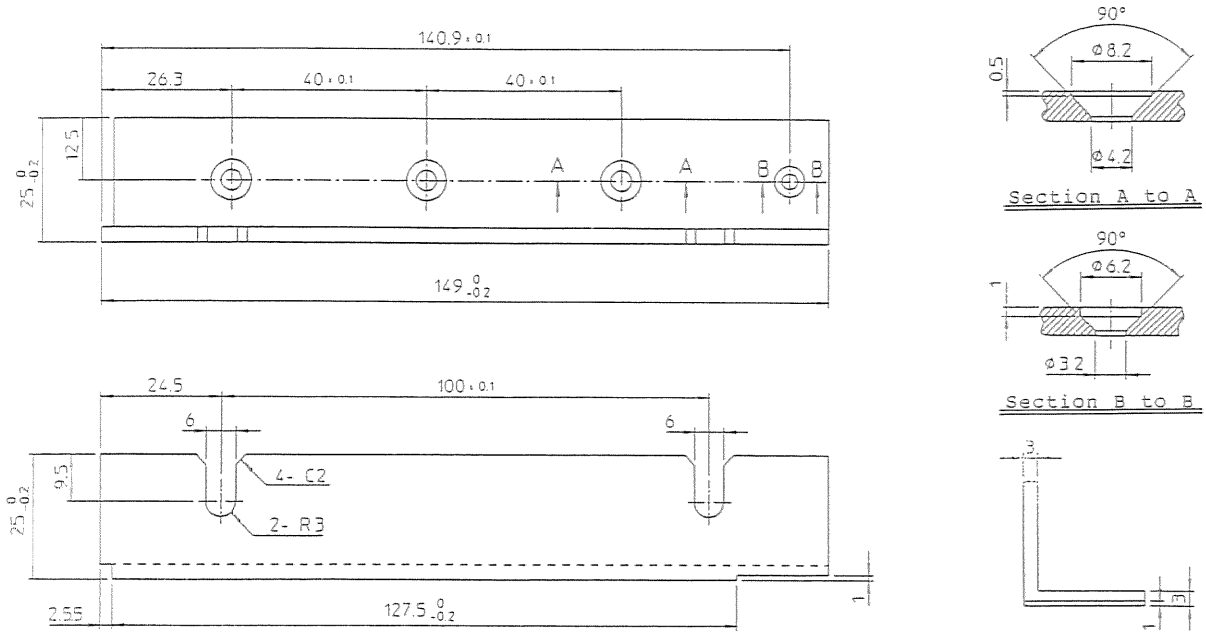


Fig. 8-8 Bracket for JIS A bracket is required at left side.

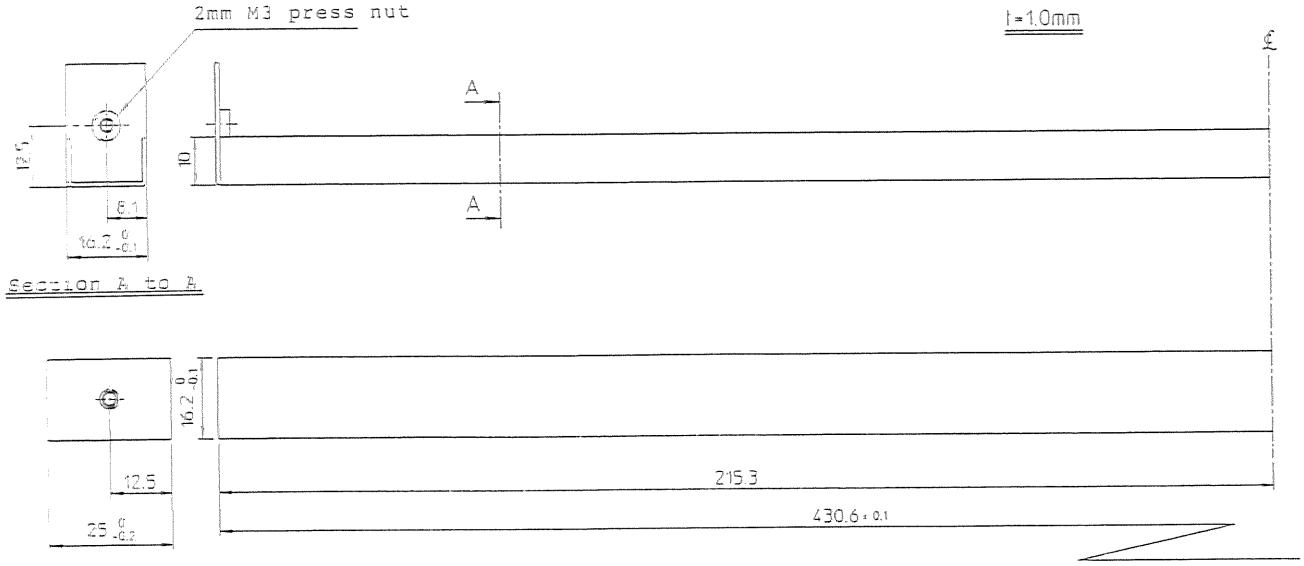


Fig. 8-9 Bracket for JIS

Appendix A

9480 Printer Unit

INSTRUCTION MANUAL

Table of Contents

1. Specifications

Printing type: Thermal type serial dot
Digits: 32 digits/line
Character format: 7x5 dot matrix (2.4 x 1.6 mm.)
Line pitch: 2.8 mm.
Printing speed: about 0.7 lines/sec.
Recording paper (type 9223): Black-printing thermal type paper
- Roll width: 80 mm x 30 meter
- Roll core diameter: 12 mm., paper diameter max. 53 mm.
- Red marking on last 3 meters

Functions
- Printing of all measured items
- Printing of selected items
- Printing at time interval (1 minute to 1000 hours)
- Manual printing and externally-controlled printing
- Starting printing by means of realtime control
- Starting printing by means of average (Timer mode) start
- Printing the total average value at the time of terminating the average time and stopping the printing
- Starting printing by starting the integrator....#1
- Printing the integrated interval value for each interval..#1
- Stopping printing by means of terminating the integration time....#1
- Printing the setting conditions by means of HELP PRINT
- Stopping printing and alarm display by means of detecting paper out
- Printing the power failure time and power restoration time.....#2
- Resuming printing after restoration from power failure.....#2

Operation keys
- Start/stop
- Manual/help print
- 1-line/10-line feed

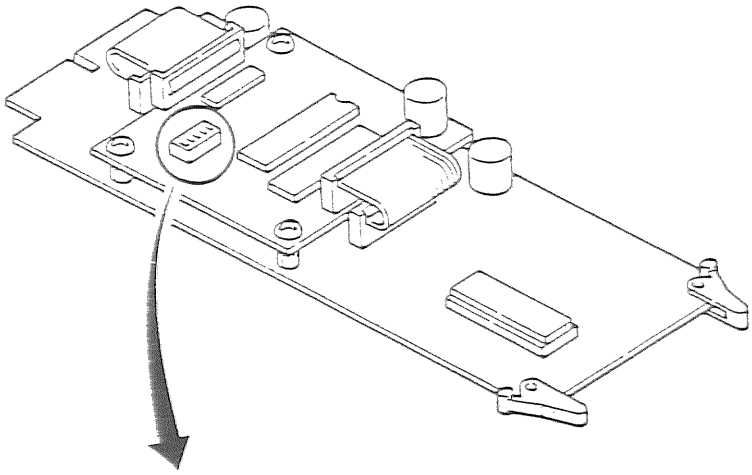
Status display
- RUN - Displayed during operation
- ERROR - Displayed for paper end or fault

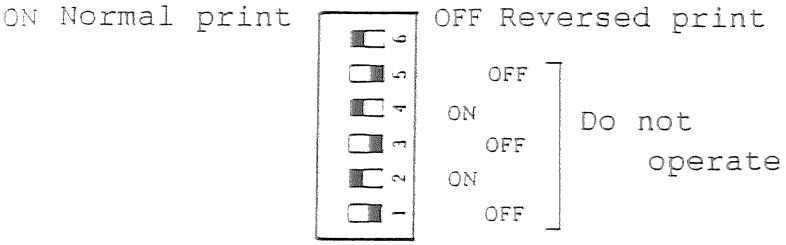
Service life - about 500,000 lines (including head replacement)

Note:#1 Requires the optional 9483 integrator interface.
#2 Refer to the 3191 instruction manual [6.16. backup.]
Optional accessory: 9223 Printer Paper (five 30-m rolls)

2. Installation

2.1 Printing direction set





DIP switch
(DIP 101)

Switching SIP101 SW6 on/off sets print for normal or reverse.

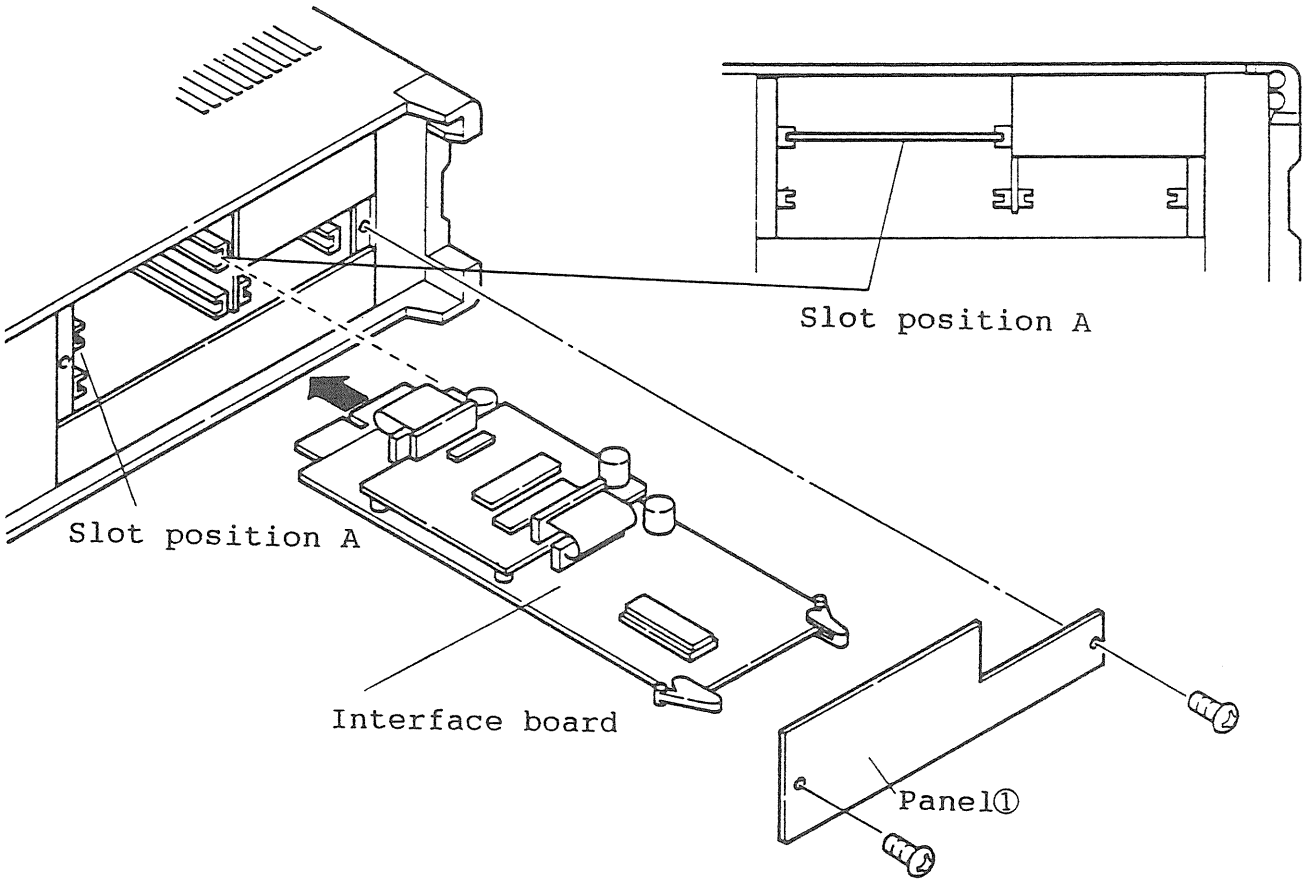
ON (normal print)

```
0000:01

                Voltage              Ampere
ch1>          30.00   V          200.0   mA

                Watt                 VA
ch1>           4.50   W           6.00   VA

                PF                   Var
ch1>          0.749                3.97 var

                INTEG                INTVL
ch1>          75.7mWh              75.7mWh


0000:00

                Voltage              Ampere
ch1>          30.01   V          200.0   mA

                Watt                 VA
ch1>           4.50   W           6.00   VA

                PF                   Var
ch1>          0.749                3.98 var

                INTEG                INTVL
ch1>             0 Wh                 0 Wh
INTEG.RUN '87-02-23 MON 18:46:20
```

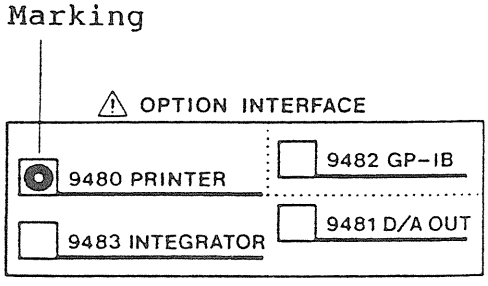
OFF (reversed print)

```
ch1>  75.5mWh          INTUL
                       INTEG  75.5mWh

ch1>  0.750            PF
                       var    3.97 var

ch1>  4.50   W         Watt
                       VA     6.00  VA

ch1>  30.01  V         Voltage
                       Ampere 200.0 mA

                                    10:0000

ch1>  0 Wh             INTUL
                       INTEG  0 Wh

ch1>  0.750            PF
                       var    3.97 var

ch1>  4.50   W         Watt
                       VA     6.00  VA

ch1>  30.01  V         Voltage
                       Ampere 200.0 mA

                                    00:0000
INTEG.RUN '87-02-23 MON 18:52:20
```

2.2 Interface board installation



1. Remove the option interface panel from the rear of the 3191.
2. Turn the interface board so that the components are up and insert it into slot A.
3. Press the board firmly into the 3191 completely.
4. Reattach panel 1, and mark the option interface label to indicate that the 9480 has been inserted.



2.3 Mechanism installation

1. Remove the sheet from the printer unit by inserting a tweezers into the section shown in the figure 1-1).
2. Loosen the 4 screws and remove the panel.
3. As shown in Fig. 2 pull out the flat cable gently and connect it to the board so that the bump on top of the connector (4) is on top. Attach the flat cable clamp to the mechanism.
4. As shown in Fig. 3, raise the side plate (5) of the mechanism over roller 7, and insert the rear roller (6) into the track. Insert roller (7) into the track at the cutout (8).
5. Press the mechanism to the back and secure it with the rotary catch.

Fig. pA5: 2. Flat cable 3. Cable clamp 4. Connector 5. Side plate 6. Roller 7. Roller 8. Cutout

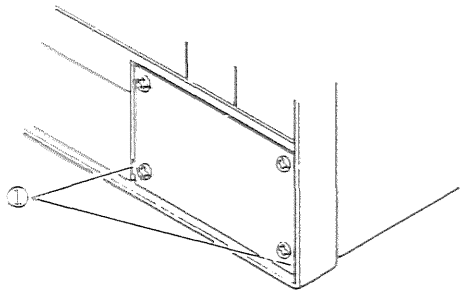


Fig. 1

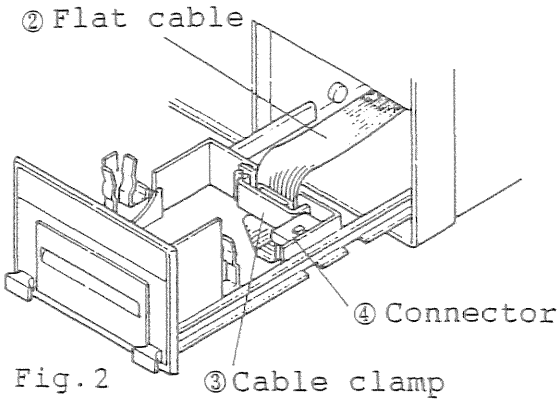


Fig. 2

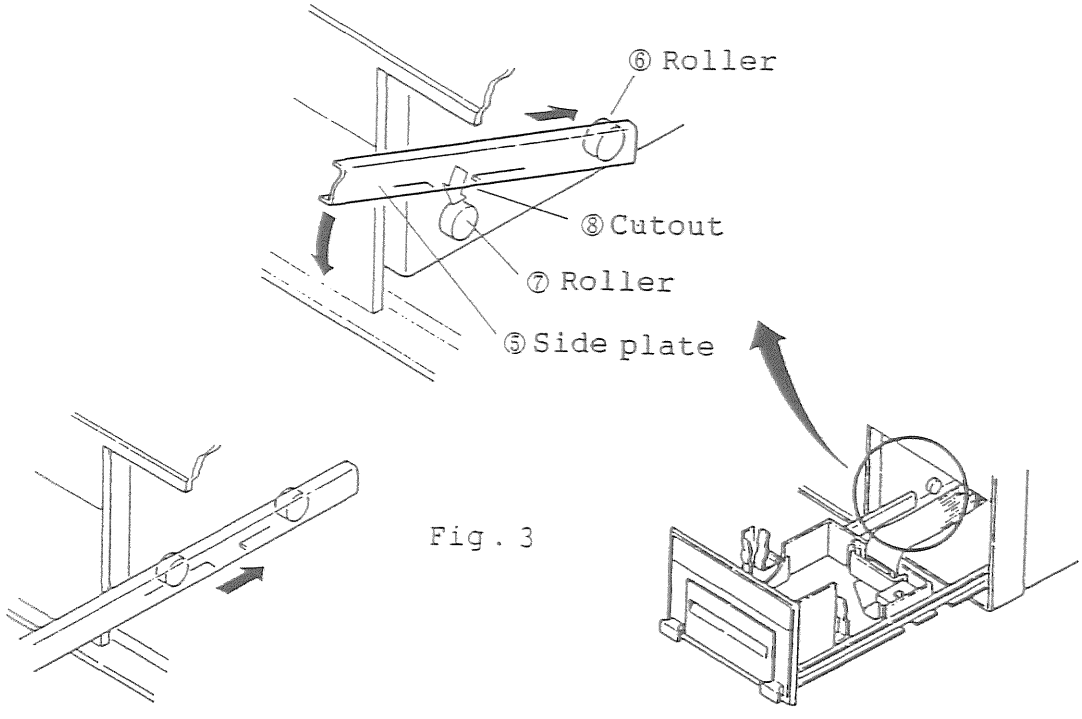
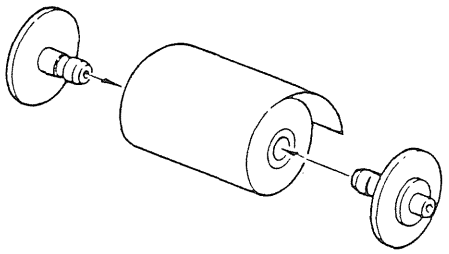


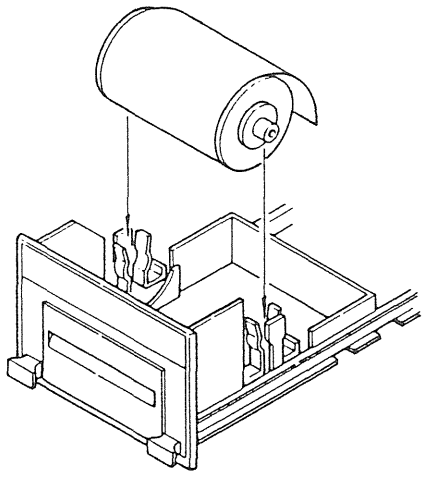
Fig. 3

2.4 Printer paper set

1. Insert the axles on both sides of the roll.

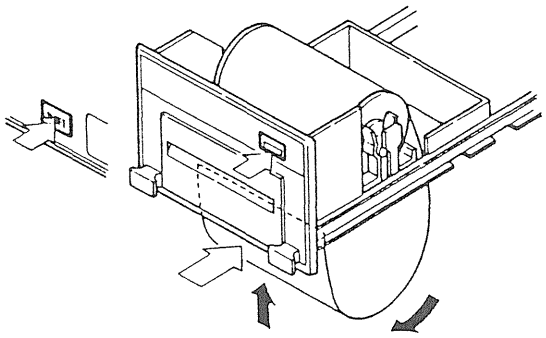


2. Open the paper end and fit the roll securely into the holders.



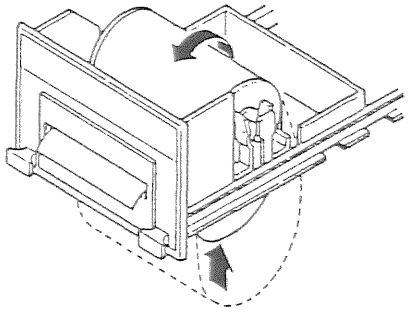
3. Pull out the paper end to the bottom of the printer guide plate.

4. Insert the end of the printer paper between the guide plate and the bottom of the printer.



5. Hold down the paper and press the SHIFT key, then the 1 LINE 10 LINE key to feed the paper. Continue pressing until the paper feeds out past the paper cutter.

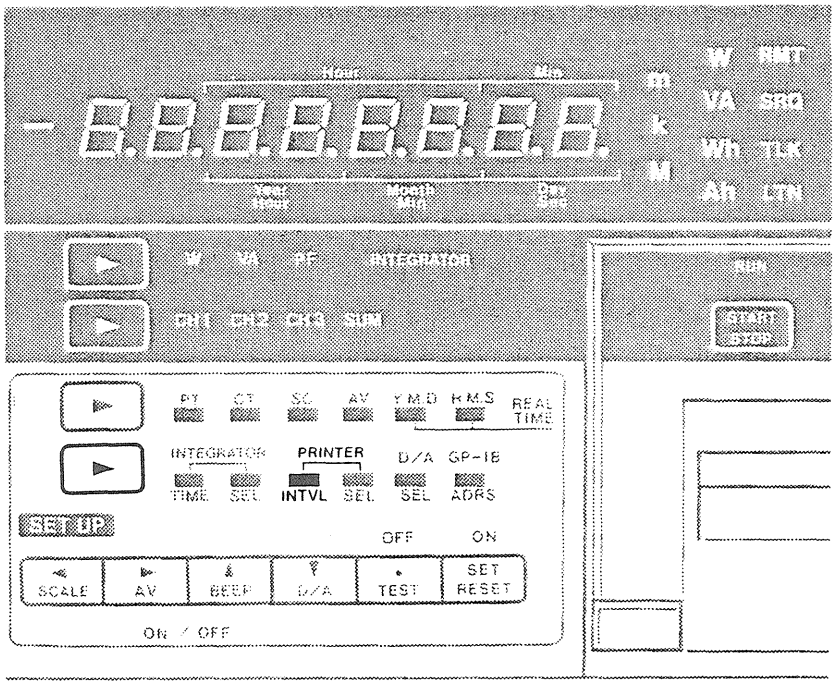
6. Roll back up the looseness in the paper roll, and set the mechanism back into the 3191, taking care that the paper does not jam or catch.



3. Time interval set

Display block c

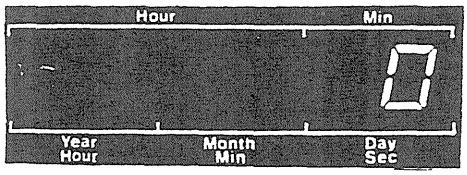
Select key b



Example: Indicates a setting for a 30-minute interval.

1. Press select key b [►] until the PRINTER INTVL lamp lights.

2. The previously-set printer interval will be displayed in display block c, and the right-most digit will flash.



3. Use the [SCALE] and [AV] keys to move the position of the flashing digit (digit to be changed).

4. Use the [BEEP] and [D/A] keys to increase/decrease the digit.

Caution

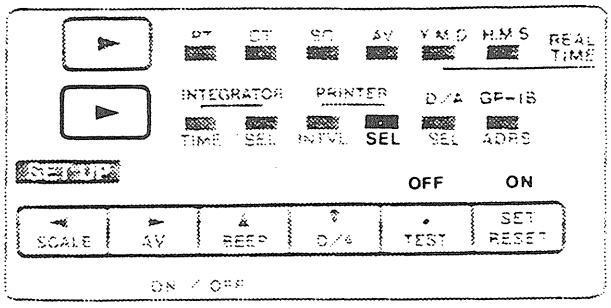
The increase/decrease in the displayed digits will be automatically stored into memory. The time setting may be from 1 minute to 1000 hours, and other values are not accepted.

5. After setting the digits to the desired value, press the SET/RESET key to complete the setting procedure. Unless this key is pressed the new value will not be stored into memory.

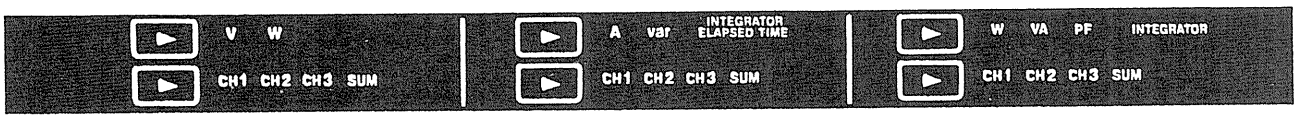
6. If time interval printing is not used, set this value to 0.

4. Printout item set

Select key·b



1. Press select key b [►] and light the PRINTER INTVL SEL display. At this time the V.CH1 lamp will light or flash.
2. First determine which functions are to be printed out. Refer to the chart below depending on the number of units installed.

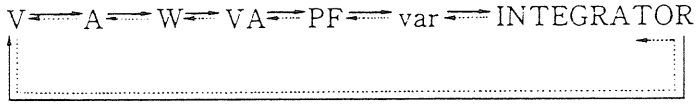


3. Use the [◄ SCALE] and [► AV] keys to move to the item to be printed out, and press the [SET RESET] key to set that item to be printed. To specify an item as no print, press [TEST]

Caution

When a function or channel lamp is flashing, it indicates that the item will not be printed out. If a lamp is on, it indicates that the item will be printed out. If the lamp is on, set with the [◄ SCALE] and [► AV] keys is possible.

Set order



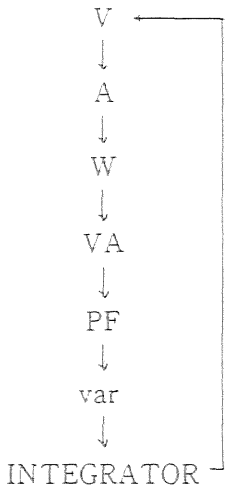
This order will be affected by the number of input units, presence of options and the setting state. The system will only allow settings that are possible for the system configuration.

Pressing the [◄ SCALE] key will enable movement in the reverse order.

Printed out functions by number of input units

Function	Input unit quantity		
	1 CH	2 CH	3 CH
V_1	○	○	○
V_2		○	○
V_3			○
V_{SUM}		○#1	○#2
A_1	○	○	○
A_2		○	○
A_3			○
A_{SUM}		○#1	○#2
W_1	○	○	○
W_2		○	○
W_3			○
W_{SUM}		○	○
VA_1	○	○	○
VA_2		○	○
VA_3			○
VA_{SUM}		○	○
PF_1	○	○	○
PF_2		○	○
PF_3			○
PF_{SUM}		○	○
var_1	○	○	○
var_2		○	○
var_3			○
var_{SUM}		○	○
#3 $INTEG_1$	△	△	△
$INTEG_2$	△	△	△
$INTEG_3$	△	△	△
$INTEG_{SUM}$		△#4	△#5

Function selection



#1; V, A indicate (V1+V2)/2 and (A1+A2)/2 respectively.

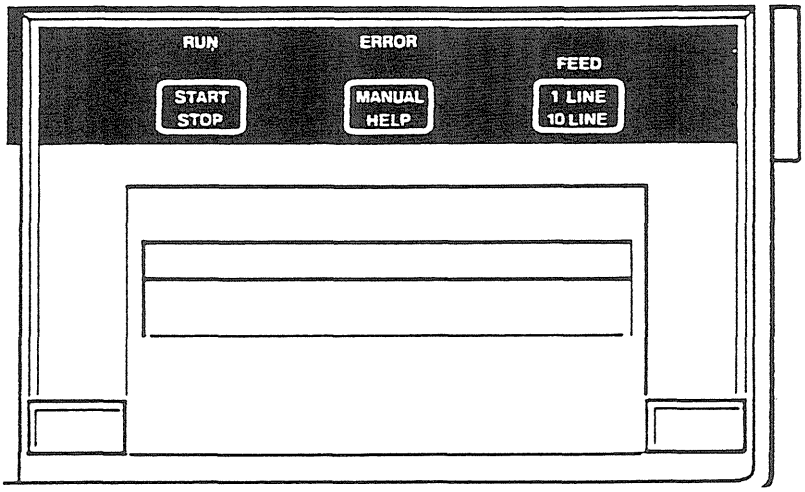
#2; When the mode is set to 1ø, 3ø3W(3V3A), 3ø4W, V indecates (V1+V2+V3)/3 and A indicates (A1+A2+A3)/3. In the case of 3ø4W, V indicates (V1+V2)/2, and A indicates (A1+A2)/2.

