HIOKI

INSTRUCTION MANUAL

3165

CLAMP ON POWER HiTESTER

HIOKI E. E. CORPORATION

Contents

Introduction

Thank you for purchasing this HIOKI "3165 CLAMP ON POWER HiTESTER."
To get the maximum performance from the unit, please read this manual first, and keep this at hand.
Also, please observe the cautions below to ensure a safe and efficient operation.

Inspection

Upon receiving the 3165, check to make sure that it has not been damaged during transportation.
Inspect the panel switches and terminals with special care.
If the unit is damaged or it does not operate according to the specifications, contact your nearest dealer.

⚠ 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 direction can result in a serious or fatal accident.

Transporting the Unit

When transporting the unit, use the original wrapping material.

Cautions on Operation

⚠ CAUTION

1. **A PT and a clamp-type CT are used for input. Since they cannot transmit a direct current, signals with a DC component (full- or half-wave rectified signals, etc.) cannot be measured.**
2. **In this unit, the reactive power (var), apparent power (VA) and power factor (PF) values are calculated from the voltage (V), current (A) and active power (W) readings using the equations given in the specifications. These values may differ from those obtained with meters using a different operating principle or different equations.**
3. **Before measuring, always confirm the range to prevent wrong inputs.**
4. **Observe the maximum voltage and current input ratings.**
5. **Be careful to prevent electric shocks and short-circuit accidents. For added safety, a fuse has been inserted in the middle of the power cord. If it blows, replace it with another fuse of the same rating (0.3 A, 250 V, with arc-extinguishing material).**

6. **This unit is not suitable for measurement of high-voltage lines, and such use would be dangerous. Also, holding a naked wire in your mouth is dangerous even for low-voltage; avoid it.**
7. **Since the electromagnetic field of transformers and high-current lines may affect the unit, make your measurements as far as possible from such items.**
8. **Do not apply voltage to any part of the unit except the voltage input terminal. It may result in unit damage or personal injury.**
9. **Protect the unit and the clamp sensor from vibration and shocks.**
10. **This unit may not be capable of accurately measuring frequency if the input waveform is too distorted, etc.**

Clamp Handling

Take care not to damage the core. Its characteristics may deteriorate if it receives a strong shock.

Chapter 1

GENERAL DESCRIPTION

1-1 Outline

- Clamp-on power meter capable of measuring from single-phase to three-phase four-wire lines.
- Small and compact, but equipped with functions to calculate reactive power, apparent power and power factor values from the voltage, current and active power readings, as well as data processing functions using those values. Ideal for a wide range of applications, from power line maintenance and supervision to development tests of control devices and mechanisms.
- Permits accurate measurement of low frequencies, a particularly difficult task with conventional meters, by using a clamp sensor and a voltage input section of special design that make measurement possible over a wide range from 10 Hz to 20 kHz.

1-2 Special Features

1. Applicable to different line types
   This single unit permits measurement on single-phase to three-phase four-wire lines. The three-voltage, three-current and three-power method is used for three-phase three-wire lines, offering an accurate measurement even on irregular lines.
2. Simultaneous and wide display of measured values
   Voltage, current, active power, reactive power, apparent power, power factor and other readings and calculated values can be displayed simultaneously on the same screen or in wide form.
3. PT and CT ratio multiplication function
   When using a PT or CT for measurement of high voltages, etc., readings such as voltage, current and active power can be obtained directly by setting the corresponding ratio beforehand.
4. Switching between true and mean voltage and current values
   The display can be switched between true and mean values for voltage and current, changing the rectification method according to the subject of measurement.
5. Built-in printer for graph processing and analog plotting
   The incorporated printer not only lets you print measurement readings, it is also capable of demand totalizing printing and graph printing, and an analog plotting can be obtained without connecting an external recorder.
6. Complete array of output terminals
   Voltage, current and active power outputs are provided. Calculated data can be output in analog form using the D/A output. This is very useful for the relay output of a comparator and other recording and control applications.
7. Real-time control
   The integrator, printer and other components can be set to start at a predetermined time.
8. Permits accurate measurement of distorted waveforms from inverters, etc.
   A wide-range clamp-on sensor and voltage input section are used, making measurement possible from several kilohertz to several tens of kilohertz.
9. RS-232C
   Except for the power switch, almost all functions can be controlled remotely through the RS-232C serial interface.
10. Backup
    Thanks to the built-in battery, the settings and the integrated and totalizing values, etc. are kept in the memory. Also, if a power failure occurs during integration, totalizing, printing, etc., these operations are restarted once power is restored.