#3; An integrator interface 9483 is required.

#4; A1h+A2h is indicated when A1 and A2 are selected as input to the integrator, and W1h+W2h is indicated when W1 and W2 are selected.

#5; With the mode being 1ø or 3ø4W, A1h+A2h+A3h is indicated when A1, A2 and A3 are selected as input to the integrator and W1h+W2h+W3h is indicated when W1, W2, and W3 are selected. With the mode being 3ø3W, 3øW (3V3A), A1h+A2h and W1h+W2h are indicated respectively.

5. Start/stop

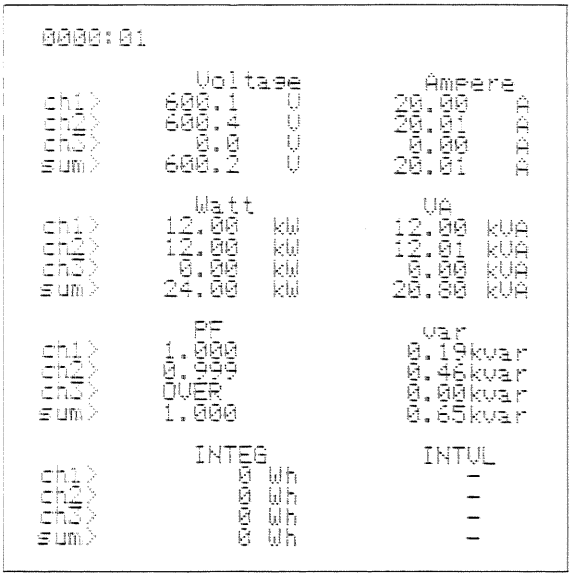


The printer starts printing with the [START STOP] key, with the RUN indication lamp lit. However, when the 3191 unit is set to the realtime control, the unit will be in the waiting start until the starting time, withe the PRINTER INTVL lamp blinking. (#1)

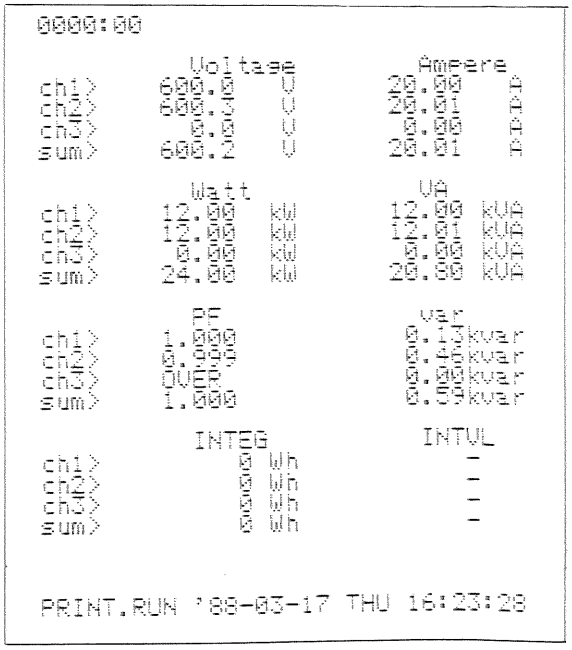
The unit prints the contents that are set in the privious selection of printing items and performs printing every time when the time set as a time interval is reached. (#2, #3)

Pressing [SHIFT] and [START STOP] will forcibly stop the printer. (#4)

<CAUTION>
#1. Refer to the 3191 instruction manual [6-12. Realtime control].
#2. It is not possible to use the set-up key while the printer is operating in the time interval mode.
#3. Changing the range, etc. when the sampling mode is in the hold state will leave the display off. At this time, the data fed to the GP-IB or printer will be ineffective. Further, measured data fed to the printer by means of external control will be also ineffective.
#4. The printer is started/stopped synchronized with the average (time mode) function and the operation of the integrator. Refer to the 3191 instruction manual [6-10. Average function] and [Instruction manual for D 9483 integrator interface].



```
0000:01

                Voltage                 Ampere
ch1>          600.1     V           20.000     A
ch4>          600.1     V           20.000     A
ch2>            0.0     V            0.000     A
ch3>            0.0     V            0.000     A
sum>          600.2     V           20.001     A

                Watt                    VA
ch1>           12.000    kW         12.000    kVA
ch4>           12.000    kW         12.000    kVA
ch2>            0.000    kW          0.000    kVA
ch3>            0.000    kW          0.000    kVA
sum>           24.000    kW         20.000    kVA

                PF                     var
ch1>          1.000                0.119kvar
ch4>          1.000                0.119kvar
ch2>          OVER                 0.000kvar
ch3>          OVER                 0.000kvar
sum>          1.000                0.000kvar

              INTEG                  INTVL
ch1>              0 Wh                 -
ch4>              0 Wh                 -
ch2>              0 Wh                 -
ch3>              0 Wh                 -
sum>              0 Wh                 -
```



```
0000:00

                Voltage                 Ampere
ch1>          600.1     V           20.000     A
ch4>          600.1     V           20.000     A
ch2>            0.0     V            0.000     A
ch3>            0.0     V            0.000     A
sum>          600.2     V           20.001     A

                Watt                    VA
ch1>           12.000    kW         12.000    kVA
ch4>           12.000    kW         12.000    kVA
ch2>            0.000    kW          0.000    kVA
ch3>            0.000    kW          0.000    kVA
sum>           24.000    kW         20.000    kVA

                PF                     var
ch1>          1.000                0.119kvar
ch4>          1.000                0.119kvar
ch2>          OVER                 0.000kvar
ch3>          OVER                 0.000kvar
sum>          1.000                0.000kvar

              INTEG                  INTVL
ch1>              0 Wh                 -
ch4>              0 Wh                 -
ch2>              0 Wh                 -
ch3>              0 Wh                 -
sum>              0 Wh                 -


PRINT.RUN '88-03-17 THU 16:23:28
```

6. Manual print/help print

Pressing the [MANUAL HELP] key will enable the previously selected data to be printed out at any time. With the [SHIFT] and [MANUAL HELP] keys it is possible to print out the panel settings.

This key operation is possible even while the printer is operating, but the command will take effect only after the current print run has been completed. If the key is pressed many times during printing, the print buffer will accept commands until full, and then ignore the remainder.

```
MANUAL.     '88-03-17 THU 16:25:40

            Voltage          Ampere
ch1>      600.0    V       20.00    A
ch2>      600.2    V       20.00    A
ch3>        0.0    V        0.00    A
sum>     ,600.1    V       20.00    A

              Watt               VA
ch1>      12.00   kW       12.00 kVA
ch2>      12.00   kW       12.01 kVA
ch3>       0.00   kW        0.00 kVA
sum>      24.00   kW       20.79 kVA

              PF              var
ch1>      1.000            0.00kvar
ch2>      1.000            0.33kvar
ch3>      OVER             0.00kvar
sum>      1.000            0.33kvar

            INTEG             INTVL
ch1>            0 Wh            -
ch2>            0 Wh            -
ch3>            0 Wh            -
sum>            0 Wh            -
```

```
HELP.       '88-03-17 THU 15:00:21

     MODE    3P3W 3ch

     RANGE
ch1>     600 V rms          20 A rms
ch2>     600 V rms          20 A rms
ch3>     600 V rms          20 A rms

SCALE(OFF)   PT         CT         SC
ch1>      1.0000     1.0000     1.0000
ch2>      1.0000     1.0000     1.0000
ch3>      1.0000     1.0000     1.0000

FILTER(OFF)

REAL TIME CONTROL(OFF)
     START   '88-03-17 THU 14:50

AVERAGE(OFF)
    >  COUNT       10
       TIME    1000h 00m
       INTVL      0h 01m

PRINT INTERVAL      INTEGRATE TIME
     0h 01m              0h 05m

          INTEG.IN     D/A OUT(OFF)
ch1>         W1             VA1
ch2>         W2             PF1
ch3>      W1+W2             var1

GP-IB ADDRESS    1
--------------------------------
```

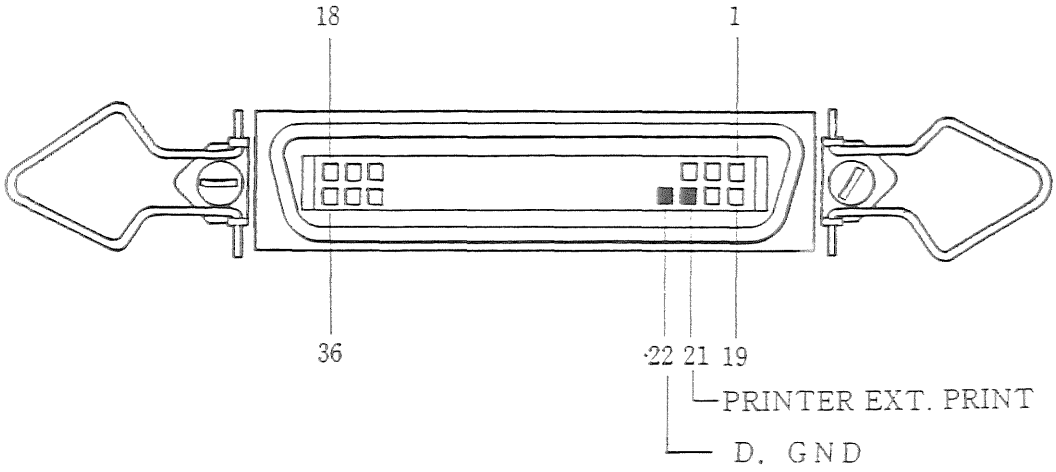
7. 1-line and 10-line feed

Pressing the [1 LINE 10 LINE] key feeds the paper 1 line, and pressing the [SHIFT] and [1 LINE 10 LINE] keys together feeds the paper 10 lines. Use the 10-line feed when changing paper rolls.

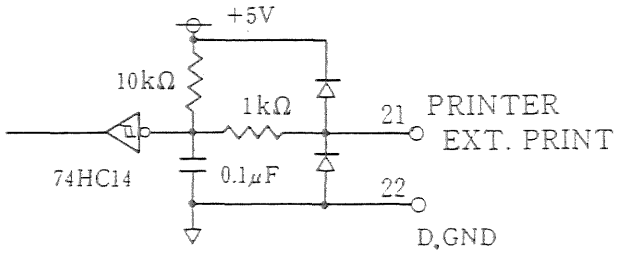
8. External print control

The ANALOG OUT/EXT.CONTROL connector on the rear panel of the 3191 can be used to operate the printer in the same way as a manual print operation. This is done with the PRINTER EXT.PRINT pin.

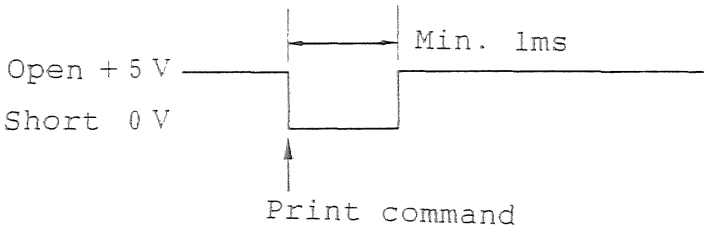
ANALOG OUT/EXT.CONTROL pin array



Input terminal



Input signal



9. Recording time

Where all data items are printed out, the printout will take up 29 lines on the paper. In length, this is equivalent to 81.2 mm (i.e. 2.8 mm/line x 29 lines), meaning that a single roll of paper can print out 369 times (30 meters / 81.2 mm.).

A red line will appear on the recording paper when only 3 meters remain, but the following guidelines are given for safety.

Time interval	Recording time per roll
1 min	6 hours, 9 minutes
5 min	30 hours, 45 minutes
10 min	61 hours, 30 minutes
15 min	92 hours, 15 minutes
30 min	184 hours, 30 minutes
1 hr	369 hours

10. Handling recording paper

Printer paper is heat-sensitive. Observe the following precautions.

Never store in a humid, warm place.
Avoid prolonged exposure to direct sunlight or fluorescent lighting
Never use organic solvent glues.
Never store in contact with polyvinyl chloride films for prolonged periods of time.
Take care to avoid moisture and tearing.
Making a copy is recommended if the copy is to stored for prolonged periods of time.

11. Printing the Load Factor

When averaging is executed in the timer mode, the total average value is printed after averaging is completed. Then, the maximum (Wmax) among average power values of each interval, as well as the load factor (LF) calculated on the basis of that maximum, and the interval during which Wmax appeared are also printed.
The load factor (LF) is calculated with the equation below.

$$LF = \frac{Wav}{Wmax}$$ where Wav is the total average power.

Wmax and LF detection is performed only for W_{SUM}. If there is an input unit installed only for channel 1, however, it will be performed for W1 in the 1 mode.

Wmax represents the maximum positive value among average power values of each interval. In case average power is negative for all intervals, Wmax= 0.

When the total average is negative, LF is equal to zero. It generates an OVER condition if Wmax= 0.

Appendix B

9481 A/D Output Interface

INSTRUCTION MANUAL

Table of Contents

1. Specifications

Configuration: 12-bit D/A converter, 3-channel
Precision: ±0.1%fs of main unit
Temperature coefficient: ±0.02%fs/C max.
Sampling rate: about 2.5 times/sec.
Output voltage: DC2Vfs (see note 1)

VA Outputs +2.047V if either input A or V is too high.
PF If either V or A input is 0, or if any of V, A or W is too high, outputs +2.047 for a lag and -2.048 for a lead.
var If any of V, A or W is too high, outputs +2.047 for a lag and -2.048 for a lead.

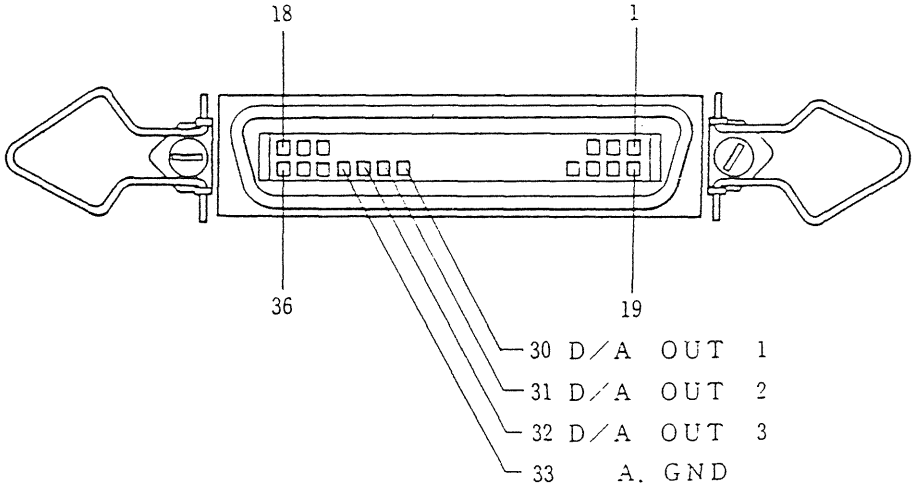
Output: Any 3 of average voltage (Vsum), average current (Asum), aparent power (VA), power factor (PF), reactive power (var), and integrator (INTEG) that are obtained by the digital calculation can be output in analog values.

Vsum....- The max.range of the channels used for the average value calculation is f.s.
- +2.047V is output when any of above channels is in an over-input state.

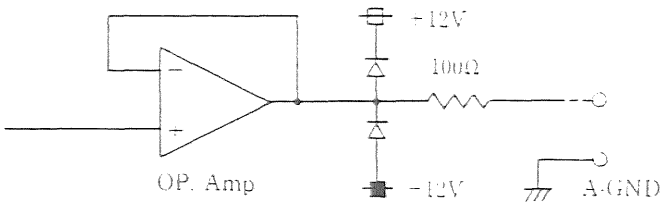
Asum....- Same as Vsum
VA.....- The voltage range (V) x current range (A) is f.s.
PF.....- -2V to 0V to 2V with respect to the advancing power factor 0 to power factor 1 to delayed power factor 0.
- +2.047V is output in the case of delay and -2.048V in the case of advancing if any of V and A is 0 or any of V, A, and W is over-input.

INTEG...- It is possible to output this value only when the integrator interface 9483 is mounted.
- "The range of A x integrated time" is f.s. in the case of the current integration, and "the range of V x the range of A x integrated time" is f.s. in the case of power integration (Wh). However, f.s. is 10000 hours if the integration time is set to 0 minute.

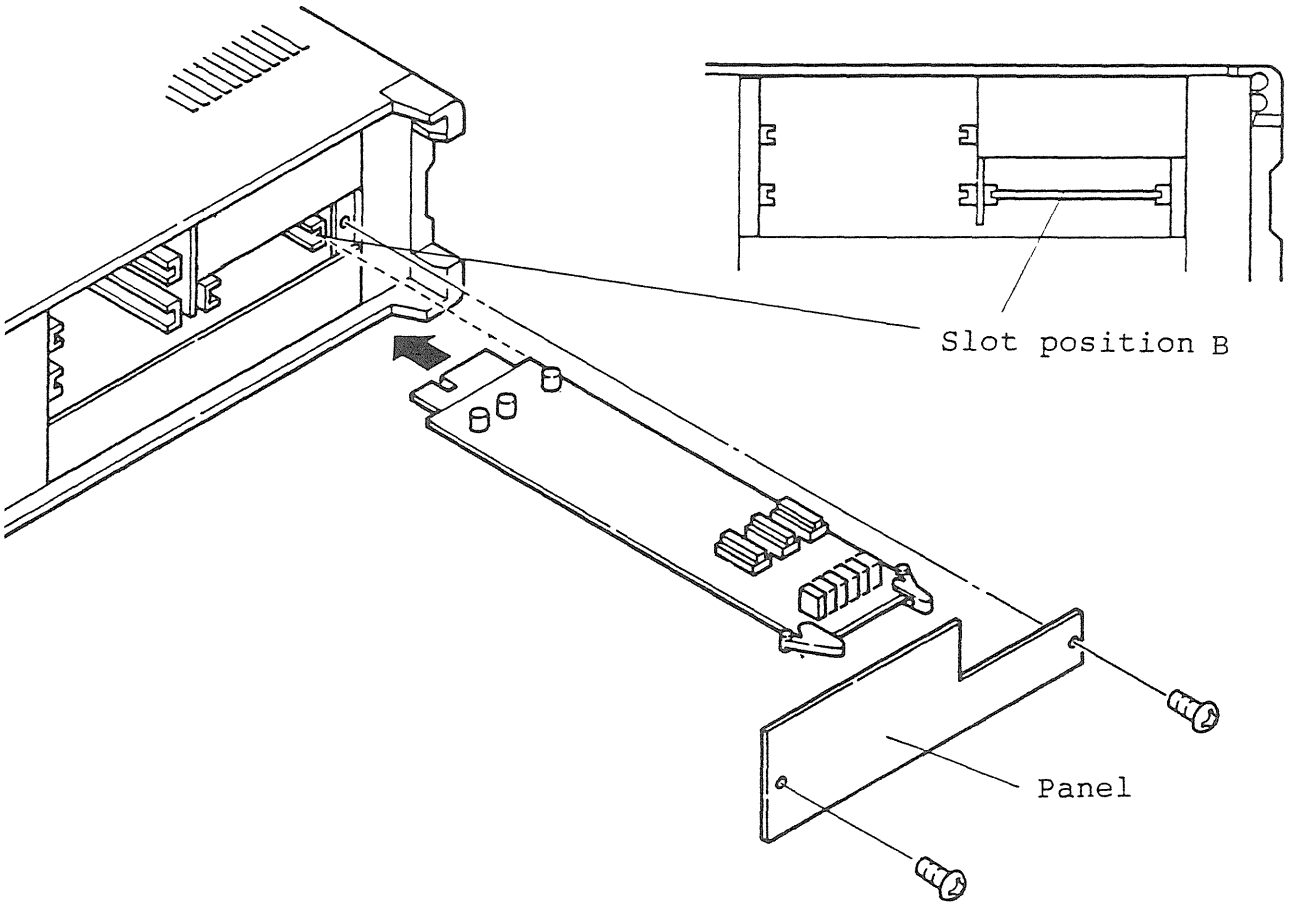
Output terminal: Output through the ANALOG OUT/EXT.CONTROL connector on the rear panel.



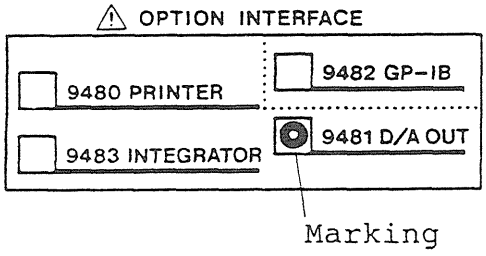
Output circuit



2. Installation

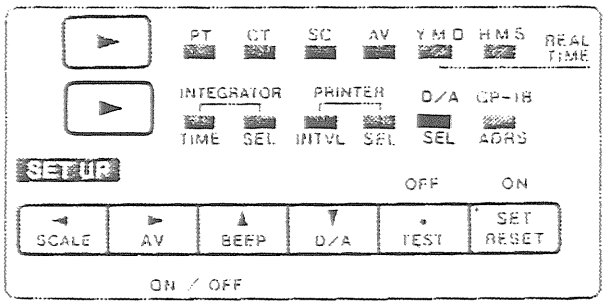


1. Remove the option interface panel from the rear of the 3191.
2. Turn the interface board so that the components are up and insert it into slot B.
3. Press the board firmly into the 3191 completely.
4. Reattach panel 1, and mark the option interface label to indicate that the 9481 has been inserted.



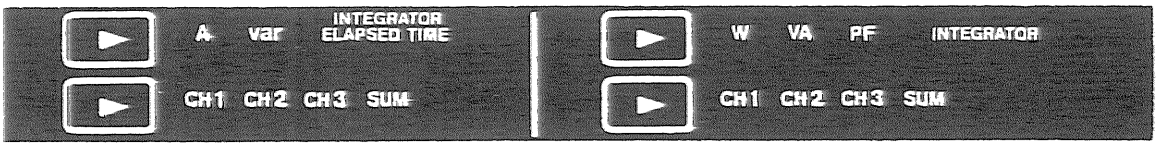
3. D/A output selection

Select key b

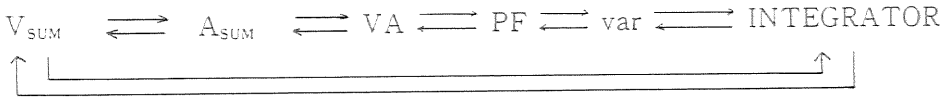


1. Press the [►] key to light the D/A SEL display (the items lighting at this time are those currently set).

2. First select which functions will be D/A output. Note that display block c will display the numeral 1, indicating that the first channel of a 3-channel D/A output specification is being made. After set is finished for one channel, press the [SET RESET] key to move to the next channel.



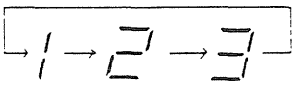
3. Cause the lamps for the functions output to flash with the [◄ SCALE] and [► AV] keys, and press the [SET RESET] key to stop the flashing and complete the setting for a channel.



4. Press the [SET RESET] key and the numeral in display block c will change to 2, indicating that channel 2 will be set next.

5. Set channel 2 in the same way as channel 1, and press the [SET RESET] key when completed. Do channel 3 in the same way. Note that only one setting can be made for each channel.

6. Selection operation order is a repetition, as:



Once a full set has been completed, pressing any key other than those used for set-up will switch back to the normal operation mode.

If the 9480 printer unit (optional) is installed in the 3191 main unit, the help print function (press the [SHIFT] and [MANUAL HELP] keys) will print out a list of which items are set to print for each channel.

Printout sample

```
HELP.      '88-03-17 THU 15:00:21

    MODE   3P3W 3ch

    RANGE
ch1>    600 V rms        20 A rms
ch2>    600 V rms        20 A rms
ch3>    600 V rms        20 A rms

SCALE(OFF)  PT        CT        SC
ch1>     1.0000    1.0000    1.0000
ch2>     1.0000    1.0000    1.0000
ch3>     1.0000    1.0000    1.0000

FILTER(OFF)

REAL TIME CONTROL(OFF)
      START  '88-03-17 THU 14:50

AVERAGE(OFF)
    >  COUNT      10
       TIME   1000h 00m
       INTVL     0h 01m

PRINT INTERVAL     INTEGRATE TIME
     0h 01m             0h 05m

         INTEG.IN    D/A OUT(OFF)
ch1>          W1           VA1
ch2>          W2           PF1
ch3>       W1+W2          var1

GP-IB ADDRESS   1
--------------------------------
```

4. D/A output on/off

The [SHIFT] and [D/A] keys can be used to enable (turn on) and disable (tutn off) D/A output.

[SHIFT] [D/A] Enabled (ON) D/A SEL lights

[SHIFT] [D/A] Disabled (OFF) D/A SEL does not light

In the disabled state the output is 0V.

It can be readily understood which state the 3191 is in by looking at the front panel and seeing whether the D/A lamp is on or off, but if the 9480 printer unit is installed it is also possible to print out the help print.

D/A output is not held even when the display values are held. Even if the averaging function is on, nonaveraged data will be output.

D/A output selection table

Function	No. of input units 1CH	2CH	3CH
#1 V_{SUM}		○	○
#1 A_{SUM}		○	○
VA_1	○	○	○
VA_2		○	○
VA_3			○
VA_{SUM}		○	○
PF_1	○	○	○
PF_2		○	○
PF_3			○
PF_{SUM}		○	○
var_1	○	○	○
var_2		○	○
var_3			○
var_{SUM}		○	○
#2 $INTEG_1$	△#3	△#4	△#5
$INTEG_2$	△#3	△#4	△#5
$INTEG_3$	△#3	△#4	△#5
$INTEG_{SUM}$			

#1; Vsum and Asum indicate the average voltage and average current respectively.

#2; An integrator interface 9483 is required.

#3 to #5;
The contents to be output are those assigned from the items in the following chart to each channel in the integrator.

Function	No. of input units 1CH	2CH	3CH
A_1h	○	○	○
W_1h	○	○	○
A_2h		○	○
W_2h		○	○
$(W_1+W_2)h$		○#6	○#6
A_3h			○
W_3h			○
$(W_1+W_2+W_3)h$			○#7
	#3	#4	#5

#6; Wsum is selected as input to the integrator in the case of 3ø3W mode (3ø3W(3V3A is also included).

#7; Wsum is selected as input to the integrator in the case of 3o4W mode.

Appendix C

9484 Direct Input Unit

INSTRUCTION MANUAL

Table of Contents

1. Specifications

(when combined with the 3191 main unit)

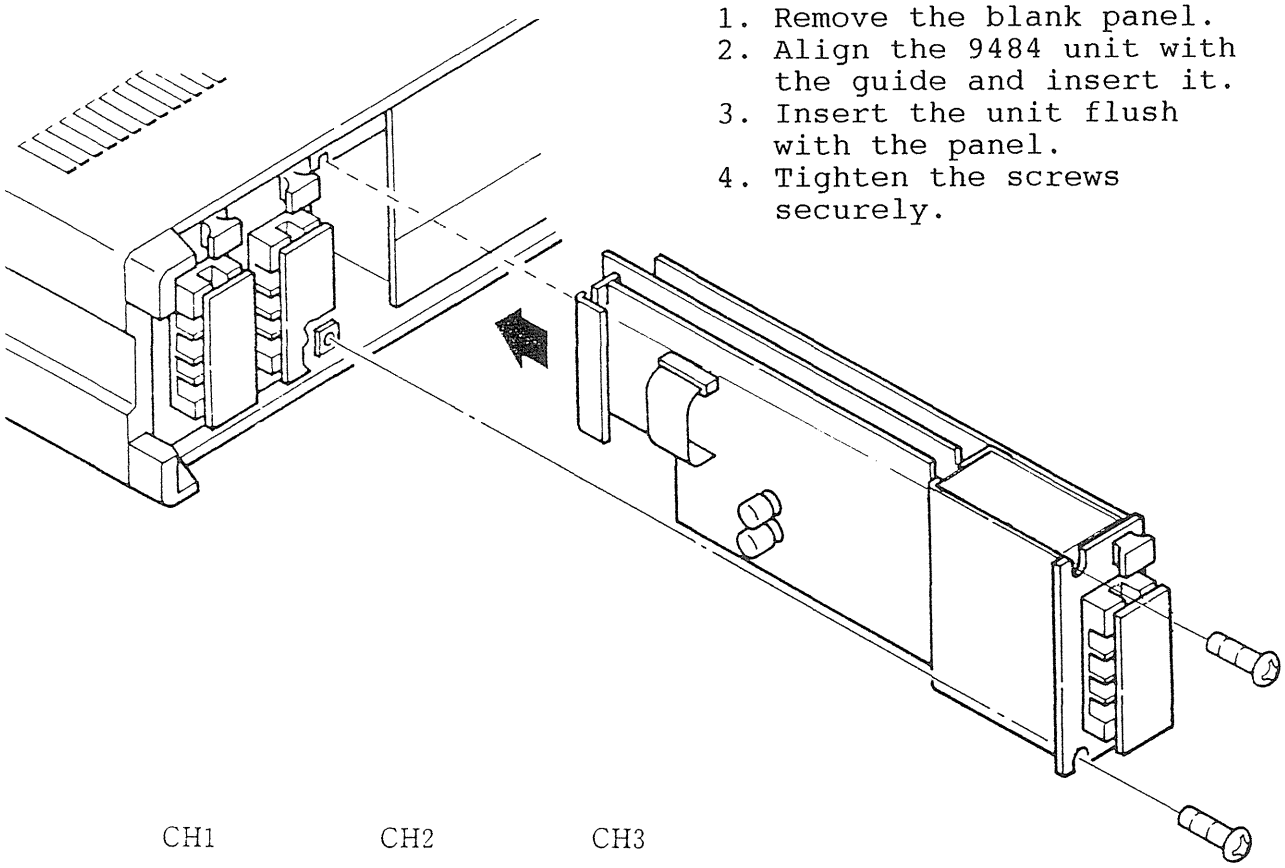
		Voltage	current	Power
Measurement range (rated)		30.00/60.00/150.0 300.0/600.0V	200.0/500.0mA/1.000 2.000/5.000/10.00 20.00A	Depends on combination of V and A
Non-destructive maximum input (continuous)		1,000V peak	70A peak	———
Crest factor		2.5 or less	2.5 or less	Same as V and A
Input resistance		1 MΩ or greater	Approx. 3 mΩ	———
Accuracy; 23℃±3C	10 to 20Hz	± 1.5%f.s. (Stipulated with ≤ 300V)	± 1.5%f.s. (Stipulated with ≤ 10A)	± 1.5%f.s. (Stipulated with ≤ 300V, ≤ 10A)
Power factor =1	20 to 45Hz	± 0.4%rdg.± 0.2%f.s.	± 0.4%rdg.± 0.2%f.s.	± 0.4%rdg.± 0.2%f.s.
	45 to 66Hz	± 0.2%rdg.± 0.2%f.s.	± 0.2%rdg.± 0.2%f.s.	± 0.2%rdg.± 0.2%f.s.
	66 to 2kHz	± 0.4%rdg.± 0.2%f.s.	± 0.4%rdg.± 0.2%f.s.	± 0.4%rdg.± 0.2%f.s.
	2k to 5kHz	± 2%f.s.	± 1.5%f.s.	± 2%f.s.
	5k to 10kHz	± 4%f.s.		± 4%f.s.
	10k to 20kHz	———	± 2.5%f.s.	———
Influence of power factor		———	———	Power factor ± 0.6% rdg. at 0.5
Temperature coefficient		Less than ± 0.04% f.s./C	Same as Voltage	Same as voltage
Operating temperature and humidity		0℃ to 40℃ (Less than 80%RH ; No condensation)		
Effective input range		10% to 102% of the range		
Response time		Approx. 0.8 sec.(Analog output of V, A, and W)		
Analog output		V, A, and W, DC 2V/f.s. Accuracy ± 0.2% f.s.		
Monitor output		V, A 2Vrms/f.s.		
Influence of common mode voltage (50/60Hz)		Voltage ; Less than ± 0.05%f.s. (Input terminal shortcircuit, 1000V applied between input terminal and case) case Current ; Less than ± 0.05%f.s. (Input terminal open, 1000V applied between input terminal and case)		
Insulation resistance		More than 100Mohm at DC 500V (Between V, A input terminal and case, between V, A input terminal and output terminal, between V input terminal and A input terminal, between case and power supply, between output and power supply)		
Withstanding volatage		AC 2.2kV ;for 1 minute (Between V, A input terminal and case, between V, A input terminal and output terminal, between V input terminal and A input terminal) AC 1.5V for 1 minute (Between case and power supply, between output terminal and power supply)		

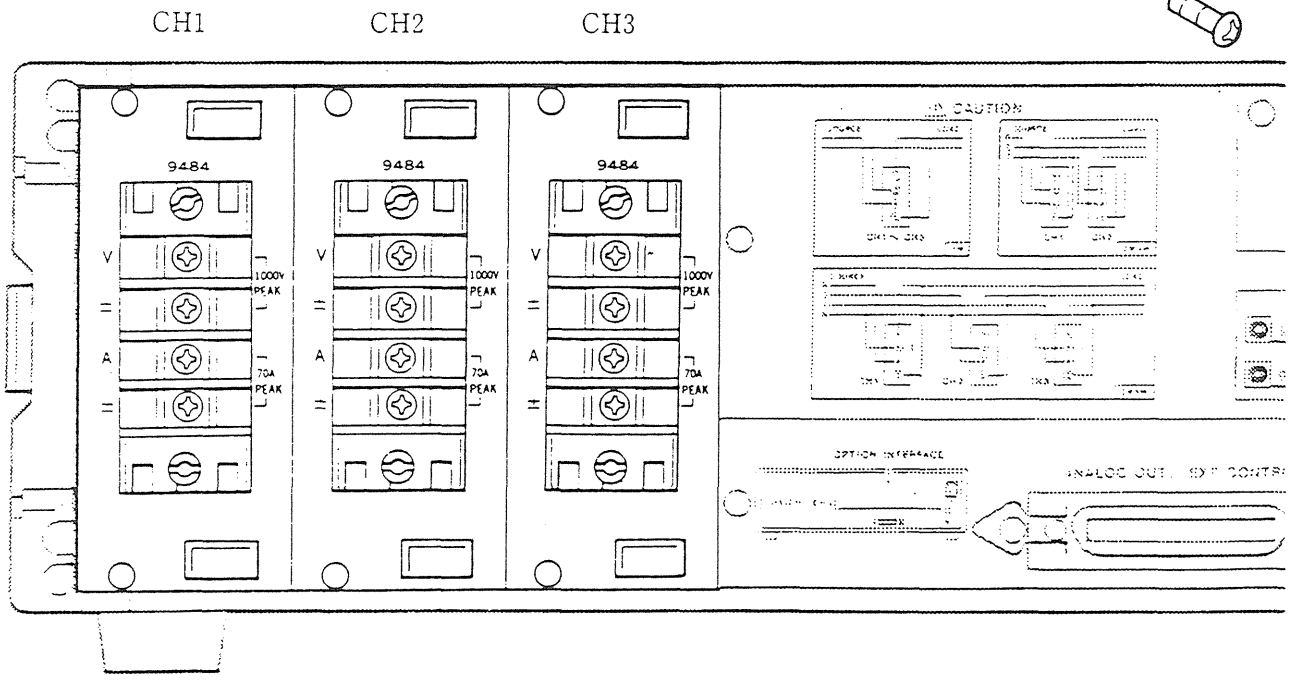
In the chart, items with 2 ranges (such as 120.0/99.99 in the 2A, 30V column), the ranges are automatically switched over.
The analog output has a full scale of DC 2V for the power range determined by [voltage range] x [current range].

V \ A		200.0mA	500.0mA	1.000A	2.000A	5.000A	10.00A	20.00A
30.00V	1φ	6.000W	15.00W	30.00W	60.00W	150.0W	300.0W	600.0W
	3φ3W	12.00/9.999	30.00	60.00	120.0/99.99	300.0	600.0	1.200k/999.9W
	3φ4W	18.00/9.999	45.00	90.00	180.0/99.99	450.0	900.0	1.800k/999.9
60.00V	1φ	12.00W	30.00W	60.00W	120.0W	300.0W	600.0W	1.200kW
	3φ3W	24.00	60.00	120.0/99.99	240.0	600.0	1.200k/999.9W	2.400
	3φ4W	36.00	90.00	180.0/99.99	360.0	900.0	1.800k/999.9	3.600
150.0V	1φ	30.00W	75.00W	150.0W	300.0W	750.0W	1.500kW	3.000kW
	3φ3W	60.00	150.0/99.99	300.0	600.0	1.500k/999.9W	3.000	6.000
	3φ4W	90.00	225.0/99.99	450.0	900.0	2.250k/999.9	4.500	9.000
300.0V	1φ	60.00W	150.0W	300.0W	600.0W	1.500kW	3.000kW	6.000kW
	3φ3W	120.0/99.99	300.0	600.0	1.200k/999.9W	3.000	6.000	12.00/9.999
	3φ4W	180.0/99.99	450.0	900.0	1.800k/999.9	4.500	9.000	18.00/9.999
600.0V	1φ	120.0W	300.0W	600.0W	1.200kW	3.000kW	6.000kW	12.00kW
	3φ3W	240.0	600.0	1.200k/999.9W	2.400	6.000	12.00/9.999	24.00
	3φ4W	360.0	900.0	1.800k/999.9	3.600	9.000	18.00/9.999	36.00

2. Installation

1. Remove the blank panel.
2. Align the 9484 unit with the guide and insert it.
3. Insert the unit flush with the panel.
4. Tighten the screws securely.





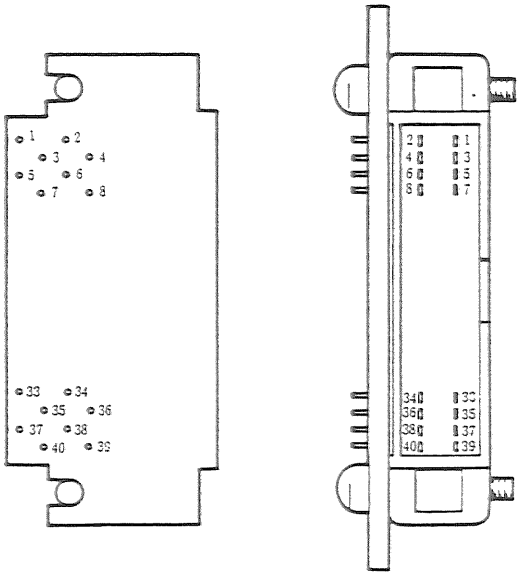
Caution: The channel number of the input unit is (counting from the rear panel, left side) 1, 2, and 3. Always insert units starting from the lowest number (left side).

3. Connector

It is possible to use 9484 independently like a transducer by providing a power supply and range signal. Technical informations are given below.
A connector suitable to 9484; PICL-40S-ST (Nihon-kouku-denshi-kogyo Inc.)

3.1 Pin array

Digital module power	+5V	2	1	+12V	Analog module power
	+5V	4	3	+12V	
	D. GND	6	5	−12V	
	D. GND	8	7	−12V	
Input to unit	FILT	10	9	A. GND	
	V MEAN	12	11	A. GND	
	Not used	14	13	V	Analog output
	VR5 (600V)	16	15	A	
	VR4 (300V)	18	17	W	
	VR3 (150V)	20	19	V monitor	
	VR2 (60V)	22	21	A monitor	
	VR1 (30V)	24	23	Not used	
Input to unit	A MEAN	26	25	OV	Unit output
	AR7 (20A)	28	27	OA	
	AR6 (10A)	30	29	PH(Polarity)	
	AR5 (5A)	32	31	Not used	
	AR4 (2A)	34	33	Not used	
	AR3 (1A)	36	35	ID3	
	AR2 (0.5A)	38	37	ID2	
	AR1 (0.2A)	40	39	ID1	



3.2 Signal functions

Power supply for the analog section (Note: the analog ground and the digital ground are separated in the 9484. Connect these grounds on the external power supply side.)

Analog module power

+12V	120mAmax.
−12V	120mAmax.
A. GND	Analog ground

Digital module power

+5V	120mAmax.
D. GND	Digital ground

Input unit signal

FILT	Switches polarity detect circuit on/off. When on, a 500Hz cut-off low-pass filter is switched in. "0" −ON
V MEAN	Switches voltaqe measurement between true and average values. "0" is average, and "1" is true
VR5 (600V) VR4 (300V) VR3 (150V) VR2 (60V) VR1 (30V)	Voltage range select. A range is selcted by setting it to "0", and therefore multiple ranges must not be set to "0" at the same time.
A MEAN	Switches amperage measurement between true and average values. "0" is average, and "1" is true
AR7 (20A) AR6 (10A) AR5 (5A) AR4 (2A) AR3 (1A) AR2 (0.5A) AR1 (0.2A)	Amperage range select. A range is selcted by setting it to "0", and therefore multiple ranges must not be set to "0" at the same time.

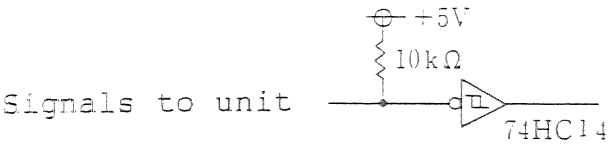
Signals from input unit

OV	When voltage peak exceeds 2.5 times range, "0" level output for about 130ms
OA	When amperage peak exceeds 2.5 times range, "0" level output for about 130ms
PH (Polarity)	Indicates lead/lag of amperage to voltage, where "0" is lag and "1" is lead
ID3 ID2 ID1	Indicates the unit type, and all are "0"

Analog signals

V A W	Voltage(V), amperage(A), power(W) analog(level) output. The output is DC2V/fs to the range (rated)
V monitor A monitor	Voltage and amperage waveform (monitor) output. The output is 2Vrms/fs to the range (rated)

Signals to and from the unit are handled through the (simplified) circuits shown below.



Signals from unit

"0" < 1.35V

"1" > 3.15V

Signal level

"0" <0.32V

"1" >4.18V

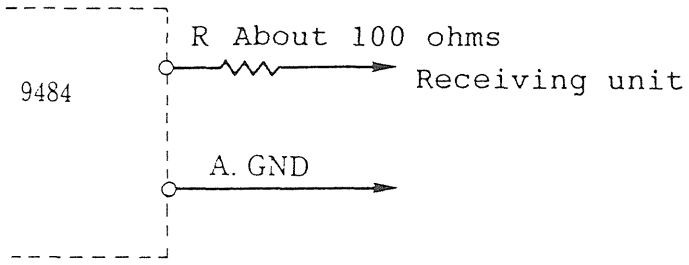
Analog signals

1. Where the input suddenly jumps from 0% to 95% of range, it will require about 0.8 seconds for the V, A and W readings to settle down within ±0.2% of the final value.

2. Low-range current circuits are extremely sensitive, and therefore may detect slight currents/voltages even when input is zero.

3. Input resistance for voltage measurement is a minimum of 1 megaohm, and therefore output may not drop to 0 even when the measurement terminal circuit is open.

4. Depending on the input capacity of the unit receiving the analog signals, the internal output circuit may oscillate. In this case, insert a direct resistor as indicated below.



NOTE

The displayed power may fluctuate periodically when measuring loads with certain frequency components. For details, this may occur with a distorted wave containing frequency components of multiples of 5.86 kHz.

3.3 Internal configuration

Figure-1 shows a block diagram of the entire unit.
Figure-2 shows the power measurement circuit.
This unit detects the voltage signal porportional to the voltage to be measured by means of PT and the current signal proportional to the current to be measured by means of CT respectively and converts them into the dc voltage signal of 2V full scale so as to calculate the power by feeding these signals into a multiplyer circuit using an analog multiplyer IC.
The result of calculation is the instantaneous power, and the dc component of this results is equivalent to the effective power. Therefore, the DC voltage proportional to the effective power is obtained by smoothing these results of the calculation.
The figures-3, 4 indicate the voltage waveform, current waveform, and power waveform in power measurement. The electric power calculation is shown in formula as follows:
The sinusodial AC voltage and sinusodial AC current are assumed to be e and i respectively, and these are assumed to be expressed in the following formula:

$$e = \sqrt{2}\, E \cos \omega t$$

$$i = \sqrt{2}\, I \cos (\omega t + \theta)$$

where,

E....Effective value of voltage
I....Effective value of current
ω....Angular frequency
t....Time
θ....Phase difference

The instantaneous power p will be the product of e and i. That is,

$$\begin{aligned} p &= e \cdot i \\ &= 2\, E\, I \cos \omega t \cdot \cos (\omega t + \theta) \\ &= E\, I \cos (2 \omega t + \theta) + E\, I \cos \theta \end{aligned}$$

The DC component in this formula is the effective power P.

$$P = E\, I \cos \theta$$

9484 Configuration

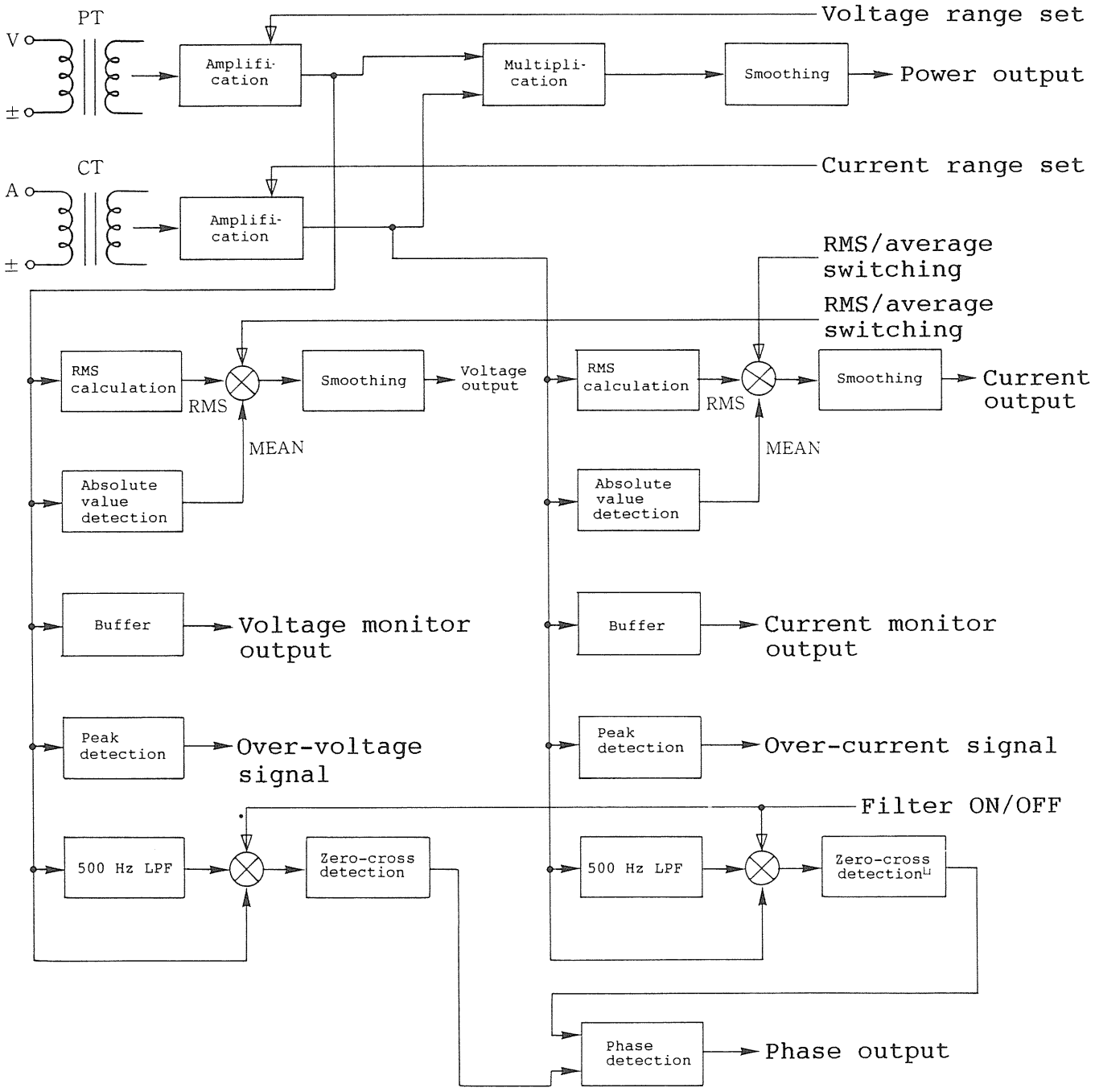


Fig. 1

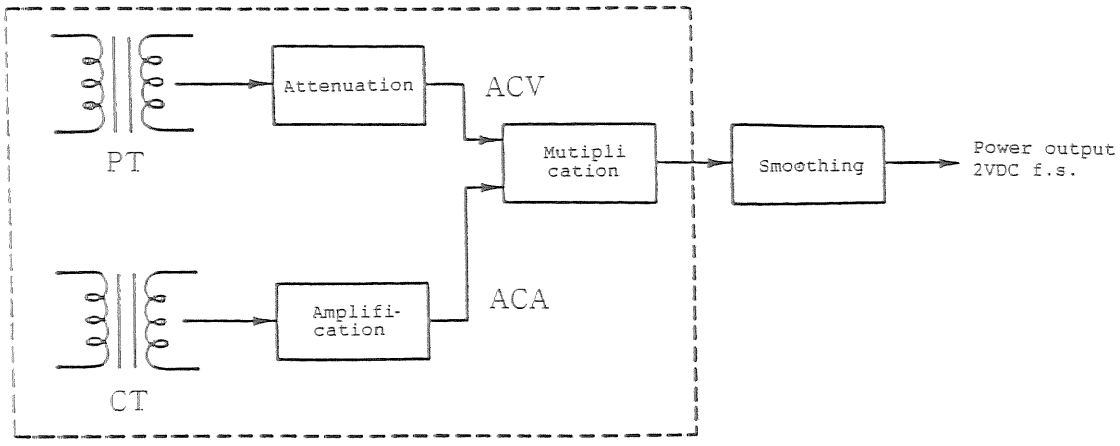


Fig. 2 Power measurement circuit

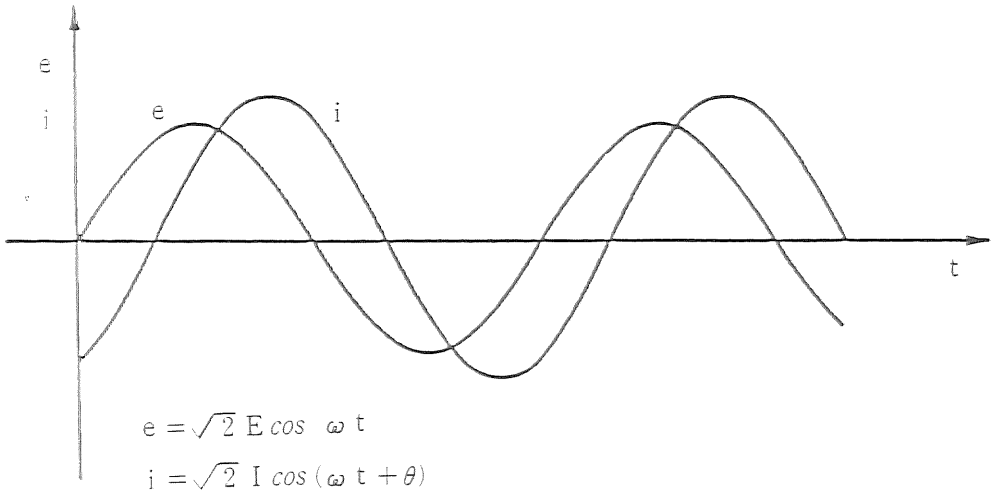


Fig. 3 Voltage, current waveforms

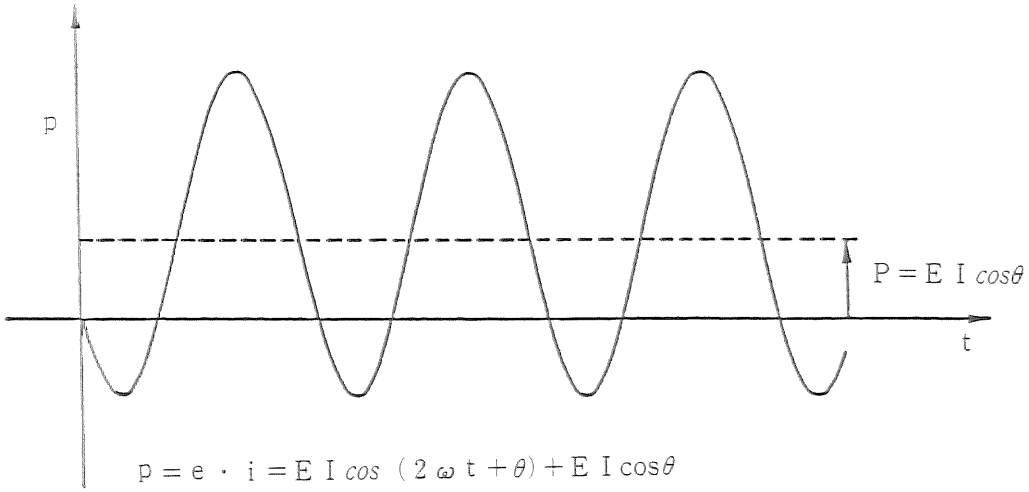


Fig. 4 Calculated power waveform

This unit incorporates a circuit which calculate the true effective value and a circuit which perform mean rectified effective value conversion for measuring the voltage and current. This unit uses a dedicated IC to calculate true effective value. This IC performs equivalent to the following expression:

$$E\,rms=\sqrt{\frac{1}{T}\int e^{2}dt}$$

Where e indicates the input signal, and T indicates the cycle of the input signal.
The unit uses an absolute value detection circuit and a smoothing circuit for mean rectified effective value conversion. The expression of the average value "E mean" is as follows:

$$E\,mean=\frac{1}{T}\int_{0}^{T} edt$$

The effective value and average value obtained for the sinusodial wave with amplitude A and cycle 2% is as follows:

$$\text{Effective value} = A/\sqrt{2}$$

$$\text{Average value} = 2A/\pi$$

With the mean rectified effective value conversion, calculation based on the formula to obtain the E mean shown above is performed and a coefficient is multiplied so that the same results as that of E rms is obtained. This coefficient is the ratio between the effective value mentioned above and the mean value, that is,

$$\frac{\text{Effective value}}{\text{Average value}} = \frac{\pi}{2\sqrt{2}} \fallingdotseq 1.1107$$

As described above, the output E rms' of the mean rectified effective value conversion will be as follows:

$$E\,rms' = \frac{\pi}{2\sqrt{2}}\,E\,mean$$

The peak detection circuit is a circuit to activate the alarm when an input signal which can not be processed with the circuit. The 3191 unit lights the alarm LED OVER V or OVER A.
The detection level depends on the crest factor in the specification. The crest factor is the dinamic range of the measuring instrument as defined in the following formula:

Crest factor = Peak value / Effective value

For example, in the case where a distorted wave whose effective value is small but its peak value is large is to be measured, setting the measuring range proportional to the effective value will result in the peak value of the distorted wave exceeding the operating range of the measuring circuit, causing a large measurement error. Therefore, it is important to know the level of the peak value of the signal to be measured.
With the 9484, the crest factor is less than 2.5. That is, in the 300V range, the error will be incresed when measuring the voltage with a peak value more than 750V.
As described above, the detection level of a peak detection circuit is made 2.5 times that of each range. When the LED OVER V or OVER A lights during measurement, switch to the next upper range.

When displaying the reactive power and power factor, the unit will display the value by attaching the polarity according to the phase relation between the voltage and current. The case where the current phase lags to the voltage is defined as LAG:Polarity +, and the case where the current phase is advancing is defined as LEAD:Polarity -.
The section evaluating the relation of phases consists of a 500 Hz low pass filter, a zero-cross detection circuit, and phase detection circuit. (The cut-off frequency is 500Hz.)
This filter is independent of the measuring circuit for voltage, current, and electric power so that there is no influence on the measured value.