1-3 Specifications

Measurement lines : 1 ϕ 2W, 1 ϕ 3W, 3 ϕ 3W, 3 ϕ 4W

Measured parameters : Voltage, current, active power, reactive power, apparent power, power factor, integrated power, frequency

Measurement ranges : Voltage (manual ranging)
100/200/400 V
: Current (manual/auto ranging)
2/5/10/20 A (with the 9270 or the 9272 in 20-A range)
20/50/100/200 A (with the 9271 or the 9272 in 200-A range)
: Power (auto ranging)
Determined by the measurement mode and the combination of voltage and current ranges
: Frequency (manual/auto ranging)
100 Hz/1 kHz/10 kHz

Accuracy : (23°C ± 3°C, 45 to 66 Hz)
: Voltage: ±0.5% rdg. ±0.2% f.s.
: Current: ±0.5% rdg. ±0.2% f.s.
: Power: ±0.5% rdg. ±0.3% f.s.
: Real time: ±100 ppm (25°C)
: Frequency: ±0.5% rdg. ±1 dgt.
: Integrator: ±0.5% rdg. ±1 dgt.
: Integrating time: ±0.02% ±1 s

Frequency characteristics (deviation from standard accuracy)

Frequency range	Voltage	Current	Power
10 to 20 Hz	±1.5%	±1.5%	±1.0%
20 to 45 Hz	±0.5%	±0.5%	±0.5%
66 Hz to 1 kHz	±0.5%	±0.5%	±0.5%
1 k to 10 kHz	±2.5%	±1.0%	±1.0%
10 k to 20 kHz	±3.5%	±2.0%	±1.5%

Temperature coefficient : ±0.05%f.s./°C or less

Effect of power factor : ±1.0% rdg. (at 55 Hz, power factor = 0.5)

Crest factor : Voltage: 2 or less
: Current: 3 or less
: Power: Same as voltage and current

Valid measurement ranges: Voltage: 10% to 150% of range setting
: Current: 10% to 150% of range setting
: Power: 10% to 125% of range setting
: Frequency: 10% to 99.9% of range setting
* Auto ranging
UP operation: 150% of A range or more; FRQ is 100% of range or more
DOWN operation: 20% of A range or less; FRQ is 10% of range or less

Input impedance	Voltage: approx. 1 MΩ Current: approx. 270 kΩ
Maximum nondestructive input	Voltage: peak of approx. 850 V (continuous) Current: peak of approx. 12 V (continuous)
Operation temperature/humidity ranges	0 to 40℃, 80% max (no condensation)
Response time	Approx 2.2 seconds (in response to an instantaneous input changing from zero to 100% f.s., the time for the output level to reach 90%) Approx. 1 second (indication sampling)
Data output	Analog output 2 VDC/f.s. (V1, V2, V3, A1, A2, A3, W) D/A output 2 VDC/f.s. (selectable among VA, var, PF, FREQ, Vave, Aave and Wos)
External control	Integration and plotting start/stop, data reset and printing commands
Display	Character LCD w/backlight (8 lines×40 characters, dot matrix)
Printer	Thermal graphic printer (8×256 dots)
RS-232C	Start stop transmission
Insulation resistance	100 MΩ min at 500 VDC (between the voltage input terminal and the case, between the voltage input terminal and the current input terminal, between the voltage input terminal and the output terminal, between the case and the power source, and between the output terminal and the power source)
Dielectric resistance	2.2 kVAC/one minute (between the voltage input terminal and the case, between the voltage input terminal and the current input terminal, and between the voltage input terminal and the output terminal)
Power requirements	85 to 250 VAC (45 to 66 Hz) Power consumption: 60 VA max.(when using a clamp sensor)
Dimensions	Approx. 360W×120H×250D (mm)
Weight	Approx. 4kg
Accessories	9178 VOLTAGE CORD (3 m) Two 0.3 A/250 V midget fuses (with non-arcing type 5.2 dia×20 mm) 9223 RECORDING PAPER 1 box (5 rolls) Power cord