Appendix D

9483 Integrator Interface

INSTRUCTION MANUAL

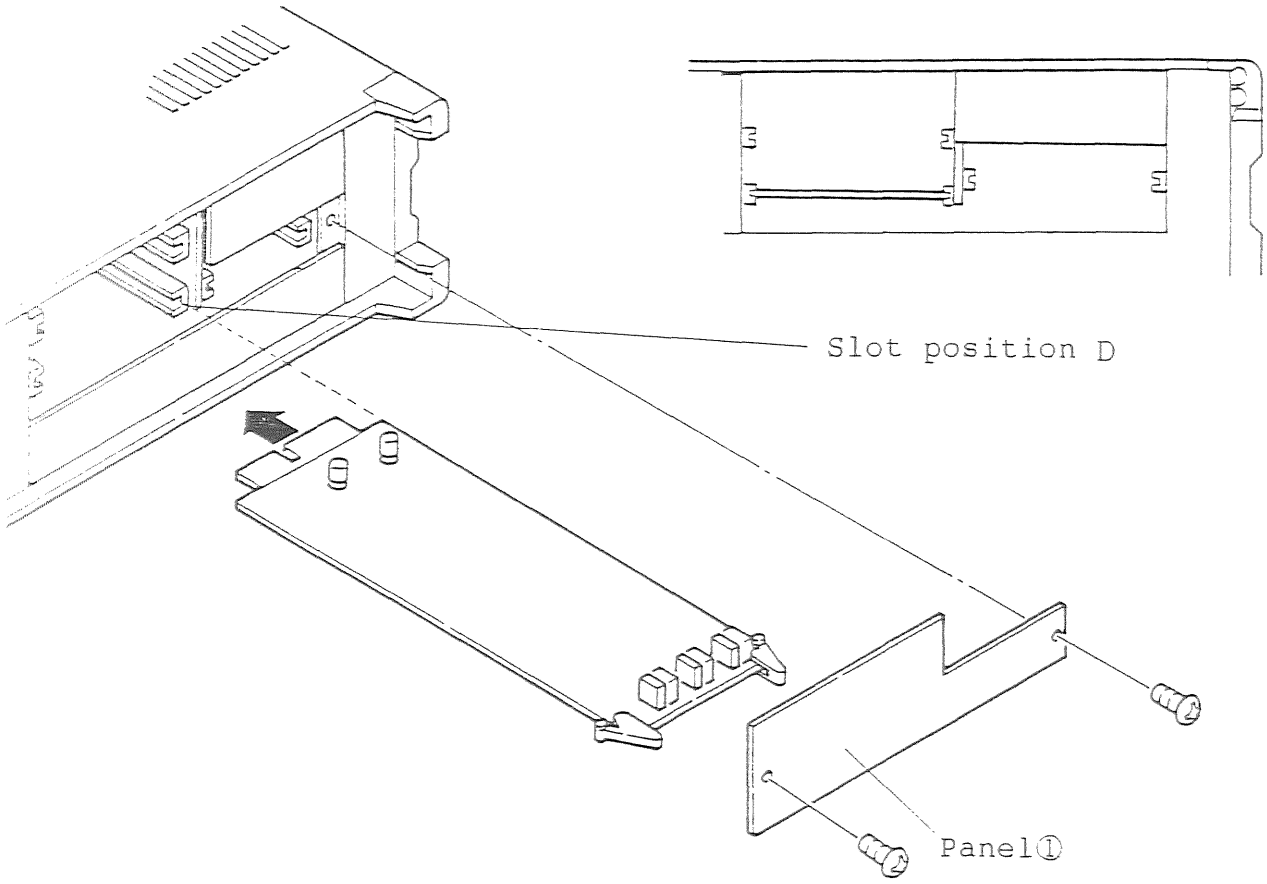
Table of Contents

1. Specifications

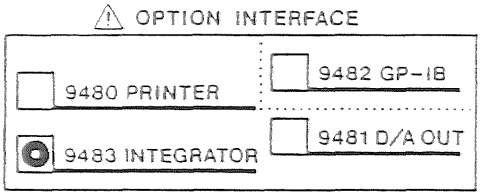
Configuration: 8-input multiplexer and V/F converter, 3-channel
Integration time: 1 minute to 1000 hours (0 setting is 10000 hours)
Maximum readout: 8 digits
Integration time precision: ±0.02%±1 second (0~40℃)
Integration precision: ±0.2%rdg to main unit ±1 digit (23℃±3℃)
Temperature coefficient: ±1.0%rdg (0~40℃, compared to 23℃)
Integration content: Any three of A, W, A1+W2 (for three-phase three-wire) or W1+W2+W3 (for three-phase four-wire) for any channel
Functions: Integration start/stop
Starting the integration by means of realtime control
Halt/continue for integration result display
Display of elapsed integration time
3-channel simultaneous start/stop through external signal control
Resuming the integration after restoring from power failure (#3)

<CAUTION>
#1 In [D 9483 integrator interface instruction manual], 3-phase 3-wire mode and 3-phase 3-wire (3 V 3 A) mode are generically called 3ø3W mode.
#2 It is not possible to integrate negative value.
#3 Refer to the 3191 instruction manual [6-16. Back-up].

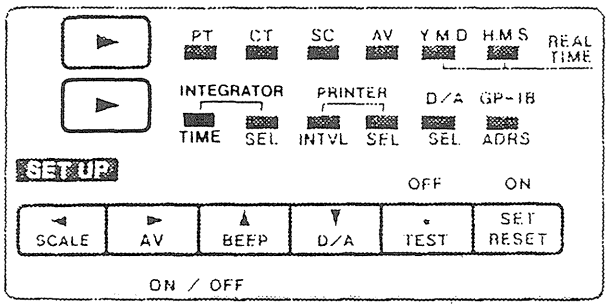
2. Installation

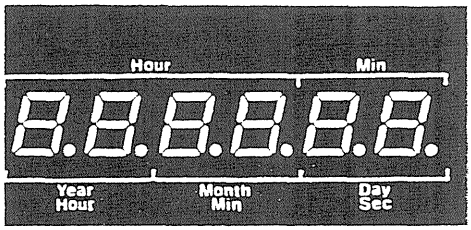


1. Remove the option interface panel from the rear of the 3191.
2. Turn the interface board so that the components are up and insert it into slot D.
3. Press the board firmly into the 3191 completely.
4. Reattach panel 1, and mark the option interface label to indicate that the 9483 has been inserted.



3. Integration time set





Hour set Minute set

1. Press select key b [►] and cause the INTEGRATOR TIME lamp to light up.

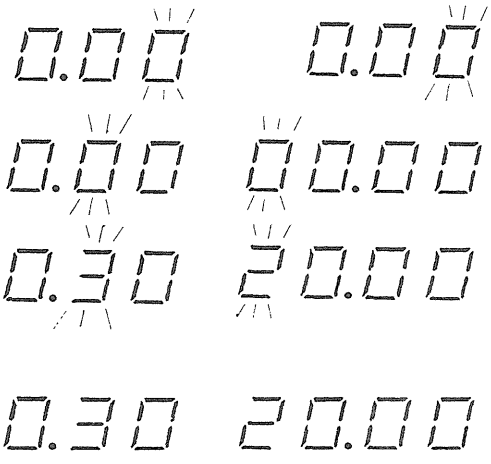
2. The previously-set integration time will be displayed in display block c, and the digit to the right will flash.

3. Press the [◄ SCALE] and [► AV] keys to move the flashing digit.

4. Press the [▲ BEEP] and [▼ D/A] keys to increase/decrease the flashing digit.

Example:

30 min 20 hr



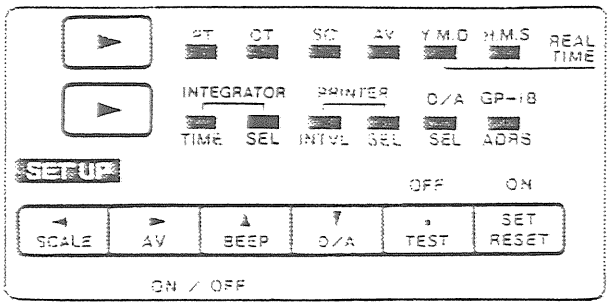
Note: Increase/decrease changes will be automatically processed. After 59 minutes one hour will be added, and the system will not accept settings above 1000 hours.

5. Press the [SET RESET] key to complete the set procedure.

Note: The possible range is from 1 minute to 1000 hours. Setting the value to 0:00 will specify the manual mode (maximum 10,000 hours). Press the [SET RESET] key after the desired value is input. unless this key is pressed the input value will not be stored to memory.

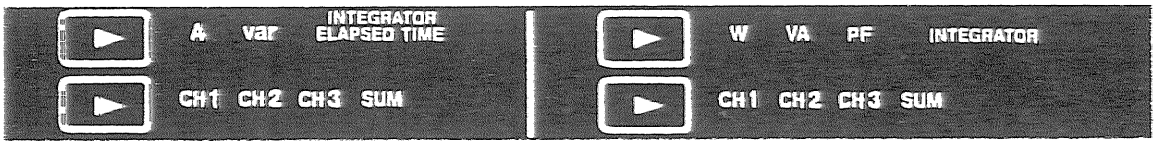
4. Integrator input select

Select key b



1. Press select key b [►] and light the INTEGRATOR TIME SEL display. The items that light at this time are those currently set for integration.

2. First select which functions are to be input for integration. Note that display block c will display the numeral 1 to indicate the first setting is for channel 1. After the [SET RESET] key is pressed, it will automatically shift to channels 2 and 3 for specification.



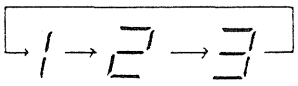
3. Cause the desired function lamp to flash with the [◄ SCALE] and [► AV] keys, and press the [SET RESET] key to make it stop flashing and complete the set procedure.

$$W1 \rightleftarrows W2 \rightleftarrows W3 \rightleftarrows W_{SUM} \rightleftarrows A1 \rightleftarrows A2 \rightleftarrows A3$$

4. When the [SET RESET] key is pressed again, display block c will display the numeral 2, and the system will accept input for channel 2.

5. Set channel 2 in the same way as channel 1, and press the [SET RESET] key to switch to channel 3. Note that only 1 setting can be made for each channel.

6. The setting procedure repeats in the following order:



After all the set-ups have been completed, pressing any key other than those used for set-up will terminate the set-up procedure.

If the 9480 printer unit (optional) has been installed in the 3191 unit, the help print function (pressing the SHIFT and MANUAL HELP keys) can be used to print out a list of what items have been set in which channels for integration.

Sample printout

```
HELP.      '88-03-17 THU 15:00:21

     MODE   3φ3w 3ch

     RANGE
ch1>    600 V rms         20 A rms
ch2>    600 V rms         20 A rms
ch3>    600 V rms         20 A rms

SCALE(OFF)   PT         CT         SC
ch1>     1.0000     1.0000     1.0000
ch2>     1.0000     1.0000     1.0000
ch3>     1.0000     1.0000     1.0000

FILTER(OFF)

REAL TIME CONTROL(OFF)
       START   '88-03-17 THU 14:50

AVERAGE(OFF)
    >  COUNT       10
       TIME    1000h 00m
       INTVL      0h 01m

PRINT INTERVAL      INTEGRATE TIME
      0h 01m              0h 05m

          INTEG.IN     D/A OUT(OFF)
ch1>         W1             VA1
ch2>         W2             PF1
ch3>      W1+W2             var1

GP-IB ADDRESS    1
--------------------------------
```

Integration input selection table

Integrator display channel	Measurement item	Input unit count: 1CH A_1	1CH W_1	2CH A_2	2CH W_2	3CH #1 $3\phi3W$ W_{SUM} (W_1+W_2)	3CH A_3	3CH W_3	3CH #2 $3\phi4W$ W_{SUM} $(W_1-W_2-W_3)$
INTEGRATOR CH1~CH3	A_1h	○							
	W_1h		○						
	A_2h			○					
	W_2h				○				
	$(W_1+W_2)h$ #1					○			
	A_3h						○		
	W_3h							○	
	$(W_1+W_2+W_3)h$ #2								○
#3 INTEGRATOR SUM	A_1h+A_2h #4 #5	○		○					
	W_1h+W_2h #4 #6		○		○				
	$(W_1+W_2)h$ #5					○			
	$A_1h+A_2h+A_3h$ #4	○		○			○		
	$W_1h+W_2h+W_3h$ #4		○		○			○	
	$(W_1+W_2+W_3)h$								○

Notes

#1 In three-phase three-wire when Wsum is selected as input to the integrator, it is possible to integrate (W1+W2)h.

#2 In three-phase four-wire when Wsum is selected as input to the integrator, it is possible to integrate (W1+W2+W3)h.

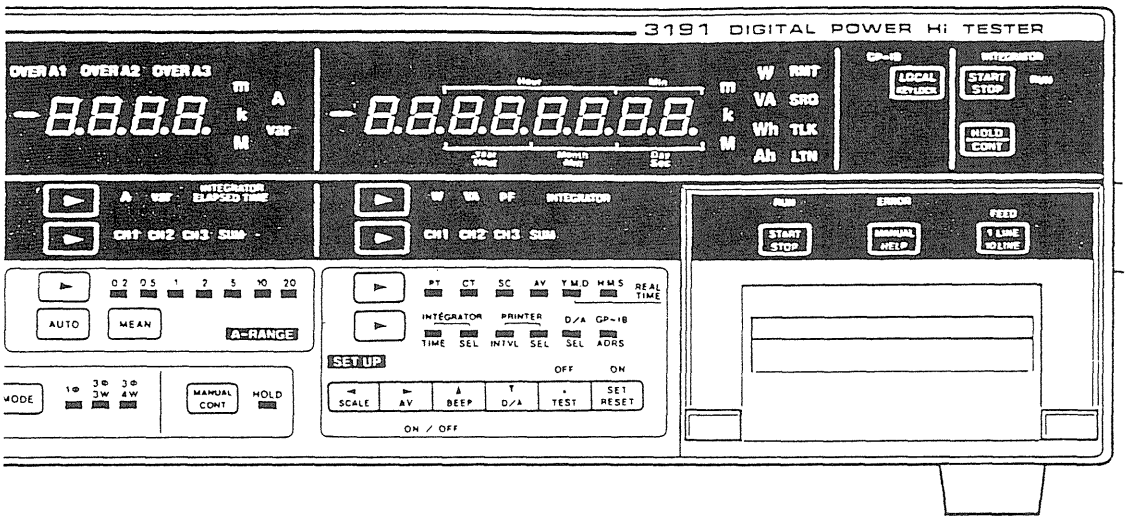
#3 Where 2 or more channels input to the integrator are current or voltage, or where Wsum is selected, the INTEGRATOR SUM display can be used to for sum displays.

#4 In three-phase three-wire mode where all three inputs are either emperage or voltage, INTEGRATOR SUM will display A1h+A2h or W1h+W2h respectively.

#5 In three-phase three-wire mode where Wsum, A1 and A2 are set, the INTEGRATOR SUM will be A1h+A2h.

#6 When measuring in the 3ø3W mode, W1 or W2 may be negative. In this case, set the unit to the setting (W1 + W2)h so as to integrate Wsum.

5. Start/stop



Pressing the [START STOP] key after setting the integration time and selecting the integration input starts the integrator. When the integrator starts, the RUN display lamp lights to indicate that the integrator is in operation. When the 3191 unit is in the realtime control mode, the unit is set in the waiting state, with the INTEGRATOR TIME lamp blinking. Refer to the 3191 instruction manual [6-12. Realtime control].
Pressing the [HOLD /CONT] key while the integrator is in operation will stop the display temporarily, with the RUN indication lamp blinking. Pressing this key switches between stopping and starting.

The integrator will stop at termination of the integration time or when pressing the [SHIFT] and [START STOP] keys. Starting integration makes it impossible to restart integration unless integration is stopped.

<CAUTION>
- The 3191 has a reference clock of 1 sec. Response may be delayed to a maximum of 1 sec. to synchronize the unit to this clock until the integrator actually starts after the key is pressed.
- When the integrator is started, the auto-ranging function will be canceled. The keys other than following keys will be ineffective.
  1) Function and channel selection keys on the display blocks a, b and c.
  2) [LOCAL KEY LOCK] [HOLD /CONT] [START STOP (RUN)] [MANUAL HELP (ERROR)] [1 LINE 10 LINE] [SHIFT] [MANUAL CONT]
  3) [SHIFT] + [AV] [BEEP] [D/A] [SET RESET]

     Namely, i) Average (at the time of counter mode) ON/OFF
     ii) BEEP alarm ON/OFF
     iii) D/A output ON/OFF
     iv) RESET

6. Display/Printing Integrated Value

The integrated value can be displayed by selecting the channel, with the function on the display block c set to the INTEGRATOR position. For the display when the channel is set to SUM, refer to the <Note> #3 in the integration input selection table described above.

The integrated value is displayed in "the format to display the value obtained by integration for 1000 hours with full scale input in 8 digits". When the displayed value exceeds 8 digits, it is displayed in "the format to display the value obtained by integration for 10000 hours with full scale input in 8 digits". However, when the integration input is scaled, the unit confirmes at the time of starting integration whether or not the value obtained by integration for 1000 hours with full scale input exceeds 99999999M, and displays [8_____] (over-calculation) if it exceeds 99999999M.

Setting the function key on the display block b to INTEGRATOR ELAPSED TIME will displays the integrator elapsed time. This display has the following formats:

	Display block b
0 minute to 99 hours 59 minutes	xx . xx Hour Minute
100 hours to 999 hours 59 minutes	xxx . x Hour Tens minute
1000 hours to 9999 hours 59 minutes	xxxx Minute
10000 hours	0000

The unit displays the value down to the tens minutes for the time between 100 hours and 999 hours 59 minutes. Only the hour digits will be displayed for more than 1000 hours, and 0000 will be displayed for 10000 hours.

CAUTION

The INTEGRATOR ELAPSED TIME on the display block b serves also as a display of average elapsed time. The display contents that is held while the integrator and averaging function are in stop are the elapsed time for the data measured previously.

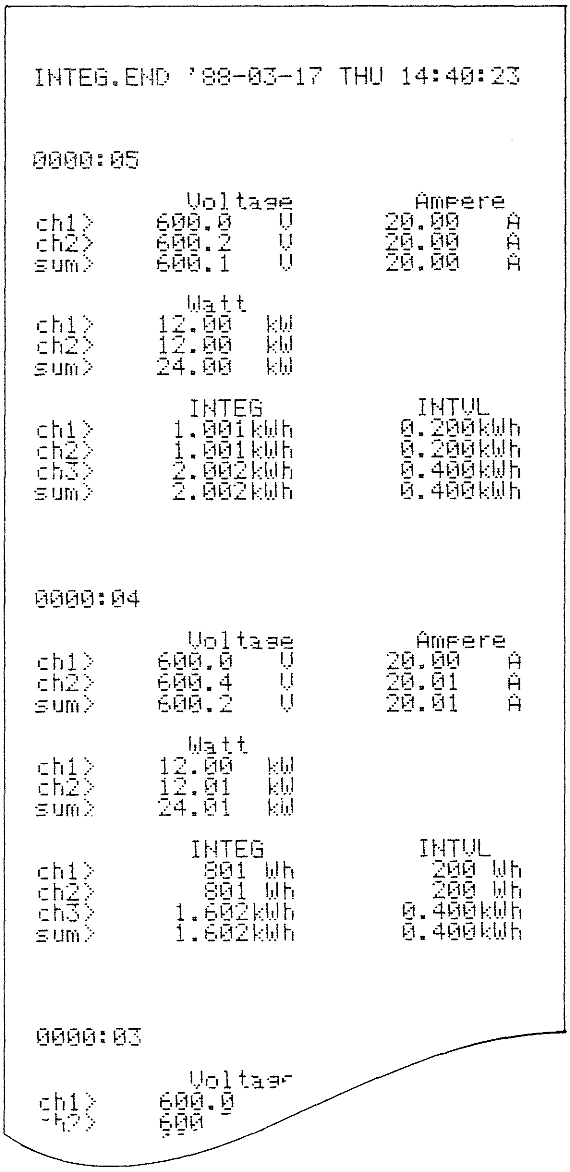
When the 9480 printer unit is built in the 3191, printing operation will be started at the same time when the integrator is started. After that, the unit will print the integrated value at every time interval of the printer and automatically stop printing operation when the integrator stop.

The printer will print the interval time together with the integrated value. This is the increment from the integrated value of the previous interval printing. This is the same when the printing is done manually.

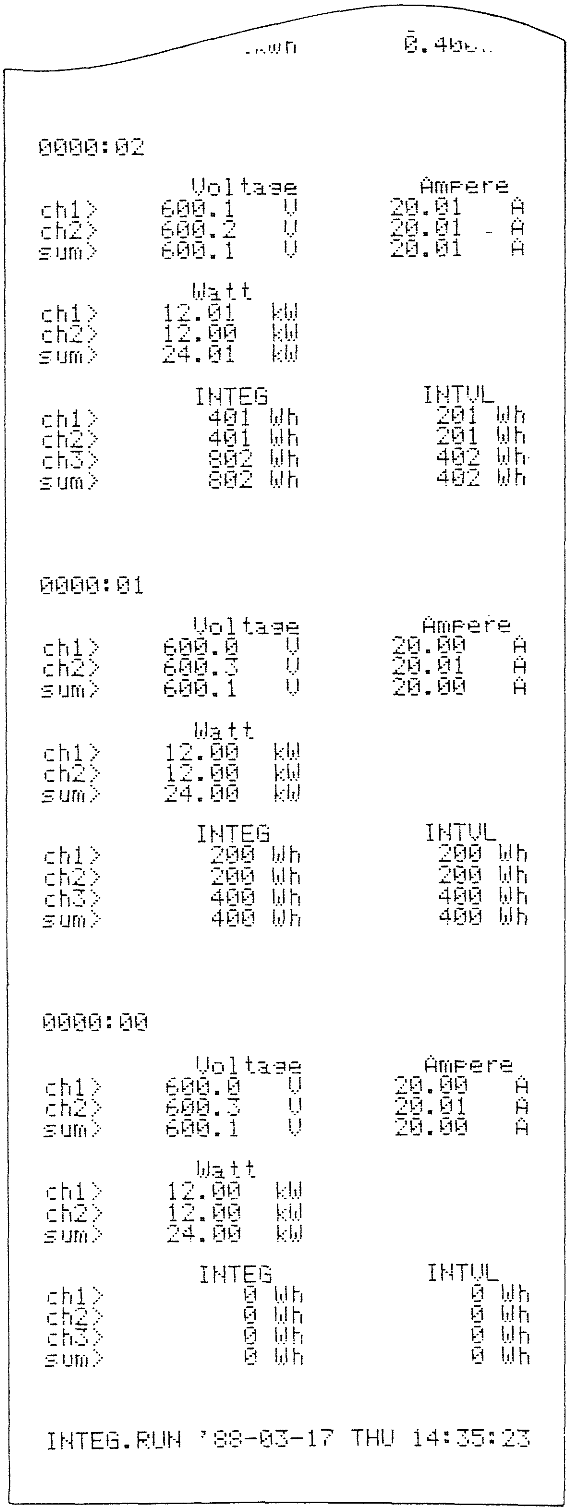
The integrated value printed on the printer is the value that is not held even if the integrator is in a holding state. The holding state of the integrator will be canceled when the interval printing is started.

For the printer unit, refer to [Instruction manual for A 9480 printer unit].

Printout sample



```
INTEG.END '88-03-17 THU 14:40:23

0000:05
           Voltage          Ampere
ch1>     600.0   V        20.00   A
ch2>     600.2   V        20.00   A
sum>     600.1   V        20.00   A
           Watt
ch1>     12.00   kW
ch2>     12.00   kW
sum>     24.00   kW
            INTEG           INTVL
ch1>      1.001kWh        0.200kWh
ch2>      1.001kWh        0.200kWh
ch3>      2.002kWh        0.400kWh
sum>      2.002kWh        0.400kWh

0000:04
           Voltage          Ampere
ch1>     600.0   V        20.00   A
ch2>     600.4   V        20.01   A
sum>     600.2   V        20.01   A
           Watt
ch1>     12.00   kW
ch2>     12.01   kW
sum>     24.01   kW
            INTEG           INTVL
ch1>       801 Wh           200 Wh
ch2>       801 Wh           200 Wh
ch3>     1.602kWh         0.400kWh
sum>     1.602kWh         0.400kWh

0000:03
           Voltage
ch1>     600.0
```



```
0000:02
           Voltage          Ampere
ch1>     600.1   V        20.01   A
ch2>     600.2   V        20.01   A
sum>     600.1   V        20.01   A
           Watt
ch1>     12.01   kW
ch2>     12.00   kW
sum>     24.01   kW
            INTEG           INTVL
ch1>       401 Wh           201 Wh
ch2>       401 Wh           201 Wh
ch3>       802 Wh           402 Wh
sum>       802 Wh           402 Wh

0000:01
           Voltage          Ampere
ch1>     600.0   V        20.00   A
ch2>     600.3   V        20.01   A
sum>     600.1   V        20.00   A
           Watt
ch1>     12.00   kW
ch2>     12.00   kW
sum>     24.00   kW
            INTEG           INTVL
ch1>       200 Wh           200 Wh
ch2>       200 Wh           200 Wh
ch3>       400 Wh           400 Wh
sum>       400 Wh           400 Wh

0000:00
           Voltage          Ampere
ch1>     600.0   V        20.00   A
ch2>     600.3   V        20.01   A
sum>     600.1   V        20.00   A
           Watt
ch1>     12.00   kW
ch2>     12.00   kW
sum>     24.00   kW
            INTEG           INTVL
ch1>         0 Wh             0 Wh
ch2>         0 Wh             0 Wh
ch3>         0 Wh             0 Wh
sum>         0 Wh             0 Wh

INTEG.RUN '88-03-17 THU 14:35:23
```

7. Manual and timer integration

When the integration time is set to 0 hours and 00 minutes, the system enters the manual mode, and is controlled by the start/stop keys on the front panel.

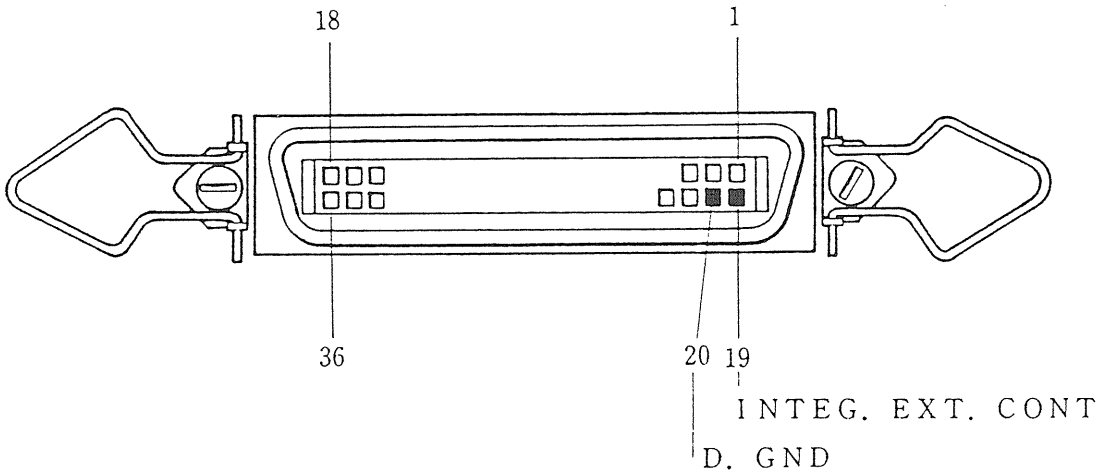
For internal processing reasons, the maximum time is 10,000 hours.

In timer operation, set the timer to the correct time (1 minute to 1000 hours), and the system will automatically stop after running for that period of time.

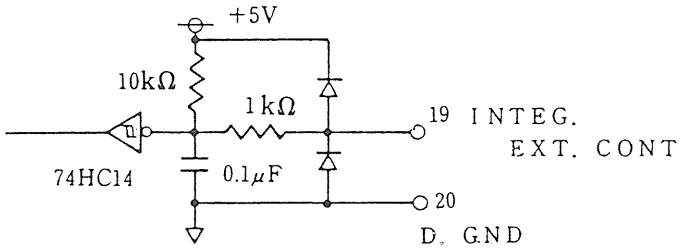
8. External control

The ANALOG OUT/EXT.CONTROL connector on the rear panel of the 3191 is used for start/stop control of the integrator from an external control, using the INTEG.EXT.CONT signal.

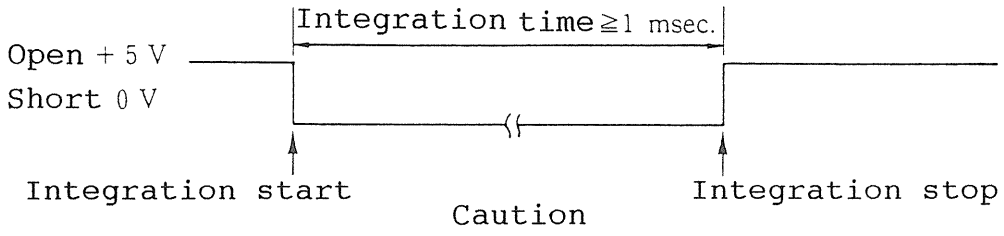
Pin array



Input circuit



Input signal



Caution

1. The system is designed to handle a response time of 1msec, but in fact this time may be extended as required to gain a meaningful result. For example, for a rated input 180msec, or for a 1/40th rated input 7.2 seconds, is required to change the lowest digit of the display.
2. Actual integration time may be delayed, depending on operation conditions (i.e. whether the system is printing or handling GP-IB processing at the same time).

Appendix E

9482 GP-IB Interface

INSTRUCTION MANUAL

Table of Contents

1. Specifications

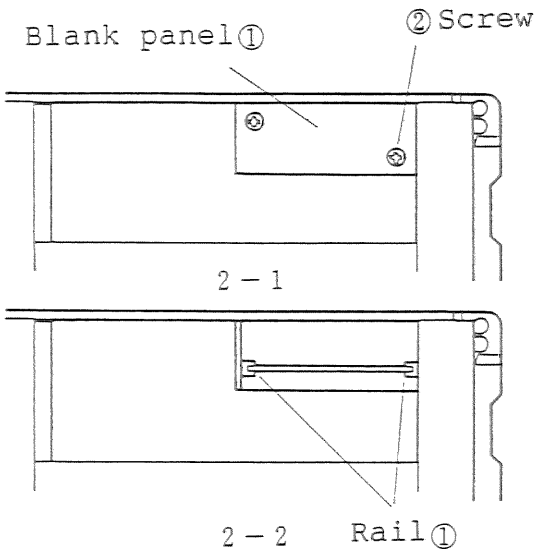
Compatible standard: IEEE Standard 488-1978

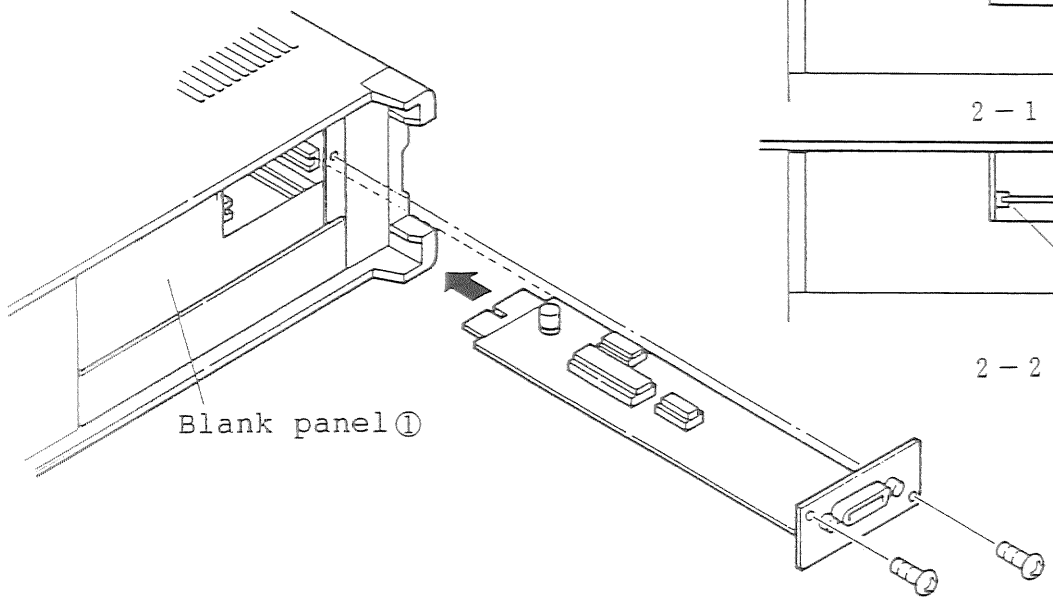
Interface functions

Display	Function
SH1	All source handshake functions enabled.
AH1	All acceptor handshake functions enabled.
T6	Basic talker function enabled, serial polling function enabled, talk only mode disabled, MLA talker release function enabled.
L4	Basic listener function enabled, listen only mode disabled, MTA listener release function enabled.
SR1	All service request functions enabled.
RL1	All remote/local functions enabled.
PP0	Parallel polling function disabled.
DC1	All device clear functions enabled.
DT1	All device trigger functions enabled.
C0	Controller function disabled.

Note: Code used is ASCII.

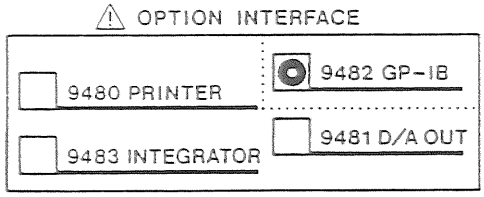
2. Installation





2 – 3

1. Remove the black panel (Fig. 2-1-(1)) from the rear of the 3191 by removing the screw (see Fig. 2-1-(2)). This will reveal two rails in the 3191 (Fig. 2-1-(2)).
2. Turn the interface board so that the components are up and insert it into the rails as shown in Fig. 2-3.
3. Press the board firmly into the 3191 completely, so that the board face with GP-IB printed on it is flush with the black panel.
4. Reattach the black panel, and mark the option interface label to indicate that the 9482 has been inserted.



3. Component names and explanations

1) Component names

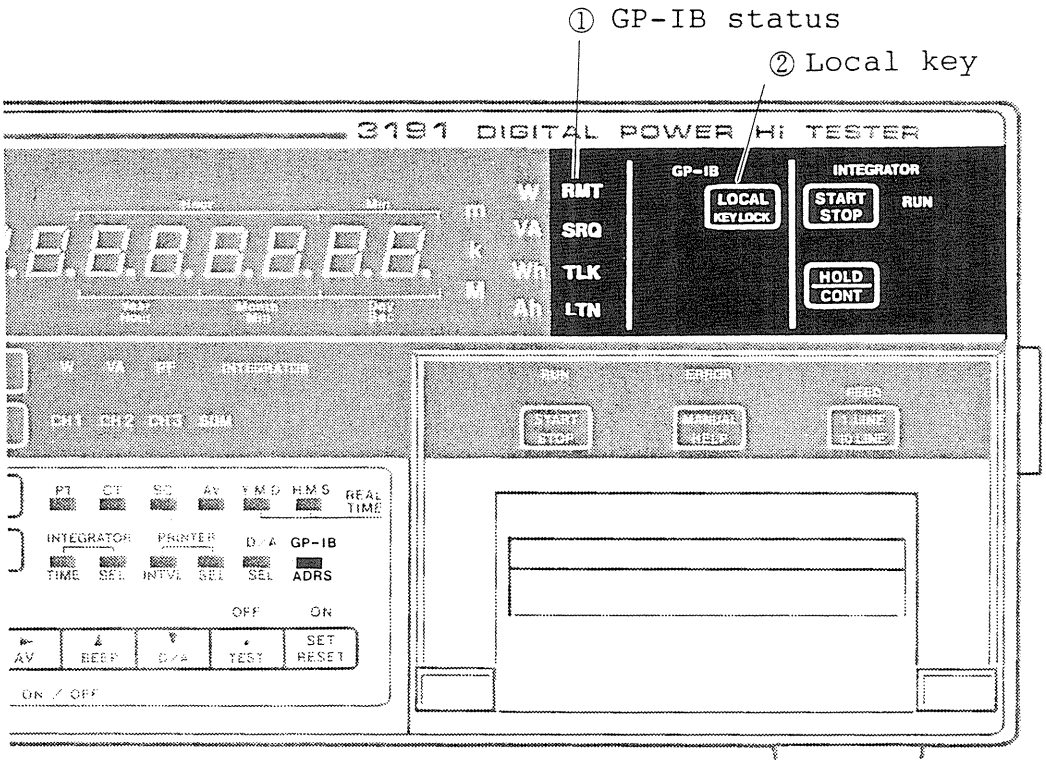


Fig. 3-1 Right side of 3191 front panel

2) Component explanations

2a) GP-IB status

This status display indicates the current conditions of the GP-IB, as any of RMT (remote), SRQ (service request), TLK (talk) or LTN (listen).

RMT - Lights when the system is in remote mode.
SRQ - Lights when the system is in service request mode.
TLK - Lights when the device has been defined as a talker.
LTN - Lights when the device has been defined as a listener.

Fig. 3-2 GP-IB status display

2b) Local key [LOCAL KEY LOCK]

Pressing this key releases the GP-IB remote mode and switches the unit to local operation.

However, this key is disabled when the LLO (Local Lock-Out) command has been issued by the controller.

2c) GP-IB address set

Entering the set-up mode allows the system to communicate with equipment with addresses from 0~30, assigned freely. See below for explanation of addressing.

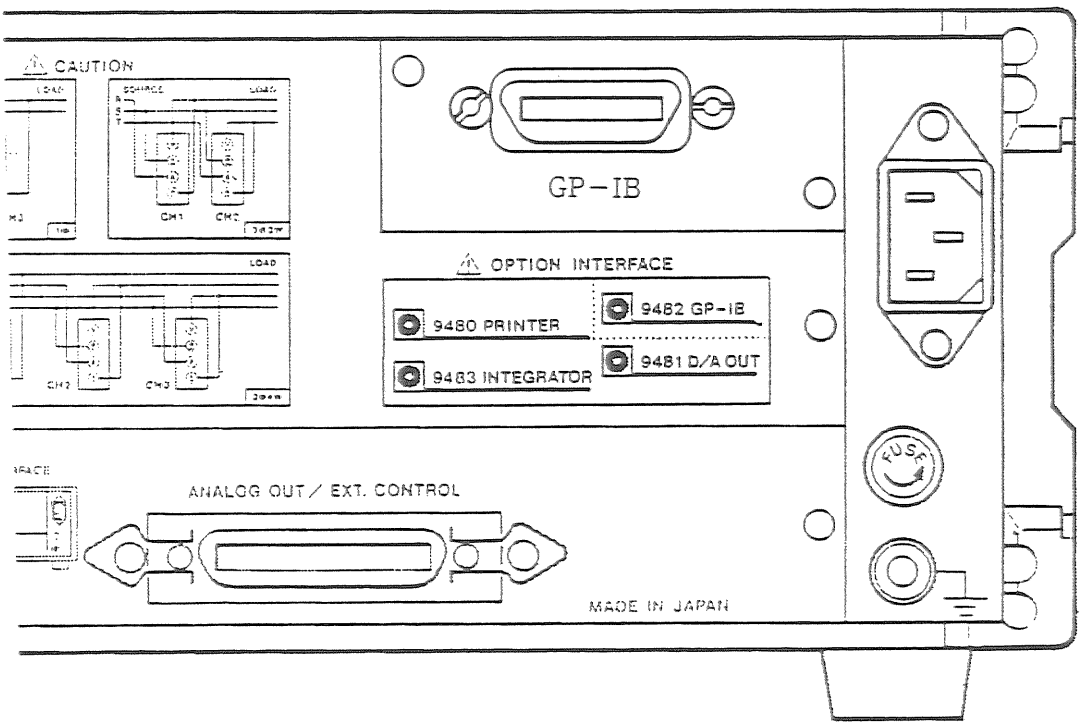


Fig. 3-3 - GP-IB Connector

4. GP-IB address set

1) Press select key b [►] to light the GP-IB ADRS lamp.
2) The address currently set will be displayed in display block c, and the digit to the right will flash.
3) The flashing indicates that the flashing digit may be changed. Use the [◄ SCALE] and [► AV] keys to select the digit to be changed.
4) Use the [▲ BEEP] and [▼ D/A] keys to increase/decrease the digit. Changes in the digit will be automatically handled by the system. Possible settings are 0~30.
5) After setting the desired address, press the set key [SET RESET] Unless this key is pressed the new address will not be stored into memory regardless of the display value.
6) Pressing and key other than a key used in set-up will cause the system to escape from the address set mode.

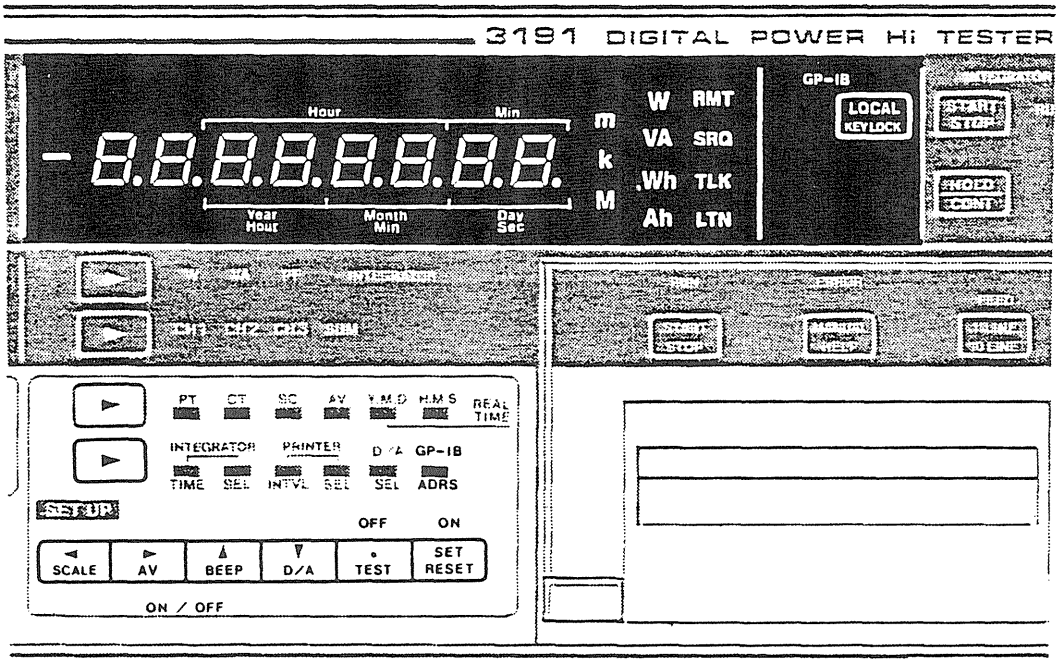
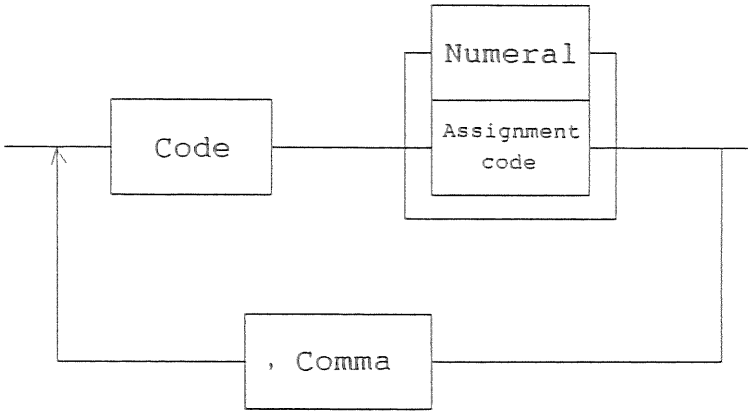


Fig. 4-1 - Address Set Procedure

5. Listener function

The 3191 listener function has the following special features:

1) Over 150 codes are supported, and a wide variety of functions.
2) All of the front-panel key operations except for power switch operation and setting the GP-IB address can be controlled.
3) Full item reset for printer output (impossible in manual) and simultaneous reset is possible.
4) Output specifications can be made for measurement and calculated data, setting status, and error codes. Data sent from the controller in the listener mode are composed of codes and attached parameters, and have the following configuration.



Code strings can be delimited with commas ",".

Example: OUTPUT_701;"MD1,VR1,...,FL1"

In the listener mode, only the first 255 bytes of data received are valid and the excessive data will be ignored.

In the remote mode, settings not specified in the control code will be those stored in the local mode memory. However, these will be cleared in specific constant set modes.

The code assignment is ristricted when the averaging function, integrator, or printer is operating. For details, refer to "5.20 Code that can be set when averaging function, integrator, or printer is operating."

The sample program below was written in HP-9816 BASIC. In the listener mode, "LF" or "EOI" is output as delimiter.

5.1 Display

Code DS: (Group1)_(Group2)_(Group3)

Description

The assignment codes given in Group1 define display block a, those of Group2 display block b, and Group2 display block c. Select one code for each display block.

Group	Assignment code
1	V1, V2, V3, W1, W2, W3, W0
2	A1, A2, A3, VAR1, VAR2, VAR3, VAR0, ET
3	W1, W2, W3, W0, VA1, VA2, VA3, VA0, PF1, PF2 PF3, PF0, I1, I2, I3, I0

Example: To display channel 2 voltage in block a, channel 3 current in block b and channel 1 power factor in block c, input:

DS:V2_A3_PF1

Notes:

1) Divide groups 1, 2 and 3 with spaces.
2) Always specify all three groups, in the same order.
3) The meaning of the codes used in the assignments are: V = Voltage, A = Current, W = active power, VA = apparent power, VAR = reactive power, PF = Power Factor, I = Integrated value, and **ET = Erapsed Time**
4) The meaning of the numerals used in the assignments are: 1~3 are channel numbers. 0 indicates that V and A are the average values and others are the SUM values.
5) Depending on input unit and option configurations there may be codes that cannot be specified.

Sample program (display set)

```
10    DIM A$[100]                          Comment
20    CLEAR 701
30    OUTPUT 701;"DS:V1 A1 W1"      ! display.a:V1 .b:A1 .c:W1
40    ENTER 701;A$
50    PRINT A$
60    END
```

Read data

```
V1  599.6E+0 ,  A1  19.98E+0 ,  W1  11.99E+3
```

5.2 Voltage and current range select

1) Fixed range selection

(code)

First code / Last code	V range				A range			
	V1	V2	V3	V	A1	A2	A3	A
R1	30 (V)				0.2 (A)			
R2	60				0.5			
R3	150				1			
R4	300				2			
R5	600				5			
R6	——				10			
R7	——				20			

Description:

1) Range set is specified through the combination of first and last codes. The ranges for the codes are as above:

V1R1, V2R1, V3R1, VR1 ———— 30V
V1R1, V2R2, V3R2, VR2 ———— 60V
...etc...

2) Numerals in the code are:
First code: channel specification
Last code: Range specification

3) When the channel specification is omitted the following default settings are used:

Three-phase three-wire mode: Channels 1 and 2 are set to the same range.
Other modes (single-phase, three-phase three-wire (3V3A), three phase four-wire): All channels are set to the same range.

Caution

1) Specification codes depend on mode and number of input units.

Mode / Unit count	Single-phase	Three-phase three-wire	Three-phase three-wire (3V3A)	Three-phase four-wire
1	V1Ri, A1Rj VRi, ARj	———	———	———
2	Single-phase 1 channel specification + V2Ri, A2Rj	VRi, ARj	———	———
3	All code specifications possible	VRi, ARj V3Ri, A3Rj	VRi, ARj	VRi, ARj

(1 ≦ i ≦ 5、 1 ≦ j ≦ 7)

2) Autoranging setting

Note: The auto-range will be canceled by setting the fixed range.

Code	Content
AV0	V autorange off
AV1	V autorange on
AA0	A autorange off
AA1	A autorange on

5.3 True/mean measurement value set

Code:

First code / Last code	V range				A range			
	V1	V2	V3	V	A1	A2	A3	A
M0	True value				True value			
M1	Effective value				Effective value			

Description:

Just as for fixed-range specification, this is handled through a combination of first and last codes.

Example:

V1M0	Measure channel 1 V as true value
A2M1	Measure channel 2 A as effective value.
VM1	Measure the voltages of channels 1 and 2 as effective values in the three-phase three-wire mode; those of all channels as effective values in other modes.

Caution

1) Specification codes are determined by mode and number of input units.

Mode / Unit count	Single-phase	Three-phase three-wire	Three-phase three-wire (3V3A)	Three-phase four-wire
1	V1Mi, A1Mi VMi, AMi	———	———	———
2	Single-phase 1 channel + V2Mi, A2Mi	VMi, AMi	———	———
3	All codes enabled	VMi, AMi V3Mi, A3Mi	VMi, AMi	VMi, AMi

i = 0 or 1

Sample program (range, true/mean value)

```
10     DIM A$[100]                                  Comment
20     CLEAR 701
30     OUTPUT 701;"MD0"                  ! Ip 3ch MODE
40     OUTPUT 701;"VR1,VM1,AV0"          ! V RANGE 30V,MEAN MANUAL
50     OUTPUT 701;"AR4,AM0,AA1"          ! A RANGE  2A, RMS   AUTO
60     READ Talk$                        ! setting data display
70             IF Talk$="END" THEN 130
80             OUTPUT 701;Talk$
90             ENTER 701;A$
100            PRINT A$
110    GOTO 60
120    DATA QVR,QAR,END
130    END
```

Read data

```
RANGE: V1-30,MEAN; V2-30,MEAN: V3-30,MEAN; MANUAL
RANGE: A1-2,RMS; A2-2,RMS; A3-0.2,RMS; AUTO
```

5.4 Measurement mode set

Code	Connection
MD0	single-phase
MD1	triple-phase three-wire
MD2	triple-phase four-wire
MD3	three-phase three-wire (3V3A)

Caution

1. MD1 can be set when 2 or 3 input units are used; MD2 and MD3 can be set when 3 input units are used.
triple-phase four-wire requires all 3 input units.

5.5 Sampling mode specification

Code	Content
M0	Holds the display, and samples one time each time M0 is specified.
M1	Continuous sampling (about 2.5 times/ second).

5.6 Filter specification

Code	Content
FL0	OFF
FL1	ON

5.7 Scaling function

1) Scaling constant set

Code:

No.	V(PT ratio)	A(CT ratio)	Power
1	PT1:x	CT1:x	SC1:x
2	PT2:x	CT2:x	SC2:x
3	PT3:x	CT3:x	SC3:x
4	PT:x	CT :x	SC :x

(0.0001≦x≦10000)

Content:

The first code sets the channel 1 value for x, for PT, CT and SC. Likewise, the next code specifies the values for channel 2, and the next for channel 3.

Caution

1) The specification codes are determined by the mode and number of input units.

Mode / Unit count	Single-phase	Three-phase three-wire	Three-phase three-wire (3V3A)	Three-phase four-wire
1	Codes 1 and 4 enabled	———	———	———
2	Codes 1, 2, and 4 enabled	Code 4 enabled	———	———
3	All codes enabled	Codes 3 and 4 enabled	Code 4 enabled	Code 4 enabled

2) Numbers 1~3 in the codes indicate channels.
3) When code 4 is used, the values are:
For single-phase, three-phase four-wire and three-phase three-wire (3V3A), the same scaling is set for all channels.
For three-phase three-wire, channels 1 and 2 have the same scaling.
4) x can be a maximum of 6 digits (including the decimal point), where 0.0001 <= x <= 10000.

2) Scaling execution

Code	Content
SL0	Releases scaling
SL1	Enables scaling

Example 1 - For a set of PT 500 for channel 1, PT1:500

Example 2 - For a set of CT 0.1 to channel 1 and SC 10.5 to channel 2, CT1:0.1,SC2:10.5

Sample program

```
10      DIM A$[200]                                  Comment
20      CLEAR 701
30      OUTPUT 701;"MD0"                          ! Ie Ben MODE
40      OUTPUT 701;"PT:2,CT:5,SC:1,SL1"           ! PT,CT,SC setting
50      READ Talk$                                ! setting data display
60              IF Talk$="END" THEN 120
70              OUTPUT 701;Talk$
80              ENTER 701;A$
90              PRINT A$
100     GOTO 50
110     DATA QPT,QCT,QSC,END
120     END
```

Read data

```
PT1:2,PT2:2,PT3:2,ON
CT1:5,CT2:5,CT3:5,ON
SC1:1,SC2:1,SC3:1,ON
```

5.8 Averaging function

1) Setting the number of measurements to be averaged (Counter mode)

Code: NA:x

Function: Sets the number (x) of V, A or W measurements to be averaged, where x is an integer from 1 to 100 inclusive.

Example: The number of measurements is set to 25.
NA:25

2) Settings relating to average calculation

2)-1 Setting average time

Code: AVT: hhhhmm

Function: Sets the average time in the range between 1 minute to 1000 hours.

Description: hhhh - hour (4 characters of 0000 to 1000)
mm - minute (2 characters of 00 to 59)

Example: Set the average time to 3 hours.
AVT:000300

2)-2 Setting the average interval

Code: AVI:hhhhmm

Function: Sets the average interval in the range from 1 minute to 1000 hours.

Description: Same as AVT.

Example: Set the average interval to 5 minutes/
AVI:000005

2)-3 Specifying the average mode

Code	Content
AVM0	Sets the average mode to the counter mode.
AVM1	Sets the average mode to the timer mode.

2)-4 Executing the average function

Code	Content
AG0	Cancels the average function.
AG1	Starts the average function.

Specifying AG1 and IS (Starting the integrator) at the same time makes it possible to start the averaging function and the integrator at the same time.

Sample program (average)

```
10    DIM A$[200]                          Comment
20    CLEAR 701
30    OUTPUT 701;"AVM0,NA:25"      ! COUNTER MODE , AVERAGE NUMBER = 25
40    OUTPUT 701;"AVT:000300"      ! AVERAGE TIME 3 hour
50    OUTPUT 701;"AVI:000005"      ! AVERAGE INTERVAL 5 min
60    OUTPUT 701;"AG1"             ! AVERAGE ON
70    OUTPUT 701;"ONA"             ! setting data display
80    ENTER 701;A$
90    PRINT A$
100   END
```

Read data

```
NA:025,AVT:000300,AVI:000005,AVM0,ON
```

5.9 Realtime set

Code RT:yymmddhhxx[ss]

Description: yy - Last two digits of the year (00~99)
mm - Month (two digits, 00~12)
dd - Date (two digits, 01~31)
hh - Hour (two digits, 00~23)
xx - Minute (two digits, 00~59)
ss - Second (two digits, 00~59, may be deleted)

Example 1: To set 10:05:30 on January 10, 1987, input:

```
RT:870110100530
```

Example 2: To set 1:30 on July 3, 2001, input:

```
RT:0107030130
```

Sample program (realtime set)

```
10    DIM A$[100]                                  Comment
20    CLEAR 701
30    OUTPUT 701;"RT:870110100530"    ! 1987-1-10 10:5:30
40    OUTPUT 701;"QRT"                ! REAL TIME display
50    ENTER 701;A$
60    PRINT A$
70    END
```

Read data

```
87-01-10 SAT 10:05:30
```

5.10 Realtime control

1) Setting control start time

Code: RTS:yymmddhhxx

Description: Same as Realtime set (RT)
However, the second digits (ss) cannot be set.

Example: To start control at 0:00 in April 1, 1988.

RTS:8804010000

2) Specifying the realtime control mode

Code	Content
RTM0	Cancels the realtime control mode.
RTM1	Sets the realtime control mode.

Sample program (realtime control) Comment

```
10    DIM A$[100]
20    CLEAR 701
30    OUTPUT 701;"RTS:8803161500.RTM1" ! REALTIME START 1988-3-16 15:00 ON
40    OUTPUT 701;"QRTS"                ! setting data display
50    ENTER 701;A$
60    PRINT A$
70    END
```

Read data RTS:8803161500.ON

5.11 Beeper set

Code	Content
B0	Beeper silenced
B1	Beeper sounds

5.12 Self-test execute

Code ST

Tests all front-panel displays, and then ROM, RAM and options.

5.13 Meter reset

Code RS

Initializes all power meter settings (full reset).

5.14 SRQ mask

1) SRQ send

Code	Content
S0	Does not transmit SRQ
S1	Transmits SRQ

2) Setting the SRQ mask

Code: SM:xxx

Function: Selects the factors for which SRQ transmission is required by xxx, an integer from 000 to 255.

Description: xxx - integer (3 characters from 000 to 255)

Status byte:

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
IE	rsv	ME	PE	DE	SE	OA	OV

(For details, refer to 7. Status byte.)

CAUTION

The SRQ mask is set to 255 when the power is turned on.

Sample program (Example of use of SRQ mask)

This example sets the SRQ mask so that SRQ is sent only for OA and OV to perform interrupt processing.

```
                                        Comment
10    DIM A$[100]                       Declare character strings
20    CLEAR 701                         Initialize 3191
30    OUTPUT 701;"S1,SM:067"            Set SRQ mask so that SRQ is sent for OA,OV
40    ON INTR 7 GOSUB Interrupt         Jump to Interrupt for GP-IB interrupt
50    ENABLE INTR 7;2                   Enable GP-IB interrupt
60    ENTER 701;A$                      Read data from 3191
70    PRINT A$                          Print data
80    GOTO 60                           Jump to line 60
90    !                                 !
100 Interrupt:                          Interrupt processing
110   STATUS 7,4;S                      Read controller status register
120   P=SPOLL(701)                      Read GP-IB status byte and reset OA and OV bits
130   BEEP                              Alarm
140   PRINT "OVER-V,A"                  Print "OVER-V,A"
150   ENABLE INTR 7;2                   Re-enable SRQ interrupt
160   RETURN                            End interrupt processing and
                                                                  return
170   !
180   END                               End
```

5.15 Header output specification

Code	Content
H0	No header output
H1	Header output

This code specifies whether the header is output with the measurement data sent from talker mode or not. The code is set to H1 when the power is turned on. For details on the header, refer to Section 6.1.

5.16 Integrator (only enabled when 9483 option installed)

1) Integrator time set

Code IT:hhhhmm

Description

hhhh - Hours (4 digits, from 0000~1000)
mm - Minutes (2 digits, 00~59)

Example 1

To set a 5-hour integraton time, input IT:000500.

Example 2

To set a 25 hour, 25-minute integration time, input IT:002525.

Example 3

To specify manual operation (maximum 10,000 hours), input IT:000000.

2) Specification of integration input items

Code	Content
II1: code	Sets items specified by assignment code for channel 1.
II2: code	Sets items specified by assignment code for channel 2.
II3: code	Sets items specified by assignment code for channel 3.

Select the assignment codes from the below (select one).

Code	Content
A1 A2 A3	Integrates current (numeral indicates input unit).
W1 W2 W3	Integrates power (numeral indicates input unit).
W0	Integrates the sum of power (for other than single-phase mode).

Example 1 - For integration of channel 3, input unit 2, current, input II3:A2.
Example 2 - For integration of the means sum of power for channel 1, input II1:W0.

3) Integration status set

Code	Content
IS	Starts integration.
IR	Stops integration.
IH	Holds (temporarily) integration.
IC	Releases the hold and continues integration.

Specifying IS and AG1 (average start) together makes it possible to start the integrator and average function at the same time.

Sample program (integration)

```
10    DIM A$[100]                                  Comment
20    CLEAR 701
30    OUTPUT 701;"IT:000500"                  ! INTEG TIME 5 hour
40    OUTPUT 701;"II1:A1,II2:A2,II3:A3"       ! INTEG ch1:A1 ch2:A2 ch3:A3
50    OUTPUT 701;"IS"                         ! INTEG START
60    READ Talk$                              ! setting data display
70          IF Talk$="END" THEN 130
80          OUTPUT 701;Talk$
90          ENTER 701;A$
100         PRINT A$
110   GOTO 60
120   DATA QIT,QII,QIS,END
130   END
```

Read data

```
IT:000500
II1:A1,II2:A2,II3:A3,II0:A
INTEGRATOR: RUN
```

5.17 Printer (only enabled when 9480 unit installed)

1) Print interval set

Code PRI:hhhhmm

Description hhhh - Hours (4-digit, 0000-1000)
mm - Minutes (2-digit, 00-59)

Example 1 - For a 1 minute interval, input PRI:000001

Example 2 - For a 25-hour, 25-minute interval, input PRI:002525.