Data Display and Equations					
Mode	1P2W	1P3W	3P3W - 2	3P3W-3	3P4W
Voltage (V)	V1	V1 V2	V1 V2	V1 V2 V3 $*V\left(\frac{V1+V2+V3}{3}\right)$	V1 V2 V3 $*v\left(\frac{V1+V2+V3}{3}\right)$
Current (A)	A1	A1 A2	A1 A2	A1 A2 A3 $*A\left(\frac{A1+A2+A3}{3}\right)$	A1 A2 A3 $*A\left(\frac{A1+A2+A3}{3}\right)$
Active power (W)	$\dot{V}1 \cdot \dot{A}1$	$\dot{V}1 \cdot \dot{A}1 + \dot{V}2 \cdot \dot{A}2$	$\dot{V}1 \cdot \dot{A}1 + \dot{V}2 \cdot \dot{A}2$	$\dot{v}1 \cdot \dot{A}1 + \dot{v}2 \cdot \dot{A}2 + v3 \cdot A3$	$\dot{v}1 \cdot \dot{A}1 + \dot{v}2 \cdot \dot{A}2 + v3 \cdot A3$
Apparent power (VA)	V1 • A1	V1 • A1 + V2 • A2	$\sqrt{3}/2$ (V1 • A1 + V2 • A2)	$\sqrt{3}/3$ (V1 • A1 + V2 • A2 + V3 • A3)	v1 • A1 + v2 • A2 + v3 • A3
Reactive power (var)	$\sqrt{VA^2 - W^2}$	←	←	←	←
Power factor (PF)	$\frac{W}{VA}$	←	←	←	←
Load factor (LF)	$\frac{\text{Overall average power}}{\text{Demand maximum power}} \times 100$	←	←	←	←

Note V: Voltage between lines; v: Phase voltage; A: Line current; $\dot{V}$, $\dot{v}$, $\dot{A}$: Vector values; *V, *v, *A: Average values

3P3W-2: Indicates 2-voltage, 2-current, 2-power measurement

3P3W-3: Indicates 3-voltage, 3-current, 3-power measurement

1-4 Internal Configuration

Fig. 1-1 shows the internal configuration of the 3165.

A PT using the AC zero-flux method and a clamp-type CT (9270 series sensor) are used for the voltage and current input sections of this unit, respectively. They ensure good characteristics over a wide frequency range from several hertz to several tens of kilohertz.

Each measured voltage and current input is processed in an isolated way in its corresponding input section, then it is converted to the specified signal level at the appropriate range amplifier and sent to the power calculator and RMS value converter circuits. Active power on a three-phase three-wire line can be calculated either from the voltage between lines and the line current using the two-power method, or by a three-power method which takes the virtual neutral point as reference. In measurement modes using this latter method, voltages detected at the various channels become a phase voltage with the virtual neutral point as reference. Therefore, vector calculations required to obtain the voltage between lines from that voltage are performed by a separate circuit.

At the RMS value converter circuit, an exclusive analog calculator IC is used to obtain either the true or mean rectified RMS value.

The obtained RMS values pass through the output buffer, then they are sent to the output terminals as DC 2 V/f.s. analog outputs.