Caution - PRI:000000 disables the interval print function.

2) Printout item set

2a) Specifying one item at a time

Code PRO:p1_p2_p3...pn

Description

Entries p1 to pn are the assignment codes for the items to be printed, selected from the below. The order is not important. See Caution 1 below.

Code	Content
V1 V2 V3 V0	Prints out V
A1 A2 A3 A0	Prints out A
W1 W2 W3 W0	Prints out active power
VAR1 VAR2 VAR3 VAR0	Prints out reactive power
VA1 VA2 VA3 VA0	Prints out apparent power
PF1 PF2 PF3 PF0	Prints out power factor
I1 I2 I3 I0	Prints out integrator results

The numerals 1 to 3 in the assignment codes specify the channel (however for integration, I1 to I3 specify channel numbers). The numeral 0 represents the average for voltage and current measurements, and the sum for other measurement items..

Insert one space between the assignment code and the next when describing the printout items.

Example: To printout unit one V, A and active power, and unit 2 V and A, input:

PRO: V1_A1_W1_V2_A2

Caution

1. Specified assignment codes are added to those already specified. The printout item initialization setting is what it what before it entered remote mode. To output only specified items, first input the PRO0 code.

2) Full item list output

Code PRO

Content: All enabled items are printed out.

3) Printout item clear

Code PRO0

Content: All set printout items are cleared.

4) Printer status set

Code	Content
PRS	Start printer
PRR	Stop printer
PRM	Manual print
PRH	Help printout
PRF	Paper 1-line feed
PRL	Paper 10-line feed
PR'xxx'	Print out characters xxx

Caution

1. PR'xxx' can specify a maximum of 32 characters (one line), and the CR and LF characters cannot be included.

Sample program (printer)

```
10     DIM A$[200]                                    Comment
20     CLEAR 701
30     OUTPUT 701;"PRI:000001"              ! PRINT INTVL 1 min
40     OUTPUT 701;"PRO0"                    ! PRINT OUT initialize
50     OUTPUT 701;"PRO:V1 A1 W1"            ! PRINT OUT -- V1 A1 W1
60     OUTPUT 701;"PR'3191 DIGITAL POWER Hi TESTER'"  ! COMMENT
70     OUTPUT 701;"PRS"                     ! PRINTER START
80     READ Talk$                           ! setting data display
90             IF Talk$="END" THEN 150
100            OUTPUT 701;Talk$
110            ENTER 701;A$
120            PRINT A$
130    GOTO 80
140    DATA OPRI,OPRO,OPRS,END
150    END
```

Read data

```
PRI:000001
PRO: V1 A1 W1
PRINTER: RUN
```

Printed data

```
0000:00

          Voltage          Ampere
ch1>      600   V        20.00   A

          Watt
ch1>    11.99  kW

PRINT.RUN '87-02-03 TUE 11:51:08
3191 DIGITAL POWER Hi TESTER
```

5.18 D/A output (only enabled when 9481 option installed)

1) D/A output item set

Code	Content
AO1:code	Sets the D/A output for the specified item for channel 1.
AO2:code	Sets the D/A output for the specified item for channel 2.
AO3:code	Sets the D/A output for the specified item for channel 3.

Select one of the following assignment codes:

VA1 VA2 VA3 VA0	D/A outputs apparent power.
VAR1 VAR2 VAR3 VAR0	D/A outputs reactive power.
PF1 PF2 PF3 PF0	D/A outputs power factor.
I1 I2 I3	D/A outputs integrated value.
V0 A0	D/A outputs average values of V and A.

The numerals 1 to 3 indicate the input unit number, except for I1 to I3, which indicates the channel number. Number 0 represents the average for voltage and current and the sum for other items.

Example 1

For output of reactive power fron input unit number 2 through D/A output channel 1, input AO1:VAR2.

Example 2

For output of channel 1 integration results through D/A output channel 3, input AO3:I1.

2) D/A output execution

Code	Content
DA0	Disables D/A output
DA1	Enables D/A output

Sample program (D/A output) Comment

```
10    DIM A$[200]
20    CLEAR 701
30    OUTPUT 701;"AD1:VA1"    ! D/A OUT ch1:VA1
40    OUTPUT 701;"AD2:PF1"    ! D/A OUT ch2:PF1
50    OUTPUT 701;"AD3:VAR1"   ! D/A OUT ch3:VAR1
60    OUTPUT 701;"DA1"        ! D/A OUT ON
70    OUTPUT 701;"OAD"        ! setting data display
80    ENTER 701;A$
90    PRINT A$
100   END
```

Read data

```
AD1:VA1,AD2:PF1,AD3:VAR1.ON
```

5.19 Transmission data set

Content - The following Q-codes specify what data is sent when the system is in the talker mode.

1) Measurement data specification

1)-1 Specification for individual items

Code	Content	Code	Content
QV1 QV2 QV3 QV0	V measurement data	QA1 QA2 QA3 QA0	A measurement data
QW1 QW2 QW3 QW0	Active power measurement data	QVAR1 QVAR2 QVAR3 QVAR0	Inactive power measurement data
QVA1 QVA2 QVA3 QVA0	Phased power measurement data	QPF1 QPF2 QPF3 QPF0	Power factor measurement data
QI1 QI2 QI3 QI0	Integration data	QIET	Averaging and integration elapsed time data

Cautions

1. Numbers 1 to 3 in the chart represents unit channels, and 0 represents the sum. However, for QV0 and QA0, 0 represents the average.
2. Integration data code (QI1 to QI0) numbers are channel numbers, and not related to original unit numbers.
3. Codes related to integration (QI1 to QI0) cannot be specified unless there is integration.
4. Talker-specified data is sent in the order specified, except that the integration elapsed time is sent first.
5. Changing the range, etc. when the sampling mode is in a holding state will leave the display disappeared. In this case, the measured data output to the GP-IB or a printer is invalid. The measured data output to the GP-IB when the constants are set is also invalid.

Sample program (Transmission of each data)

```
10    DIM A$[500]
20    CLEAR 701
30    OUTPUT 701;"QV1,QA1,QW1,QV2,QA2,QW2,QV3,QA3,QW3"
40    ENTER 701;A$
50    PRINT A$
60    END
```

Read data

```
V1  599.5E+0 ,  A1  19.98E+0 ,  W1  11.99E+3 ,  V2  599.8E+0 ,  A2  19.99E+0
W2  11.99E+3 ,  V3  000.0E+0 ,  A3  00.00E+0 ,  W3  00.00E+3
```

1)-2 Specification for all items

Code Q1

Content - All items listed in the above chart are output through the talker. Data is sent in the order of elapsed time, voltage, current, effective power, apparent power, power factor, reactive power and integrated value.

Sample program (Transmission of all data)

```
10    DIM A$[500]
20    CLEAR 701
30    OUTPUT 701;"Q1"
40    ENTER 701;A$
50    PRINT A$
60    END
```

Read data

```
ET 000000 ,  V1  599.7E+0 ,  V2  599.7E+0 ,  V3  000.0E+0 ,  V0  399.8E+0 ,  A1
 19.98E+0 ,  A2  19.99E+0 ,  A3  00.00E+0 ,  A0  13.32E+0 ,  W1  11.99E+3 ,  W2
 11.99E+3 ,  W3  00.00E+3 ,  W0  23.98E+3 ,  VA1  11.98E+3 ,  VA2  11.99E+3 ,
A3  00.00E+3 ,  VA0  23.97E+3 ,  PF1  1.000E+0 ,  PF2  1.000E+0 , QPF3 999999E-
 , QPF0 999999E+9 ,  VAR1  00.00E+3 ,  VAR2  00.00E+3 ,  VAR3  00.00E+3 ,  VAR0
 00.00E+3 ,  AH1 000000000E+0 ,  WH1 000000000E+0 ,  AH1 000000000E+0
```

2) Status set (see caution 1)

Code	Content	Required equipment
QVR	V range	3191 Main unit
QAR	A range	
QMD	Measurement mode	
QM	Sampling	
QFL	Filter	
QPT	PT ratio	
QCT	CT ratio	
QSC	Scaling	
QNA	Averaging quantity	
QRT	Realtime	
QRTS	Realtime control	
QSM	SRQ mask	
QIT	Integration time	9483 Integrator
QII	Integration input item	
QIS	Integration	
QPRI	Print interval	9480 Printer
QPRO	Printout items	
QPRS	Printer	
QAO	Analog output items	9481 D/A converter

The listed codes cannot be used without the equipment listed in the right column.

Caution

1. It is possible to specify only a single code. If multiple codes are specified, only the last is enabled.

3) Error code output

Code: QER

Function: This outputs the error code and error message if there is invalid data received in the listener mode, or in equipment status.

Caution

This code will continue to output error messages even if other Q-codes are set in the talker mode. It will remain enabled until the listener receives a Q0 code.

4) Talker code clear

Code Q0

Function: When this code is received all Q-codes are cleared. In the talker mode, receipt of this mode will transmit all displayed data.

CAUTION

The Q code is canceled by ST (self test), and RS (reset) as well as Q0. The Q code is also canceled when the unit is returned from the remote state to the local state.
The header will be set to H1 when the Q code is canceled by a code other than Q0.
The Q code is set to Q0 when the power is turned on.

5.20 Codes that can be set when averagingfunction, integrator or printer is operating

The codes marked with o in the chart can be set.

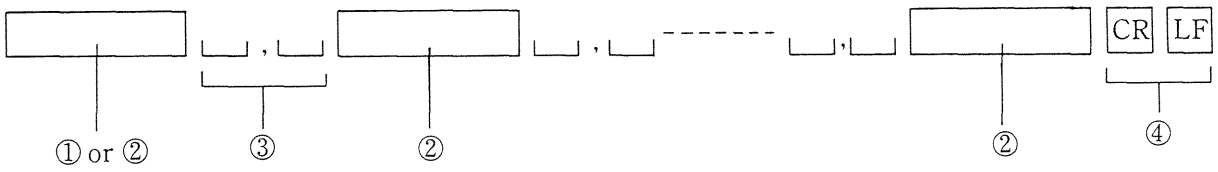
Item \ Operation	Average		Integrator	Printer
	Couter mode	Timer mode		
Display (DS)	o	o	o	o
Range (VR,AR,AV,AA)	o			o
RMS/MEAN (VM,AM)	o			o
Mode (MD)	o			o
Sampling (M)	o	o	o	o
Filter (FL)	o			o
Scaling (PT,CT,SC)	o			o
Scaling ON/OFF (SL)	o	o		o
Averaging (NA,AVT,AVI,AVM)				o
Average ON/OFF (AG)	o	o	*	o
Realtime (RT)	o			o
Realtime control (RTS, RTM)				
Beep (B)	o	o	o	o
Self test (ST)	o			o
Reset (RS)	o	o	o	o
SRQ (S, SM)	o	o	o	o
Header (H)	o	o	o	o
Integration time, input (IT,II)	o			o
Start (IS)	o		o	o
Stop (IR)	o	o	o	o
Halt/continue (IH,IC)	o	o	o	o
Print interval (PRI)	o			
Print item (PRO)	o			
Printer start/stop (PRS/PRR)	o	o	o	o
Manual/help print (PRM/PRH)	o	o	o	o
1-line/10-line feed (PRF/PRL)	o	o	o	o
Print (PR '...')	o	o	o	o
D/A output select (AO)	o			o
D/A output ON/OFF (DA)	o	o	o	o
Overall Q code	o	o	o	o

*: Can be set only when the average function is in the counter mode.

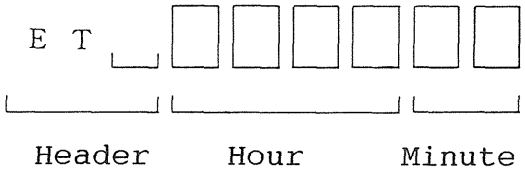
6. Talker functions

The talker transmits the data specified in the listener mode Q-codes to the controller. If there are no Q-codes specified then the current display data is sent. The maximum size of data transmitted in the talker mode is 491 bytes.

6.1 Measurement data output format



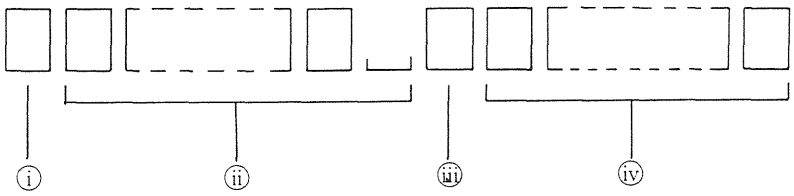
(1) Elapsed time data (format)



[Output example]
Elapsed time: 1 hour 30 minutes
ET 000130

* When H0 (no header) is received in the listener mode, only the hour and minute data is output.

(2) Measured data (format)



1) Overflow display

Code	Content
0	The input V or A is offscale.
space	The input V or A is within the scale range

2) Header (may be omitted, set by code H0 in listener mode)

Header	Content	Header	Content
V 1 V 2 V 3 V 0	Voltage	W 1 W 2 W 3 W 0	Effective power
A 1 A 2 A 3 A 0	Current	VAR 1 VAR 2 VAR 3 VAR 0	Reactive power
VA 1 VA 2 VA 3 VA 0	Apparent power	PF 1 PF 2 PF 3 PF 0	Power factor
AH 1 AH 2 AH 3 AH 0	Integration (A)	WH 1 WH 2 WH 3 WH 0	Integration (power)

3) Data polarity

Sign	Content
space	Data polarity is +
-	Data polarity is -
9	Data is overscale

* No polarity is attached to the output format of the integrated value.

4) Data

Data is output with 12 characters for an integrated value and with 8 characters for other values.

Example 1: 10.0 [V] 0.10.0E+0
Example 2: 1000[Wh] 000001000E+0

If data is overscale, 99999E+9 or 999999999E+9 will be output.

* If H0 (no header) is received in the listener mode, only data shown in 4) is output for integrated value, and data shown in 3) and 4) for other values.

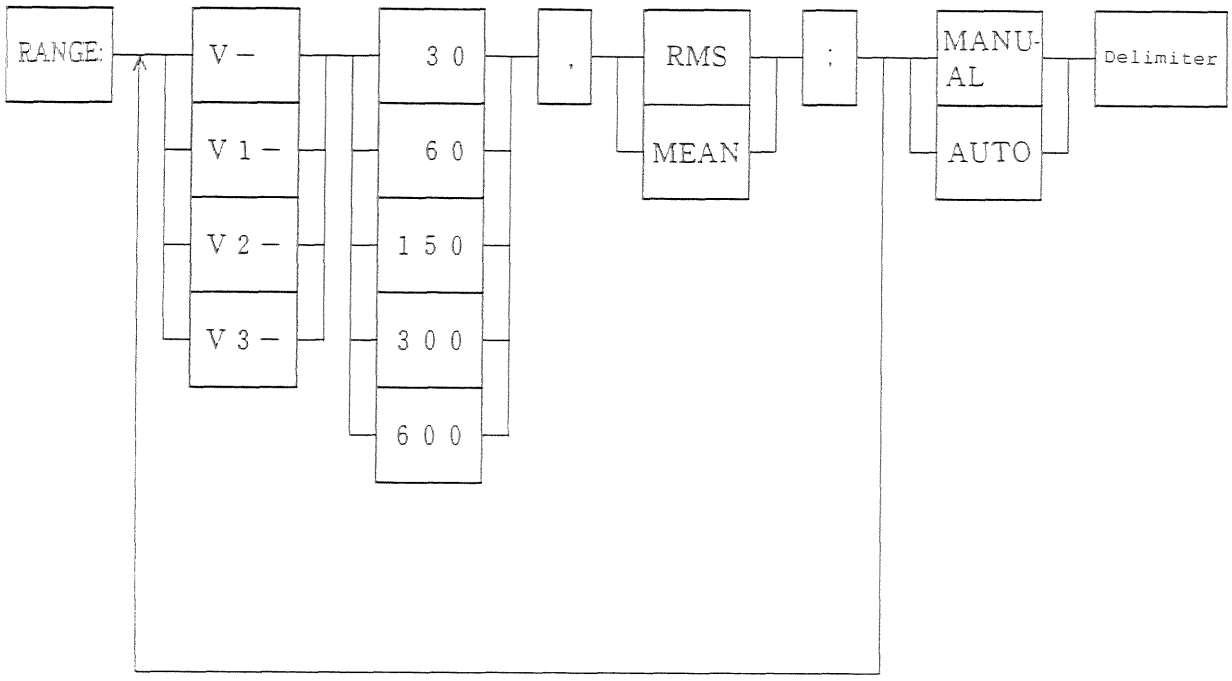
(3) Comma

(4) Delimiter

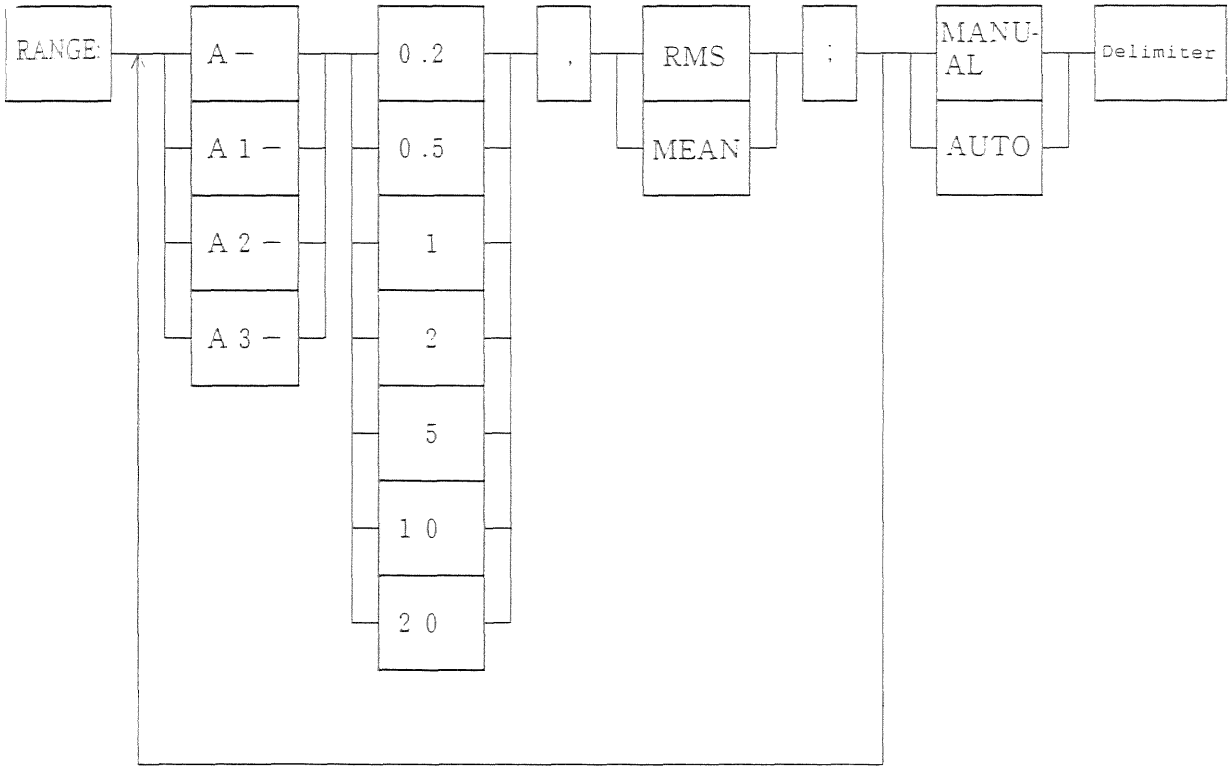
CR and LF are output, and EOI is output at the same time as LF.

6.2 Set status data output format

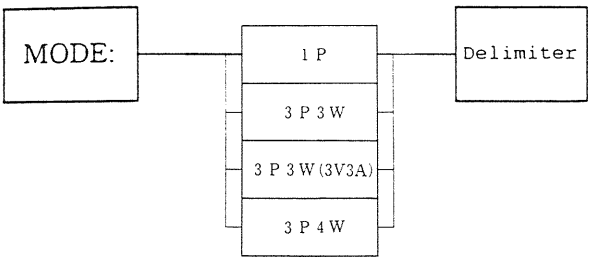
1) Output format for recepit of QVR



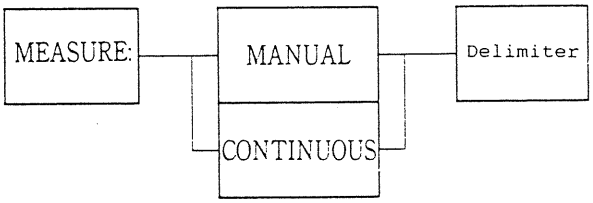
2) Output format for receipt of QAR



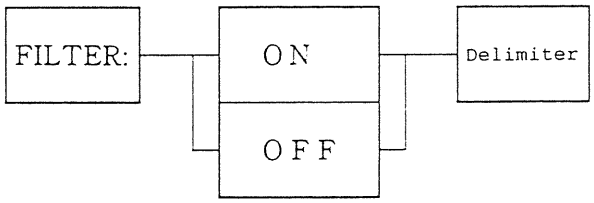
3) Output format for receipt of QMD



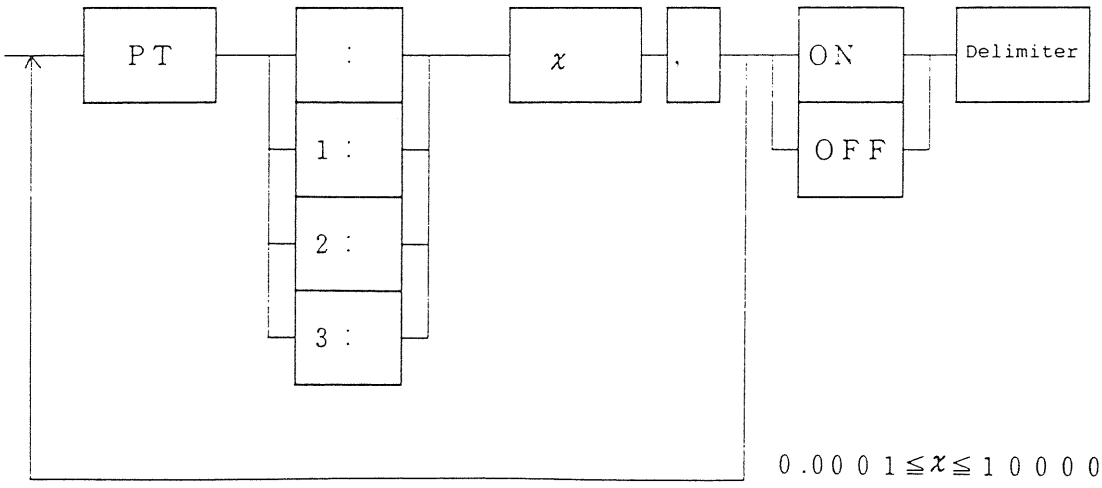
4) Output format for receipt of QM



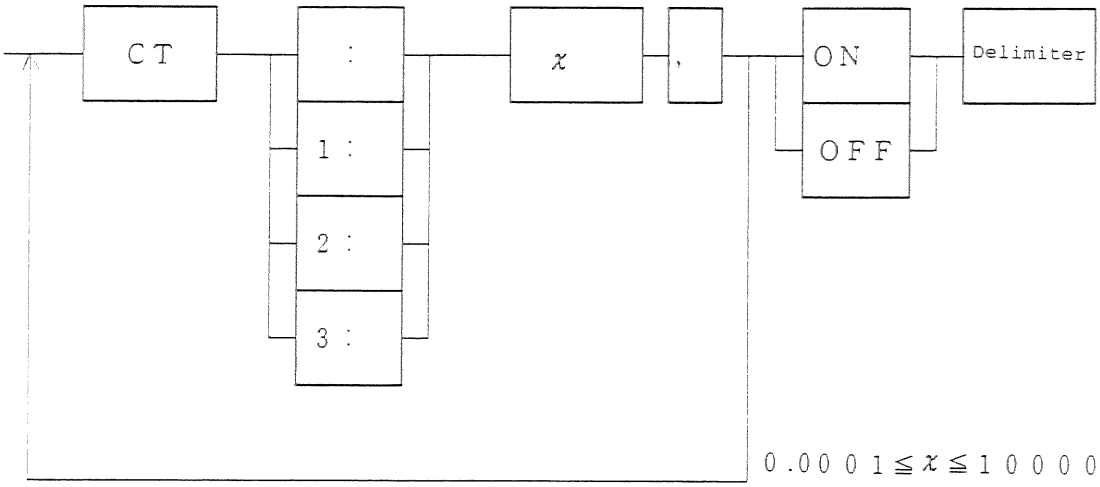
5) Output format for receipt of QFL



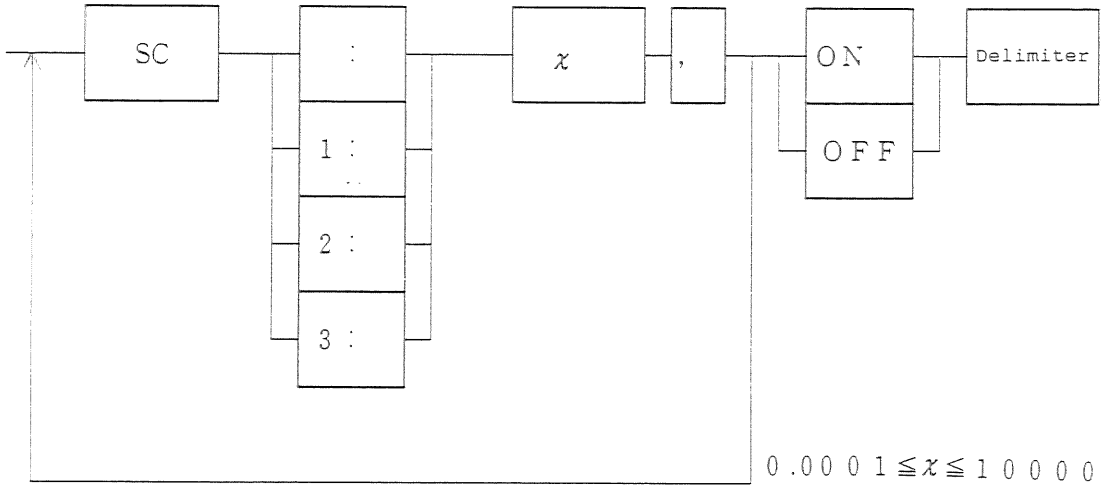
6) Output format for receipt of QPT



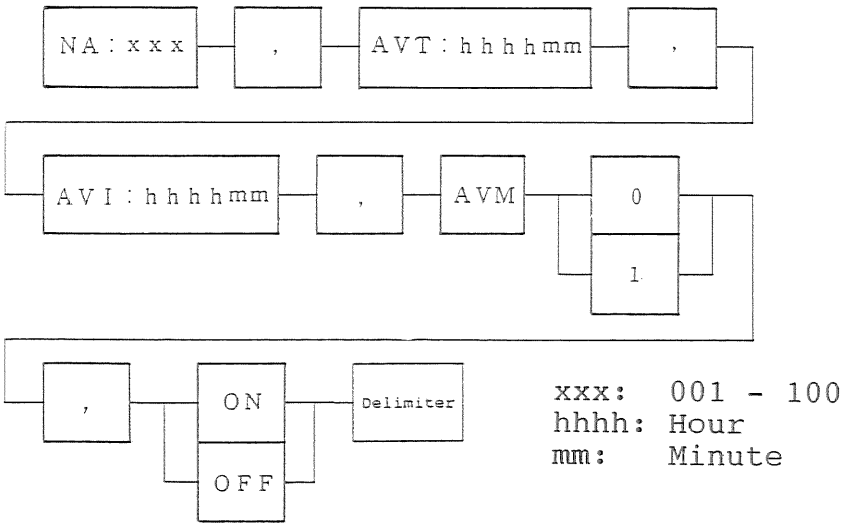
7) Output format for receipt of QCT



8) Output format for receipt of QSC

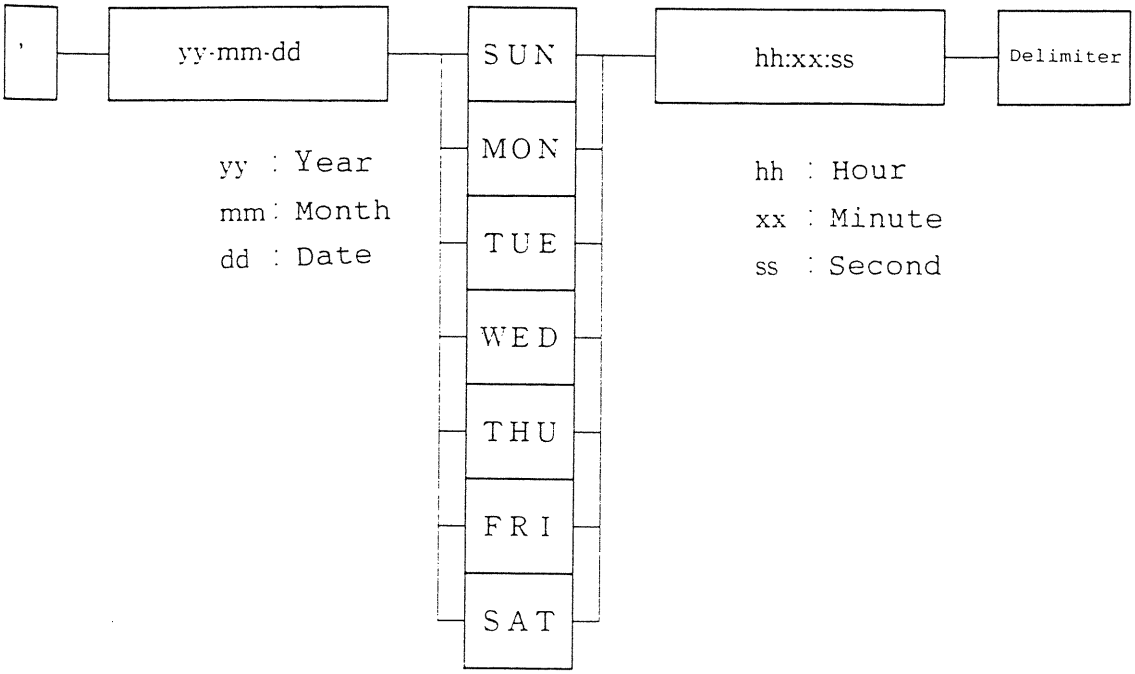


9) Output format for receipt of QNA

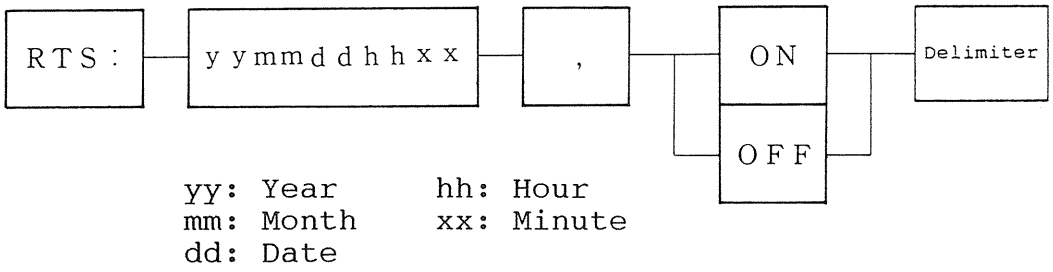


xxx: 001 - 100
hhhh: Hour
mm: Minute

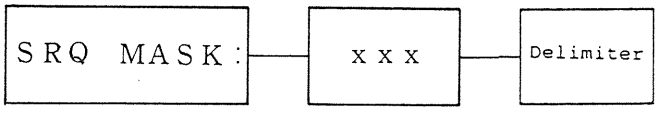
10) Output format for receipt of QRT



11) Output format for receipt of QRTS

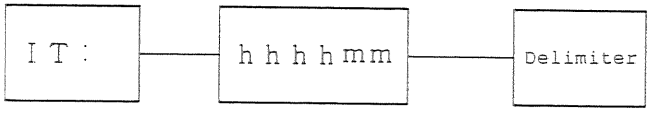


12) Output format for receipt of QSM



x x x : 0 0 0 ~ 2 5 5

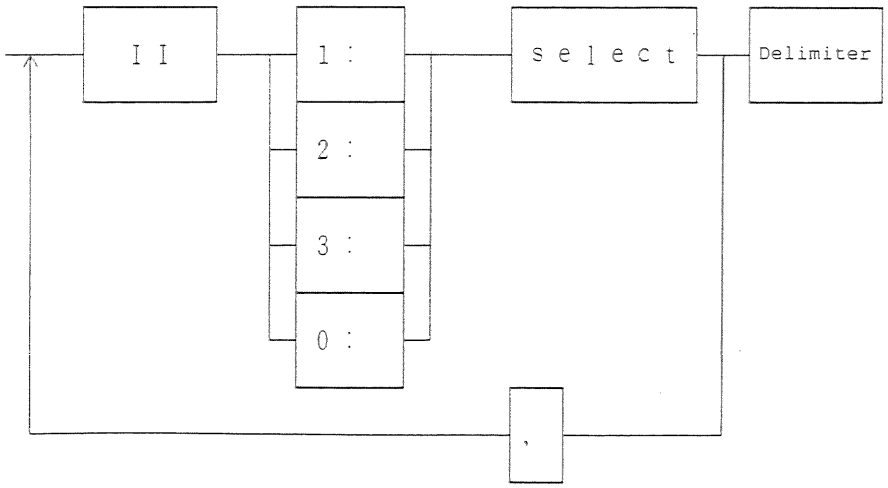
13) Output format for receipt of QIT



hhhh : Hour

mm : Minute

14) Output format for receipt of QII

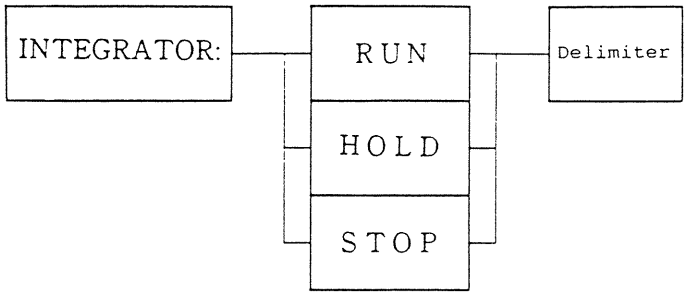


select : A 1, A 2, A 3, A,

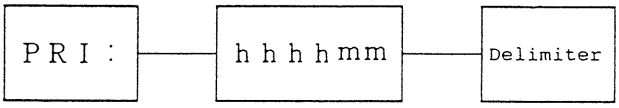
W 1, W 2, W 3, W 0, W

Note: IIO indicates functions A, W only.

15) Output format for receipt of QIS



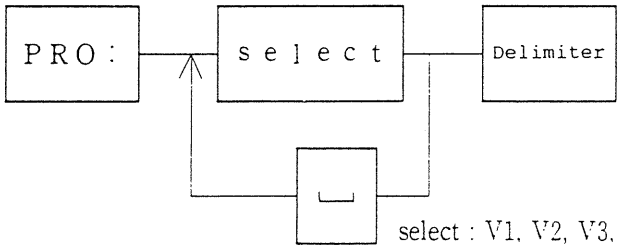
16) Output format for receipt of QPRI



h h h h : Hour

mm : Minute

17) Output format for receipt of QPR0



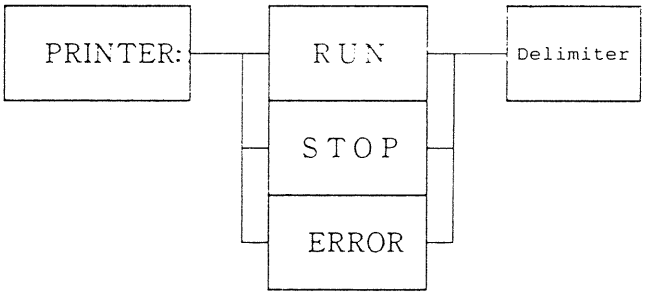
select : V1, V2, V3, A1, A2, A3 **A0**

W1, W2, W3, W0, VA1, VA2, VA3, VA0

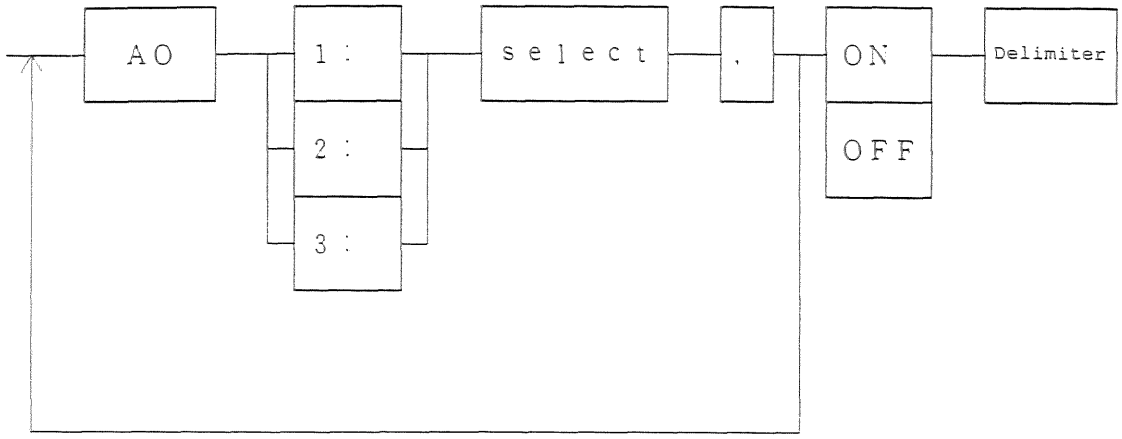
VAR1, VAR2, VAR3, VAR0, PF1, PF2, PF3, PF0

I1, I2, I3, I0

18) Output format for receipt of PRS



19) Output format for receipt of QAO



select: **V0**, **A0**, VAR1, VAR2, VAR3, VAR0, VA1, VA2, VA3, VA0, PF1, PF2, PF3, PF0, I1, I2, I3

6.3 Error message output

Error message	Code	Content
Printer Err		Printer fault, such as no paper.
Over V		V-range crest factor exceeded.
Over A		A-range crest factor exceeded.
Syntax Err	1	Description error (option code specified without that option).
Syntax Err	2	Description error (input outside range).
Syntax Err	3	Error in code receiving control (range, scaling verify).
Syntax Err	4	SUM specified without SUM being generated.
Syntax Err	5	Other (range change during integration).
ALL RIGHT		No errors detected.

Note: When using a NEC PC-9801 as the controller, specify the 3191 as the talker and use LINE and INPUT statements to read measured data into variables. In this case, the Q code must be specified so that the data length sent by the 3191 is 255 bytes or less.

7. Status byte

1) Status byte output format

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
IE	rsv	ME	PE	DE	SE	OA	OV

2) Explanation

bit	code	Content
0	OV	Over-voltage. One of V1, V2 or V3 exceeded crest factor for range, and value set to 1.
1	OA	Over-current. One of A1, A2 or A3 exceeded crest factor for range, and value set to 1.
2	SE	Syntax error. Set to 1 when code received in listener mode invalid.
3	DE	Device error. Set to 1 when device fault detected.
4	PE	Printer error. Set to 1 when printer fault detected (no paper, mechanical fault).
5	ME	Manual error. Set to 1 when manual measurement terminated in sample hold status.
6	rsv	Request service. Set to 1 then a service request generated.
7	IE	Integration end. Set to 1 when integration ends.

8. GP-IB commands

The following commands can be used through interface and function capabilities.

Command	Content
GTL	Release remote status and goto local mode.
LLO	Set the local key, the only enabled key in the remote mode, to Local Lock Out (disable).
DCL	Device Clear. Clear all parameters.
SDC	Selected Device Clear. Clear all parameters.
GET	Group Execute Trigger. Measure one data set in manual measurement mode.

9. GP-IB response speed

The GP-IB interface is operated by the instructions from the controller as folows:

In the LISTENER mode: Internal processing
In the TALKER mode: Sending data

Examples of the time required for data transfer and the time required for internal processing are shown below.

	Setting items or data item	Internal processing time	Transfer time
Listener	Scaling ON	300 ms	Approx. 400 us/byte
	Average ON	340 ms	
	Range select	450 ms	
	RMS/MEAN select	450 ms	
	Filter On	450 ms	
	Printer start	1.4 s	
	Self test	2.6 s	
Talker	Display data (any 3 items)	160-240 ms	Approx. 400 us/byte
	Settting data (any)	80-160 ms	
	All measured data	960 ms	

The internal processing time is the time required for internal evaluation and calculation, thereby the unit being incapable of responding to the next instruction from the GP-IB. The processing time varies a little depending upon the setting conditions. The response may be delayed due to the processing other than that for GP-IB depending upon the timing of reception of instructions from the controller. The transfer time is limited by the operation speed of the controller.

10. GP-IB option code table

Function	Code	Explanation		Page
Display item select	DS:g1 _ g2 _ g3	Displays g1 in display block a Displays g2 in display block b, g3 in display block c	g1 — **V0~V3,W0~W3** (one only) g2 — **A0~A3,**VAR0~VAR3 **ET** (one only) g3 — W0~W3,VA0~VA3 PF0~PF3,I0~I3	E-8
Range select	V i R j	Selects V range	1 ≦ i ≦3 or deleted Channel number 1 ≦ j ≦5 range number	E-9
	A i R j	Selects A range	1 ≦ i ≦3 or ditto 1 ≦ j ≦7	
Autorange set	AV i AA i	Selects V autorange, A autorange	i = 0 OFF clear i = 1 ON	E-10
True/mean measurement select	V i M j	V	1 ≦ i ≦3 or deleted Channel number j =0 — RMS j =1 — MEAN	E-11
	A i M j	A		
Measurement mode	MD i	Changes mode	i=0 — Single-phase i=1 — Three-phase three-wire i=2 — Three-phase four-wire i=3 — Three-phase three wire (3V3A)	E-12
Scaling execution	SL i	Specifies scaling/no scaling	i=0 — OFF disabled i=1 — ON enabled	**E-14**
Averaging execution	AG i	Specifies averaging/no averaging	i=0 — OFF disabled i=1 — ON enabled	**E-16**
Filter	FL i	Specifies filter/no filter	i=0 — OFF disabled i=1 — ON enabled	E-13

Function	Code	Explanation		Page
Beeper	B i	Sounds beep or not	i=0 — OFF Disabled i=1 — ON Enabled	E-19
Self-test	S T	Runs self-test		E-19
Reset	R S	Initializes settings		E-19
Service request	S i	Sends SRQ or not	i=0 — Disabled i=1 — Enabled	E-19
V scaling value	P T i : x	Sets PT ratio to x $0.0001 \leqq x \leqq 10000$	$1 \leqq i \leqq 3$ deleted (channel number)	E-13
A scaling value	C T i : x	Sets CT ratio to x	$1 \leqq i \leqq 3$ or deleted (Channel number)	E-13
Power scaling value	S C i : x	Sets scaling to x	$1 \leqq i \leqq 3$ or deleted (Channel number)	E-13
Averaging count	N A : x	Averages x times $1 \leqq x \leqq 100$		E-15
Average time set	AVT:hhhhmm	hhhh - hour	1 min. to	E-15
Average interval set	AVI:hhhhmm	mm - minute	1000 hours	E-15
Average mode set	AVMi	Specifies counter mode and timer mode.	i=0 - counter mode i=1 - timer mode	E-15
Realtime set	R T :yymmddhhxx(ss)	Last 2 digits yy — of year, mm— month, dd — date, hh — hour, xx — minute, ss — second		E-17

Function	Code	Explanation		Page
Realtime control start time	RTS: yymmddhhxx	Same as realtime set for yy, mm, dd, hh and xx.		E-18
Realtime control mode set	RTMi	Specifies realtime control mode. i=0 - OFF, i=1 - ON		E-18
SRQ mask set	SM:xxx	Masks with an integer (xxx). xxx:000 - 255 (3 char fixed)		E-19
Header during talker	H i	Outputs header or not	i=0 — Disabled i=1 — Enabled	E-19
Measured data (talker xmit)	Q V i	Voltage	1 ≦ i ≦ 3 (channel number) i = 0 (SUM) (Average or sum)	E-27
	Q A i	amperage		
	Q W i	active power		
	Q V A i	phased power		
	Q V A R i	inactive power		
	Q P F i	power factor		
	QET	Elapsed time		
	Q 1	all measurement items		E-28
Set status (talker xmit)	Q V R	V range		E-29
	Q A R	A range		
	QMD	measurement mode		
	QM	sampling		
	Q F L	filter		
	Q P T	PT ratio		
	Q C T	CT ratio		
	Q S C	scaling		
	Q N A	averaging count		
	Q R T	realtime		
	QRTS	Realtime control status		
	QSM	SRQ mask status		
Error code xmit	Q E R			E-30
Q-code clear	Q 0			E-30

Integrator

Function	Code	Explanation		Page
Integration time set	I T : hhhhmm	hhhh — hour mm — minute	1 minute to 1000 hours 0 setting is 10,000 hours	E-20
Integrator input items	I I i : Assignment code	1 ≦ i ≦ 3 channel number	Assignment code A1 ~ A3 W1 ~ W0	E-20
Integrator status set	I S I R I H I C	integrator start integrator stop integrator hold integrator continue		E-21
Talker xmit data	Q I T Q I I Q I S	Integration time integration input items intregrator status		E-29
	Q I i	Integrator data	1 ≦ i ≦ 3 channel number i = 0 SUM	E-27

Printer

Function	Code	Explanation		Page
Print interval	PRI : hhhhmm	hhhh — Hours mm — minutes	1 minute to 1000 hours No interval printed when 0 specified.	E-22
Printout items	PRO:p1 _ p2 _ pn	Individual item set	Select p1~pn from below V0 ~V3,A0 ~A3,W0~W3 VAR0~VAR3, VA0~VA3 PF0~PF3,I1~I0	E-22
	PRO	All items set		E-23
Printout item clear	PRO 0	All items reset		E-23
Printer status	PRS PRR PRM PRH PRF PRL PR'.....'	Printer start printer stop manual print help print paper feed paper long feed printer comment		E-24
Talker xmit	QPRI QPRO QPRS	Print interval printout items printer status		E-29

D/A output

Function	Code	Explanation		Page
D/A og output items	AO i : Assignment code	1 ≦ i ≦3 channel number	assignment code VA0~VA3,VAR0~VAR3 PF0~PF3, I1~I3, V0, A0	E-25
D/A og output execute	DA i	D/A output or not	i=0 — disabled i=1 — Enabled.	E-26
Talker xmit	QAO	D/A output items		E-29

Appendix F

9485
BROAD BAND INPUT UNIT

INSTRUCTION MANUAL

Table of Contents

1. Outline

The 9485 Broadband Input Unit is a direct-input unit with a wide frequency range of 10 Hz to 30 kHz. It uses an insulated amplifier for the voltage input, unlike the 9484 which uses a PT.

2. Specifications

Same as for the 9484, except for accuracy. Refer to C. 9484.

Accuracy		Voltage	Current	Power
〔23℃ ± 3 ℃〕 Power factor = 1	10Hz	± 0.4 % rdg. ± 0.4 % f.s.	± 0.4% rdg. ± 0.4% f.s. (Up to 10A when frequency is less then 20Hz)	± 1 % f.s. (10A以下)
	20Hz			± 0.4 % rdg. ± 0.4 % f.s.
	45Hz	± 0.2 % rdg. ± 0.2 % f.s.	± 0.2% rdg. ± 0.2% f.s.	± 0.2% rdg. ± 0.2% f.s.
	66Hz			
	2kHz	± 0.4 % rdg. ± 0.4 % f.s.	± 0.4% rdg. ± 0.4% f.s.	± 0.4 % rdg. ± 0.4 % f.s.
	10kHz			± 1 % f.s.
	20kHz	± 1 % f.s.	± 1.5 % f.s.	± 3 % f.s.
	30kHz			± 6 % f.s.

3. Notes Concerning Use

A maximum capacity of 350 mA is required by the digital block power source (compare with page C-6).
Due to internal circuit conditions, a voltage reading may appear (even if there is no input) when power is turned on. This is not a sign of malfunction, and will reset itself to zero after 30 seconds.

Appendix G

9486 CLAMP UNIT

INSTRUCTION MANUAL

Table of Contents

1. Outline

The 9486 Clamp Unit permits current measurement by means of a clamp sensor without having to disconnect the measured line. It uses an insulated amplifier for the voltage input, unlike the 9484 which uses a PT. Also, a clamp sensor is used for current input instead of the CT used by the 9484.

2. Specifications

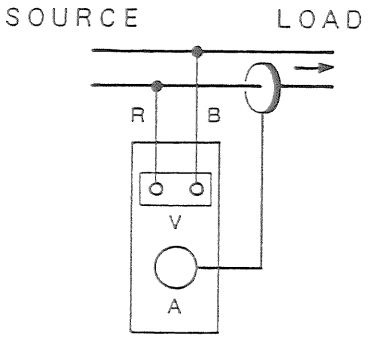
The specifications below are for the 9486 when used alone. Combine them with the clamp sensor specifications to obtain values applicable to actual use.

Item \ Function	Voltage	Current	Power
Measurement range	30.00/60.00/150.0 30.0/600.0(V)	0.02/0.05/0.1/0.2/ 0.5/1/2(V)	Depends on combination of current and voltage (Current depends on sensor rating.)
Maximum continuous input without damage	1,000V peak	12V peak	————
Crest factor	2.5 or less	2.5 or less	Same as for voltage and current
Input impedance	Approx. 1MΩ	Approx. 200KΩ	————
Precision(at 23 ℃ ±3℃, 45Hz~ 66Hz, Power factor 1)	±0.2 %rdg. ±0.2 %f.S.	±0.2 %rdg. ±0.1 %f.S.	±0.2 %rdg. ±0.2 %f.S.
Frequency response (deviation from precision at 23℃ ±3 ℃, power factor 1)	Within±1.0 % (10Hz~30KHz) Within±2.0 % (5Hz~50KHz)	Within±1.0 % (10Hz~30KHz) Within±2.0 % (5Hz~50KHz)	Within±1.0 % (10Hz~10KHz) Within±3.0 % (10KHz~30KHz)
Effect of power factor (55 Hz)	————		Power factor=±0.4 %rdg. at 0.5
Temperature coefficient	Within ±0.04% f.s./ ℃	Within ±0.04% f.s./ ℃	Within ±0.04% f.s./ ℃
Operating environment	0 ℃ to 40℃, max. 80 % RH (no condensation)		
Effective input range	10% to 102 % of range		
Response time	Approx. 0.8 sec (for V, A, W analog output)		
Analog output	output precision is ±0.2 %f.s. of display value.		
Monitor output	V, A, 2Vrms/f.s.		
Effect of common mode voltage (50/60Hz)	Less than ±0.05%f.s. for both voltage and current (with 1000V applied between input terminal and case and voltage input terminals shorted)		
Insulation resistance	Greater than 100MΩ at 500Vdc (between V/A input terminals and case, between V/A input terminals and output terminals, between V and A input terminals, between case and power supply, and between output terminals and power supply)		
Dielectric strength	2.2KVac for 1 minute (between V/A input terminals and case, between V/A input terminals and output terminals, and between V and A input terminals) 1.5KVac for 1 minute (between case and power supply, and between output terminals and power supply)		

3. Connection

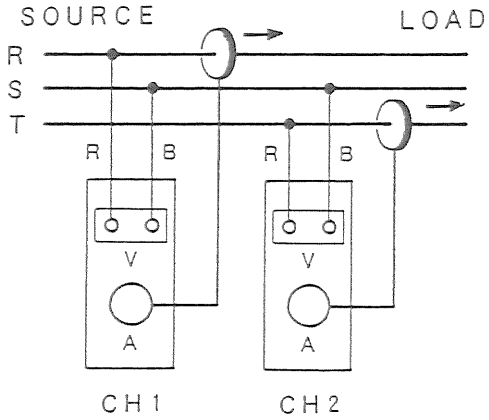
Please refer to the 3191 Instruction Manual for procedures applicable to connection using an external transformer(PT).

2.1 Single phase, 2 conductor connection (1ϕ 2W)



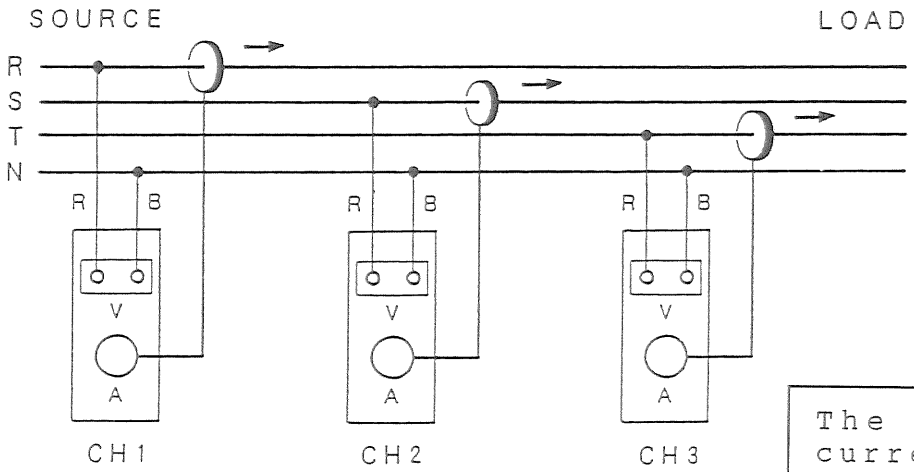
CH1 to CH3

2.2 Three phase, 3 conductor connection (3ϕ 3W)



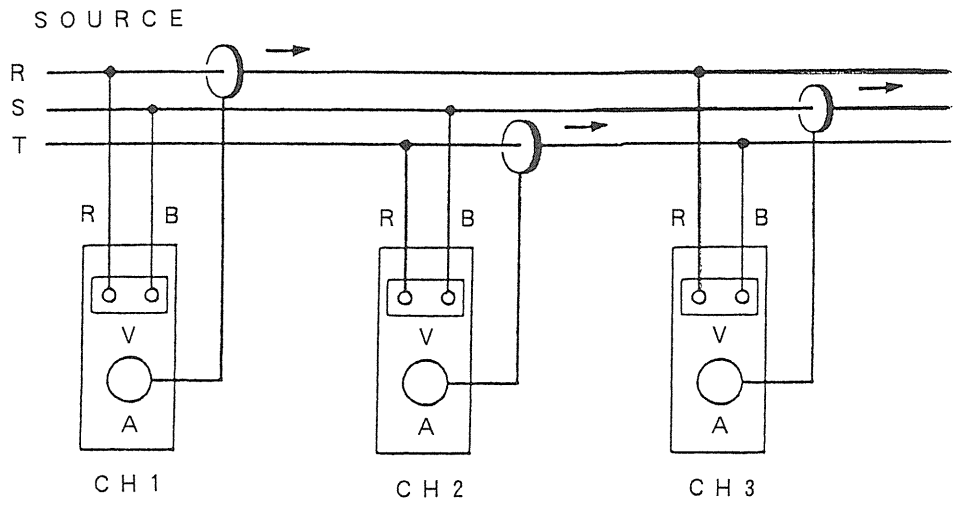
Note
The same rated current is used for sensor of channels 1 and 2.

2.3 Three phase, 4 conductor connection (3ϕ 4W)



Note
The same rated current is used for sensor of all channels 1 to 3.

3-4. Three phase, 3 conductor connection (3φ 3W· 3V3A)



Note
The same rated current is used for sensor of all channels 1 to 3.

4. Notes

- When using the 9486 with the former-type 3191 (versions before the 2.10), you will need the updated versions of the built-in software and hardware. Please contact your nearest Hioki dealer (to check the version of your software, see 6-14. Self test in the 3191 Instruction Manual.)
- Due to internal circuit conditions, voltage, current, power and other readings may appear (even if there is no input) when power is turned on. This is not a sign of malfunction, and will reset itself to zero after 30 seconds.
- Current range is indicated as 0.2 A to 20 A on the 3191 front panel. When using a 200-A sensor, there will be a difference of one decimal place between the indicated and actual ranges. (for example when the range is indicated as 20A, actual range is 200A.) The reading, however, will be accurate as it is.
- If sensors of different current ratings are used together, available mode are restricted. Sensors of the same rating must be used for channels 1 and 2 in the 3-phase 3-wire mode, and, for channels 1 to 3 in the 3-phase 3-wire (3-v, 3-A) and 3-phase 4-wire modes.
- The 9167 voltage input cord is supplied with the 9486 as a standard accessory.

Appendix H

9270, 9271, 9272
CLAMP ON SENSOR

INSTRUCTION MANUAL

Table of Contents

1. Note Concerning Use

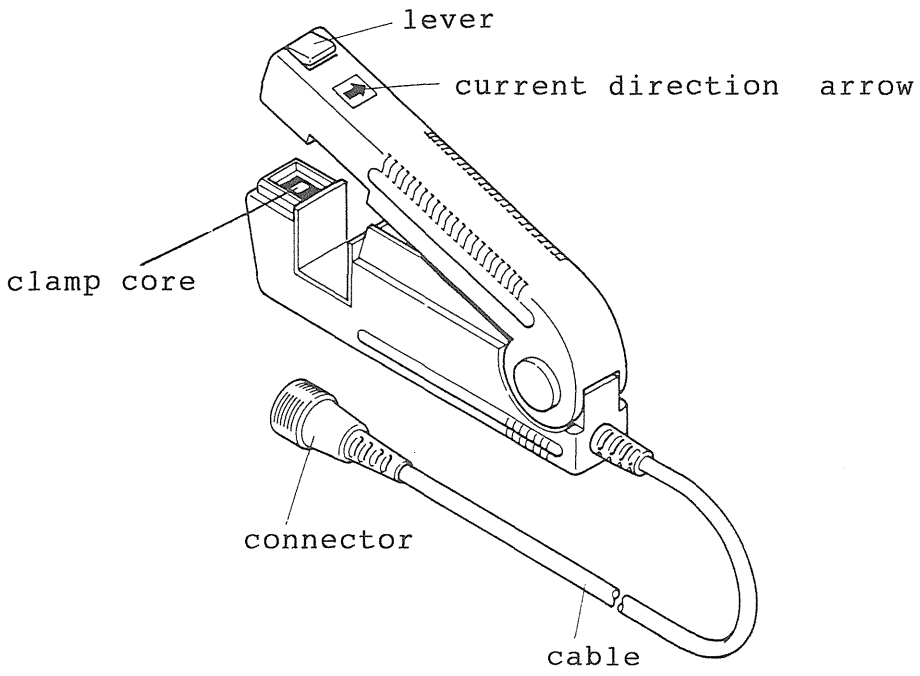
To ensure that this product serves you safely and as intended.please observe the following points.