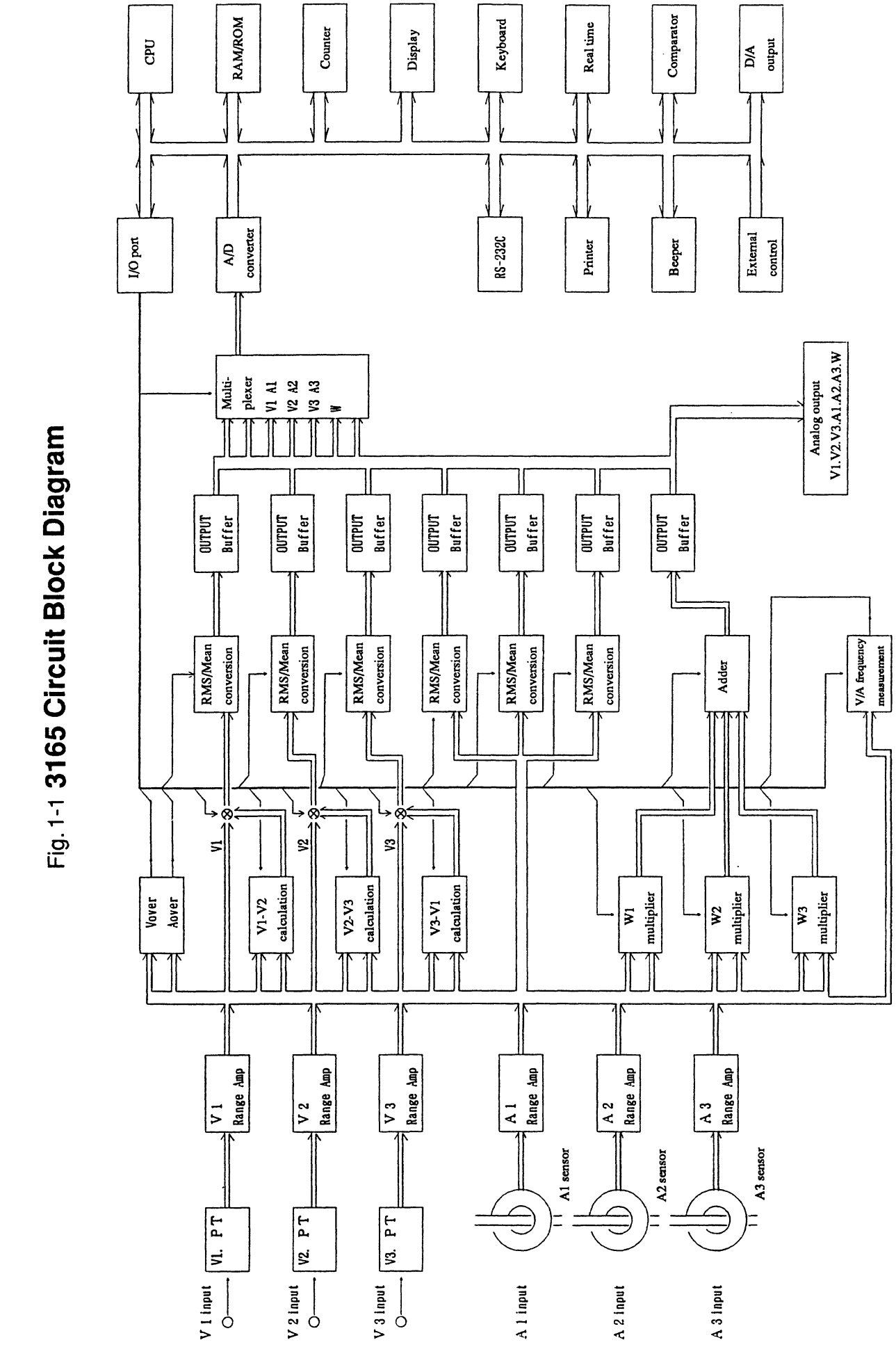
At the power calculator circuit, voltage and current multiplication is performed for each channel by an analog multiplier, the outputs from each channel are added at the adder circuit, then they are sent to the output terminal as a DC 2 V/f.s. analog output.

At the frequency measurement circuit, the period of the input voltage or current waveform is detected by a comparator, then the detection signal is sent to the digital section. Since this circuit might be unable to accurately measuring the fundamental component in a signal with many harmonic components, a low-pass filter circuit is included to suppress these components.

The overload detector circuit checks at the voltage and current range amplifier outputs whether a signal beyond the circuit operation levels is being input. When it is, the circuit sends a detection signal to the digital section.

At the digital section, voltage, current and power analog output signals are converted into digital in sequence by the A/D converter, and the resulting data are sent into the CPU. These data are then used to calculate apparent power, reactive power, power factor and integrated power, which are finally displayed.

Fig. 1-1 **3165 Circuit Block Diagram**



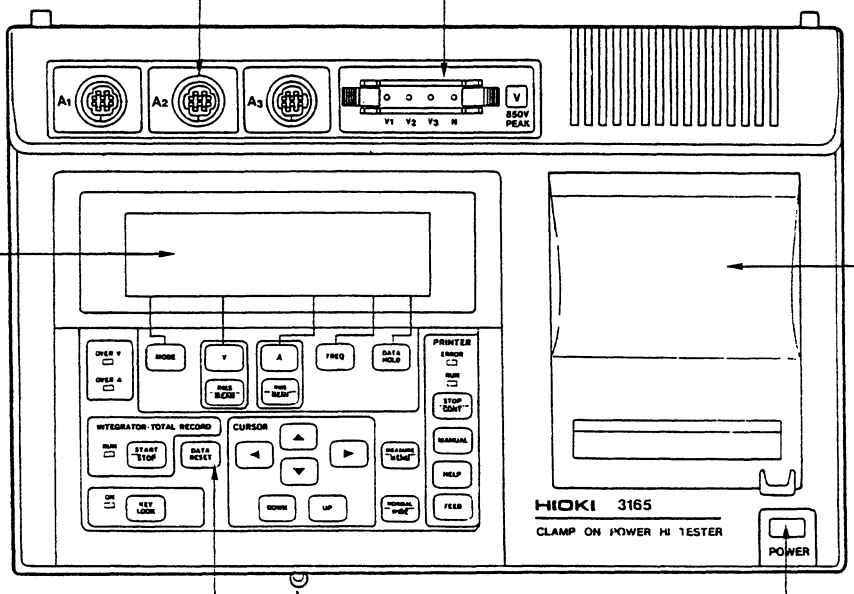
Chapter 2

COMPONENT NAMES

2-1 Front Panel

Clamp sensor connector
Connect the optional 9270 clamp sensor here.
The connection method depends on the measured line. Refer to the Connections section in Chapter 4 or to the instruction plate in the main unit to ensure correct connections.

Voltage cord connector
Connect the attached voltage connector cord (9178) here. Lock it firmly in to prevent it from getting off.



Printer
Built-in thermal printer for 80-mm-wide paper.

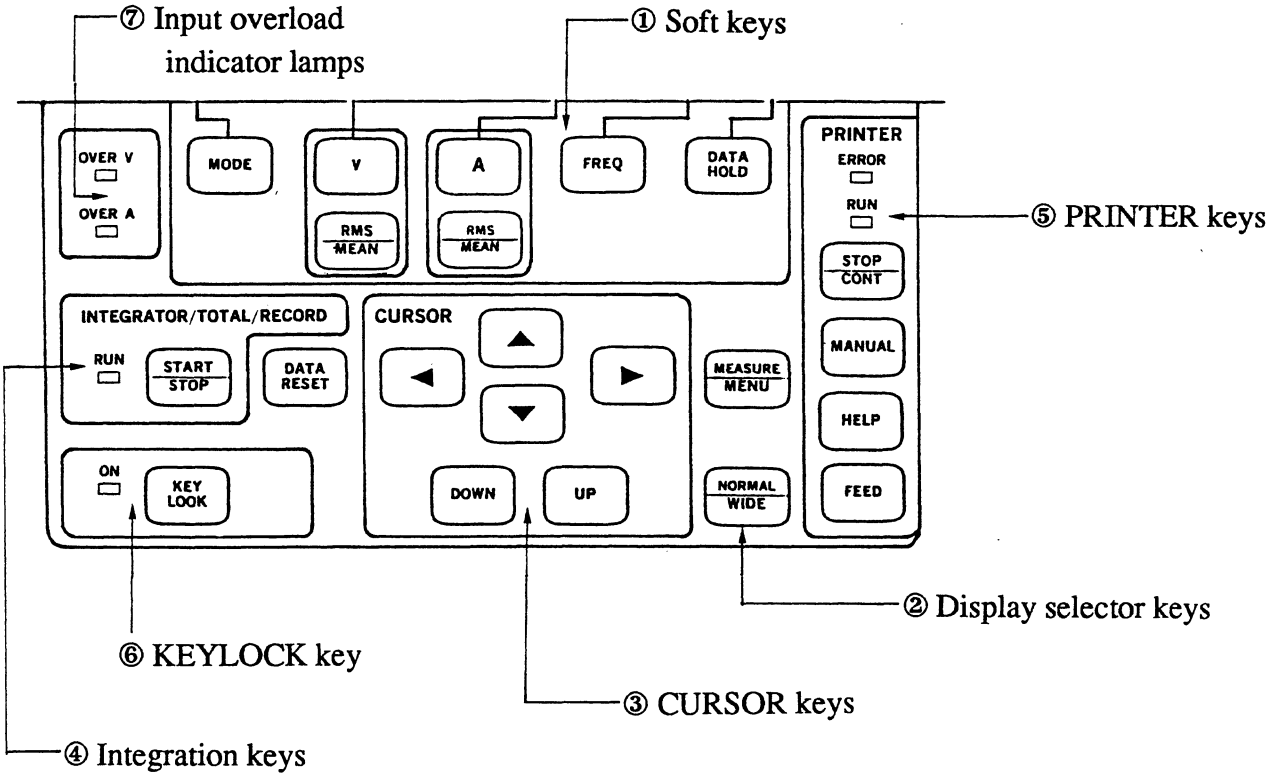
Liquid-crystal display
8-line × 40-char. dot matrix LCD (with EL backlight).