(1) Be careful to avoid application of power levels exceeding the unit's rated measurement range.
(2) Be gentle when plugging in or unplugging the connector. when the connector is plugged in, never pull on the cable. Also, never plug in or unplug the connector when the 9486 clamp unit's power is turned on.
(3) The clamp sensor's polyvinyl case is subject to deformation by excessive heat. Never leave the sensor in places where it might be subjected to high temperatures.
(4) If the split face of the core becomes dirty, clean it by wiping lightly with a soft cloth. Be very careful to avoid subjecting the core to mechanical shock.
(5) When transporting the sensor, be careful to avoid subjecting it to excessive jolting or vibration. Be especially careful to avoid dropping it.
(6) Avoid storing the sensor in places that are very hot, humid, or subject to condensation. Never store in locations where it might be exposed to direct sunlight or sudden changes in temperature.

2. Introduction

The 9270, 9271, was developed for to provide for use with the 9486 clamp unit of the 3191 Digital Power Hi Tester. Together with the 3191, the 9270 makes it possible to measure alternating current in live power lines without cutting into the lines.
The sensor features good frequency response (amplitude and phase), and is easy to connect and use. Its versatility will find application in a wide variety of fields dealing with current and power measurement.

3. Names of Parts



4. 9270, 9271 clamp sensor specifications

4.1 9270 Specifications

Rated current : 20Aac f.s.
Output voltage : 2Vac / 20A (output inpedance Approx. 50Ω)
Input impedance : Less than 0.2 mΩ
Effect of external magnetic fields : 20mA equiv. Typ.
(in an AC field of 400A/m)
Operating input range : 50A
Maximum rated input : 100A
Power consumption : Approx. 960mW (at rated input level)

4.2 9271 Specifications

Reted current : 200Aac f. s.
Output voltage : 2Vac / 200A (output inpedance Approx. 10Ω)
Input impedance : Less than 0.02mΩ
Effect of external magnetic fields : 200mA equiv. Typ.
(in an AC field of 400A/m)
Operating input range : 300A
Maximum rated input : 500A
Power consumption : Approx. 2.8W (at rated input level)

4.3 Common Specifications

Precision (23℃ ± 3℃) : Better than ± 0.5% rdg. ± 0.05% f.s. ± 0.2°
(45 to 66Hz)
Frequency response (deviation from precision)
: Less than ± 1.0 % between 10Hz to 30KHz
Less then ± 2.5 % between 5Hz to 50KHz
Phase characteristic : Less than± 0.5° between 10Hz to 20KHz
Less than± 1.0° between 5Hz to 50KHz
Temperature coefficient : Within ± 0.05% f.s. / ℃ (0℃ to 40℃)
Operating environment : 0℃ to 40℃ , less than 80% RH (no condensation)
Storage environment : -10℃ to 50℃ , less then 80% RH (no condensation)
Effect of conductor position : Less than ± 0.3%
Dielectric strength : 2,200 Vac for 1 minute (between electrical
circuit and case, and case and core)
Maximum circuit voltage : 600 Vac
Measurable conductor diameter : Up to Φ 20
Cord length : Approx. 3m
External dimensions : Approx. 60(H) × 145(W) × 33(D) mm
Weight : Approx. 230g
Accessories : 9355 carrying case, 1
Instruction Manual, 1
Mark bands, 6 (3 sets)

5. 9272 Specifications

5.1 20A range Specifications

Rated current	: 20 Aac f.s.
Output Voltage	: 2 Vac/20 A
Operating input range	: 60A
Power consumption	: Approx. 1.2W (at rated input level)

5.2 200A range Specifications

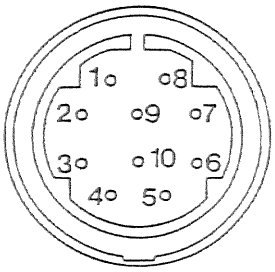
Rated corrent	: 200 Aac f.s.
Output Voltage	: 2 Vac/200 A
Operating input range	: 300A
Power consumption	: Approx. 2.9W (at rated input level)

5.3 20A/200A range Specifications

Precision (23℃ ± 3℃ , 45 to 66Hz)	: Better than ± 0.5% rdg. ± 0.05% f.s. ± 0.2°
Frequency response	: Less than ± 1.0% between 10Hz and 1kHz
(deviation from precision)	: Less than ± 2.5% between 5Hz and 10kHz
Phase Characteristic	: Less than ± 0.5° between 10Hz and 1kHz Less than ± 2.0° between 5Hz and 10kHz
Input impedance	: Less than 0.02mΩ
Thermal coefficient	: Within ± 0.05% f.s./℃ (0℃ to 40℃)
Operating environment	: 0℃ to 40℃ , less than 80% RH (no condensation)
Storage environment	: -10℃ to 50℃ , less than 80% RH (no condensation)
Effect of conductor Position	: Less than± 1.5%
Effect of external magnetic fields	: 2.5A equiv. Typ (in an AC field of 400A/m)
Maximum rated input	: 400A (for 10 seconds)
Dielectric strength	: 2,200 Vac for 1 minute between (electrical circuit and case, and case and core)
Maximum circuit voltage	: 600 Vac
Measurabble conductor diameter	: Up to Φ 46mm or 50mm×20mm bus bar.
Cord length	: Approx. 3m
External dimensions	: Approx. 174(H)×62(W)×33(D) mm
Weight	: Approx. 420g
Accessories	: 9355 carrying case, 1 Instruction Manual, 1 Mark bands, 6 (3 sets)

6. Connector

6.1 Connector pin assignments



Connector

①	Power supply	GND
②	〃	(+)
③		(−)
④		GND
⑤	Output	(+)
⑥	〃	(−)
⑦	ID signal -	(connected to power supply GND)
⑧	〃	connected to power supply GND 20A range N.C 200A range
⑨	〃	(N. C)
⑩	Shield (cable)	

6.2 Connector

RM515EPA-10PC (Hirose)

6.3 Mating receptacle

RM515ERB-10SD (Hirose)

7. Measurement ranges

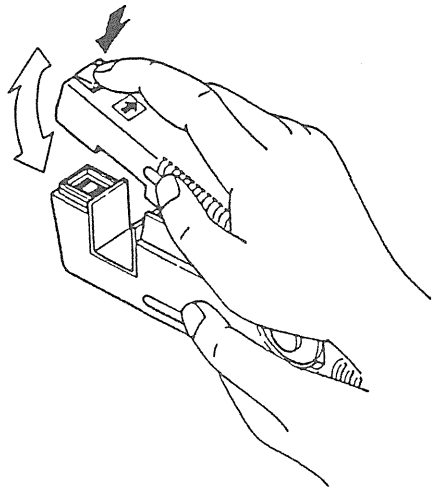
The 9272 has a 20A range and a 200A range. To take greatest advantage of the sensors characteristics, select the range according to the magnitude of current to be measured as follows.

Range	← 20A range →	← 200A range →
Current measured	20mA ····· 20A	····· 200A

8. Operations

8.1 9270,9271 Measurement Procedure

- Lightly press the lever and spread the tips of the clamp with both hands, then position the clamp so that the conductor is approximately centered in the jaws with the current direction arrow facing in the direction of the load.Next, grip the clamp lightly so that the lever snaps securely shut.



8.2 9272 Measurement Procedure

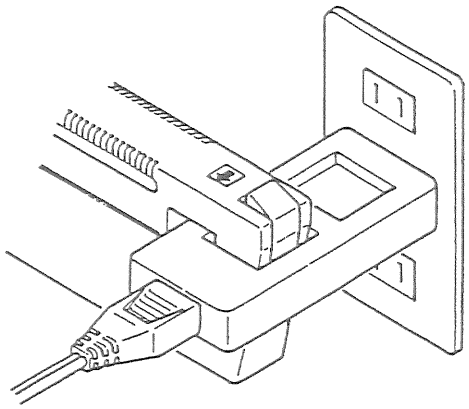
- Clamp the jaws of the sensor onto the conductor so that the current direction on the clamp points in the direction of the load, and so that the conductor is approximately centered between the jaws. Make sure that the jaws of the clamp are fully closed.

8.3 Causion

- Do not clamp the sensor onto more than one conductor at a time.
- Note that a DC component of more than a few amperes will result in an erroneous reading.
- Also note that operation will not be correct if the power frequency is very low (less than about 1.5Hz)
- The circuit is such that a DC voltage is output briefly after the power is turned on. Stabilization of the output takes about 30 seconds.
- With the 9271, do not apply more than 200A at frequencies greater that 10(d). This is to prevent the sensor from becoming too hot.
- With the 9270, do not apply more than 100A at frequencies greater than 10kHz. This is to prevent the sensor from becoming too hot.measurements should be kept as short as possible.
- When using the 200A range of the 9271 and 9272, the range selected on the 3191 becomes ten times than indicated on the panel. However, corrent can be read directly.
- When multiple input units are connected to the 3191, the clamp sensor can only be used in the single phase mode if different ranges are selected or direct input units are used.

○ Measurement of currents exceeding the rated capacity (200A range of the 9272) will cause considerable heating of the clamp sensor body.
Keep the measurement time as short as possible.
Maximum input is 400A. Do not exceed this limit under any circumstance.

○ Measurement of 2-conductor electrical appliance cords
Measurement of current used by electrical appliances with 2-conductor cords that are designed to plug into conventional AC outlets can be easily accomplished using the optional CT-101A line splitter.As shown in the figure, plug the CT-101A into the AC outlet, then plug the appliance being checked into the CT-101A.
Measurement can than be accmplished by clamping through the window in the CT-101A.
If the current flow is very low, clamp the sensor through the × 10 window in the line splitter. This will multiply the output of the clamp sensor by a factor of ten, then the actual value can be obtained by dividing the measured value by 10.



Caution
○ The maximum rated current of the CT-101A is 15A, Never use the power splitter with appliances that draw more than 15A.

⚠ WARNING

● For safety's sake, never use the clamp unit measure current on high voltage lines (600 V or more), and never use in to measure any line that is uninsulated. (Core and shield case is not insulated.)

A power unit (9555 sensor unit) that permits to obtain a monitor (waveform) output with a clamp sensor of the 9270 series used alone is also available.

Appendix I

9290
CLAMP ON ADAPTER

INSTRUCTION MANUAL

Table of Contents

1. Notes Concerning Use.

⚠ CAUSION

(1) Maximum circuit voltage for this unit is AC 600 V. For safety reasons, never measure lines over that voltage.
(2) Do not measure currents over 1000 A for long periods of time. Since the core section heats up proportionally to current, complete measurement as quickly as possible (see Graph 1)
(3) Take care of electric lines that may reach high a temperature. Avoid measuring under strong external magnetic fields as faras possible.
(4) When transporting the sensor, be careful to avoid subjecting it to excessive jolting or vibration. Be especially careful to avoid dropping it.
(5) Avoid storing the sensor in places that are very hot, humid, or subject to condensation. Never store in locations where it might be exposed to direct sunlight or sudden changes in temperature.

2. Outline

This unit is a clamp on adapter with a CT ratio of 10:1, designed for use with high-accuracy clamp sensors 9270, 9271 and 9272. Combined with a clamp sensor, it can be used for a wide range of current and power measurements.
Though it is possible to combine it with an ordinary clamp ammeter, for power measurement we recommend the 9270 series, offering outstanding phase characteristics.

3. Specifications

Measurement range : AC 0 to 1500 A
CT ratio : 10:1
Mesurement time : Continuous for 1000 A and below, within 2 minutes at 1500 A.
Preasion (23℃ ± 3℃) : Amplitude; ± 1.5% rdg.
Phase difference ; within ± 1.0 °
(see Graph 3)
10A to 1500A
45Hz to 66Hz

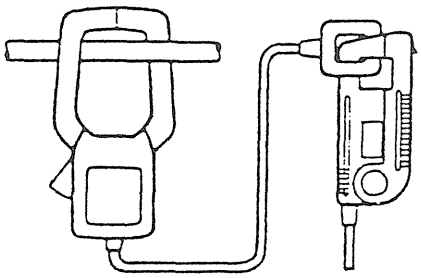
Frequency characteristic : Amplitude ; ± 1.0% rdg. 40Hz to 1kHz
± 2.5% rdg. 20Hz to 4kHz
Phase difference ; within± 1.0° 40Hz to 1kHz
; within± 3.0° 20Hz to 4kHz
(see Graph 2)

Effect of conductor position : With in 1.5% (using the method specified by JEMIS-020)
Effect of external magnetic fields : 1.5 A equivalent (under a 400-A/m alternationg field)
Dielectric resistance : AC 2200 Vrms (between the core and the case.)
Maximum circuit voltage : AC 600 V
Core opening : 55mm dia., accepts up to 80mm wide busber.
OPeration temperature/humidity ranges:
0 to 40℃ , 80% RH or less (no condensation)
Dimensions : Main unit ; 194(H)× 99(W)× 33(D)mm
Weight : Approx. 500g
Cord lenght : Approx. 3m
Accessories : 9148 Carrying case....1
Instruction manual....1
Marking bands.....6(3 sets)

4. Measurement Procedure

① Pass one conductor through the core.
② Clamp the clamp sensor to the secondary coil.
③ Multiply the reading by 10 to obtain the desired current value.

9290 9270



● When combined with an ammeter

⚠ CAUSION

● For safety reasons, do not perfrom current measurement on high-voltage lines (over 600 V). Also, avoid holding a naked conductor in your mouth, even when measuring a low-voltage line.

5. Applicable Instruments

5.1 Clamp Ammeters

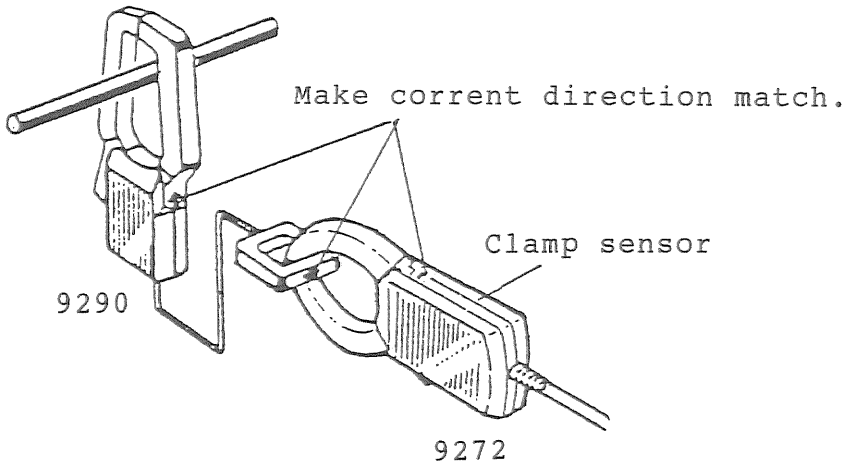
9270, 9271, 9272
3261, 3262, 3263, 3264, 3265
3127, 3108, 3109
9005, 9006, 9008, and any other clamp ammeter

5.2 Clamp Power Meters

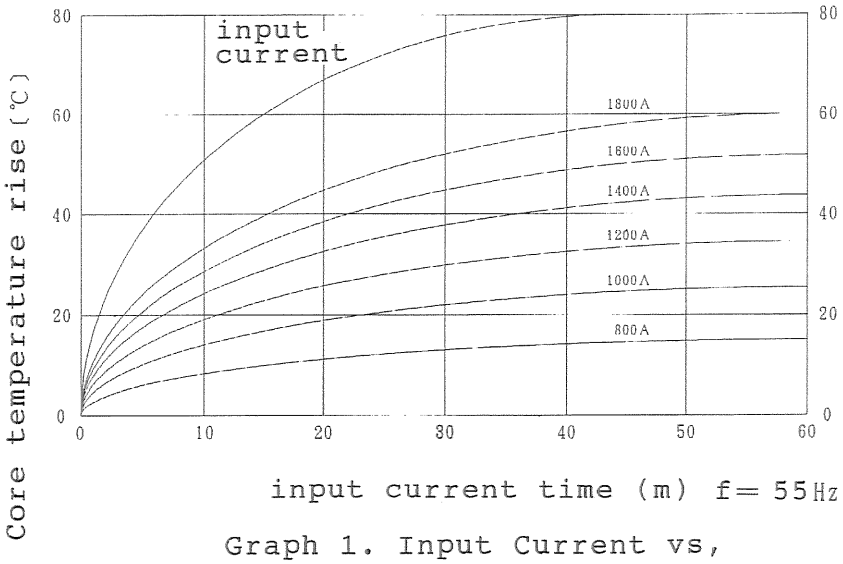
3165, 3191 (when using a clamp unit)
3161, 3162, 3164

- Please ask for additional information on unit performance when combined with Hioki clamp-on Power meters.

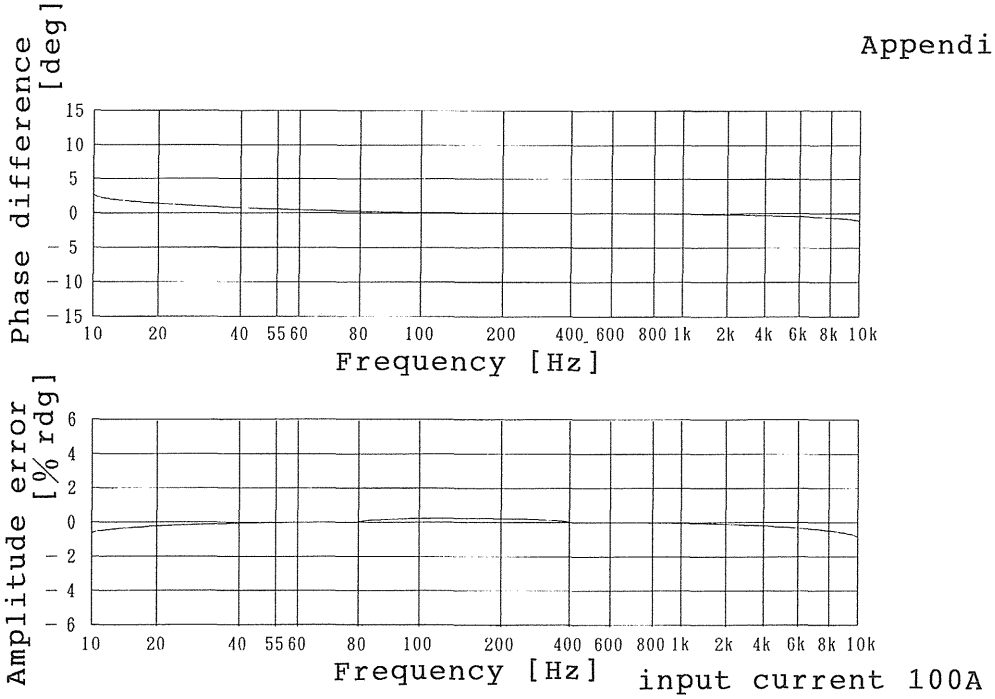
● When combined with a power meter



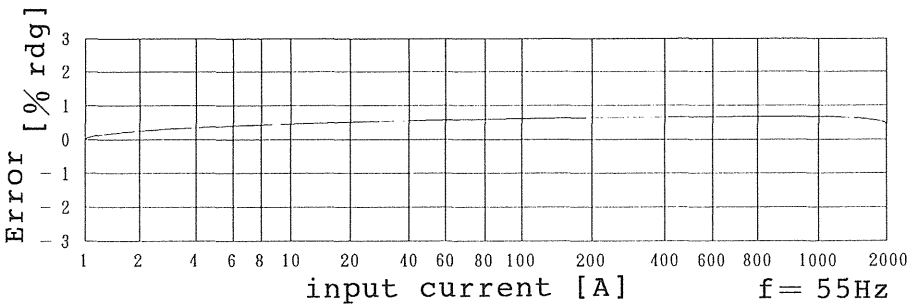
6. Characteristic Curves



Graph 1. Input Current vs, Core Temperature



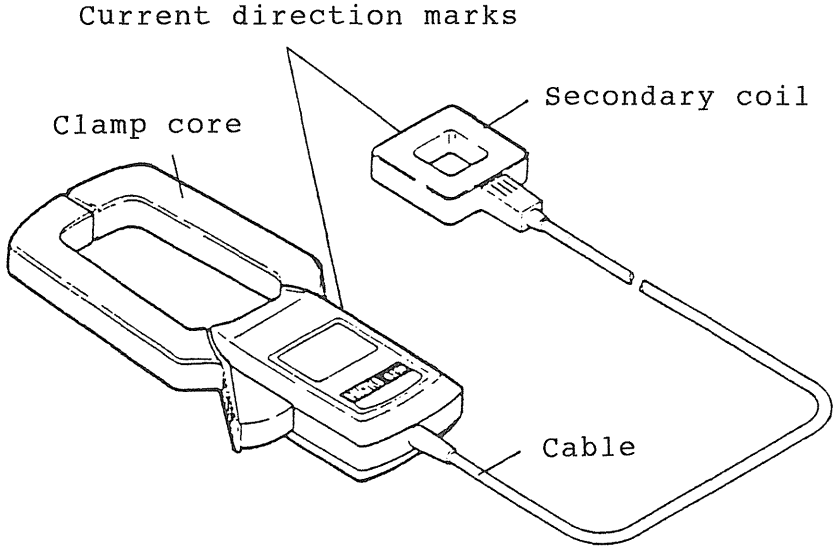
Graph 2. Frequency Characteristic



Graph 3. Linear Carrent Characteristic

○ The characteristics shown in Graphs 1 to 3 are obtained by combination with the 9270.

7. Part Names



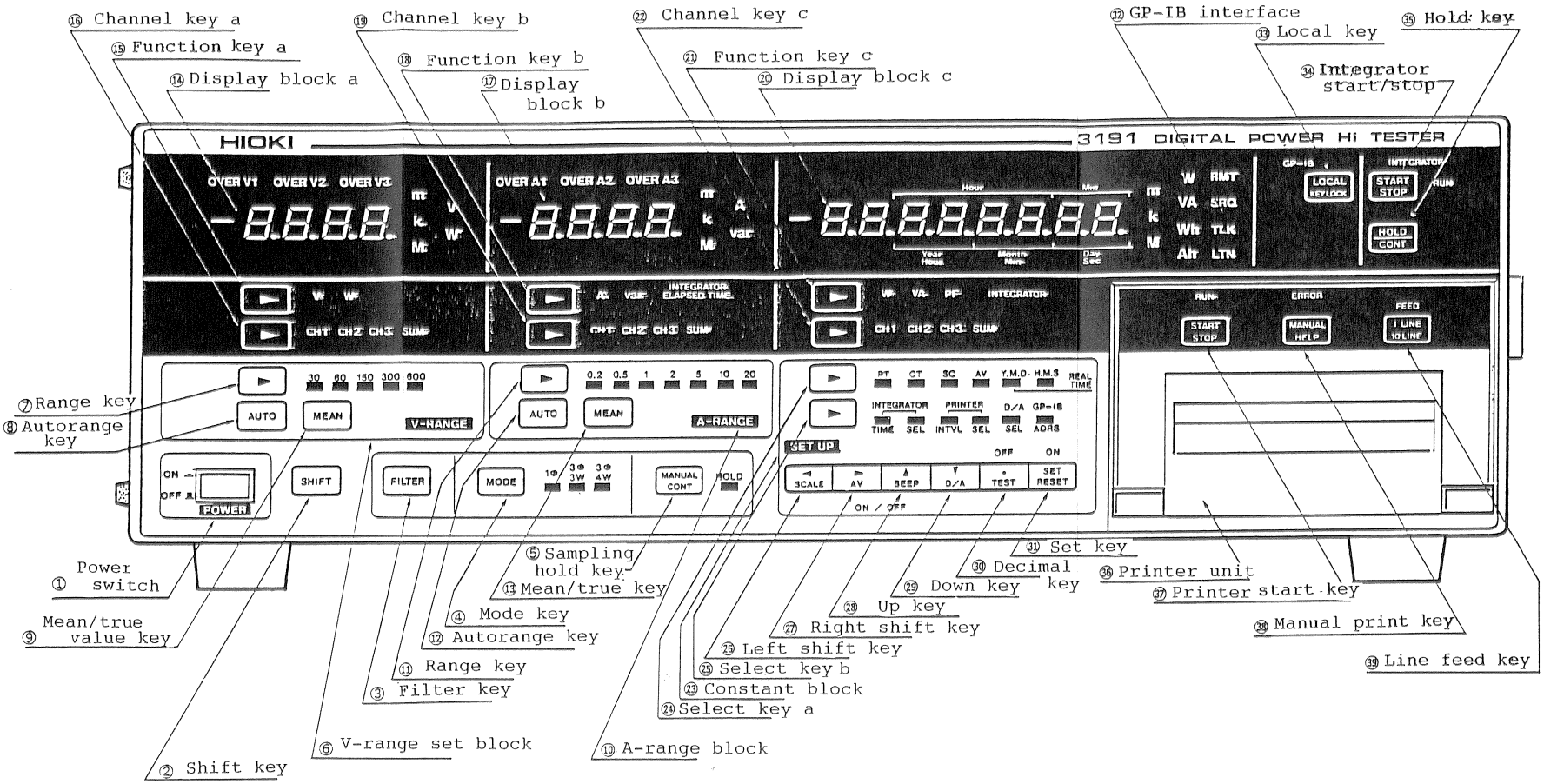
A

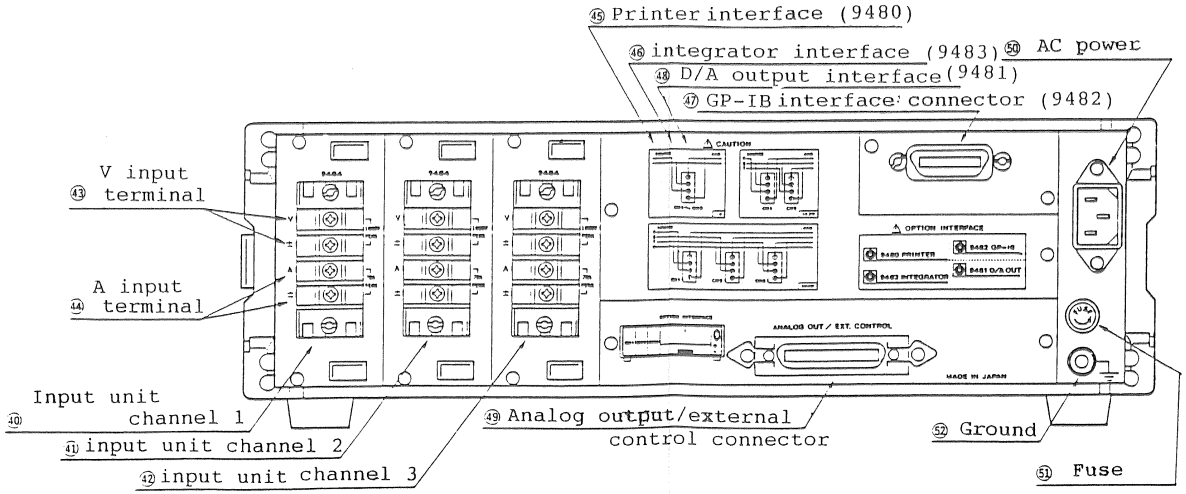
B

C

D

E


⑯ Channel key a
⑮ Function key a
⑭ Display block a
⑲ Channel key b
⑱ Function key b
⑰ Display block b
㉒ Channel key c
㉑ Function key c
⑳ Display block c
㉜ GP-IB interface
㉝ Local key
㉟ Hold key
㉞ Integrator start/stop
HIOKI
3191 DIGITAL POWER Hi TESTER
⑦ Range key
⑧ Autorange key
Power ① switch
Mean/true ⑨ value key
② Shift key
⑥ V-range set block
③ Filter key
⑪ Range key
④ Mode key
⑫ Autorange key
⑤ Sampling hold key
⑬ Mean/true key
⑩ A-range block
㉔ Select key a
㉓ Constant block
㉕ Select key b
㉖ Left shift key
㉗ Right shift key
㉘ Up key
㉙ Down key
㉚ Decimal key
㉛ Set key
㊱ Printer unit
㊲ Printer start key
㊳ Manual print key
㊴ Line feed key


㊺ Printer interface (9480)
㊻ integrator interface (9483)
㊽ D/A output interface (9481)
㊼ GP-IB interface connector (9482)
㊿ AC power
V input ㊸ terminal
A input ㊹ terminal
Input unit ㊵ channel 1
㊶ input unit channel 2
㊷ input unit channel 3
㊾ Analog output/external control connector
㊷ Ground
㊶ Fuse

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