Connection instruction plate
Explains the connection method for each measurement mode. To read, pull the knob towards you.

POWER switch
Press to turn the unit on and off.

Control panel
To operate the display, the printer, etc.

2-2 Control Panel

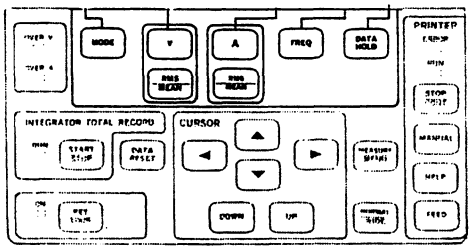


Precaution

After pressing a key, always check whether the entry has been accepted.

* Key input is limited with some operation modes. For details, see page 140, "Keys valid in each mode"

① Soft keys



MODE : Mode selector key

Selects the method for connection to the measured line (single-phase, two-wire to three-phase, four-wire). The mode changes in the following sequence as the key is pressed repeatedly.

→1P2W → 1P3W → 3P3W-2 → 3P3W-3 → 3P4W

[V] : Voltage range switch

Use this key to set the voltage range.

The voltage changes in the following sequence.

→ 400V → 200V → 100V →

It is not possible to set a different range for each channel.

[A] : Current range switch

Use this key to set the current range.

Ranging can be set to either auto or manual. Available ranges depend on the sensor used, as indicated below.

☆ Available ranges

When using a 20-A sensor (9270 or 9272 in 20-A range)

→ AUTO → 20A → 10A → 5A → 2A →

When using a 200-A sensor (9271 or 9272 in 200-A range)

→ AUTO → 200A → 100A → 50A → 20A →

It is not possible to set a different range for each channel.

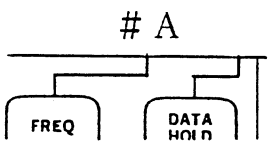
Do not use sensors of different range (or 9272 sensors set to different ranges) at the same time.

[RMS MEAN] : RMS/mean value switch

Selects the rectification method for voltage and current. When "rms" is shown to the right of the range indication, the true RMS value is displayed. If nothing is shown, the mean rectified RMS value is displayed.

[FREQ] : Frequency measurement mode key

Use this key to choose whether frequency measurement is to be performed in the voltage or current mode. When auto ranging is used, a "#" is shown to the left of the measurement mode indication.



Current Frequency Measurement in the Auto Range Mode

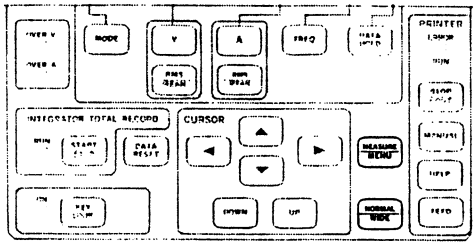
DATA HOLD : DATA HOLD key

Press to freeze all displayed data. The "HOLD" indication will appear on the display. The display mode can still be switched in this condition. To release the display, press the DATA HOLD key again.

In the hold condition, integrated values are frozen on the display, but integration is continued. Therefore, it has not effect on integration time or results.

Data might change in the hold condition under certain circumstances. For details, refer to the sections on integrating functions (page 53) and totalizing processing *page 61).

② Display selector keys



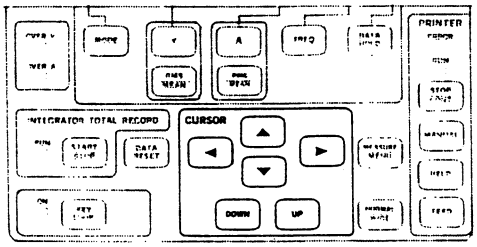
MEASURE MENU : MEASURE/MENU mode switch

Switches between the measurement and setting modes. If you press it twice, you will return to the same page you were before.

NORMAL WIDE : NORMAL/WIDE switch

Switches between normal and wide display in the measurement mode. Refer to Wide Display Function (page 56).

③ CURSOR keys



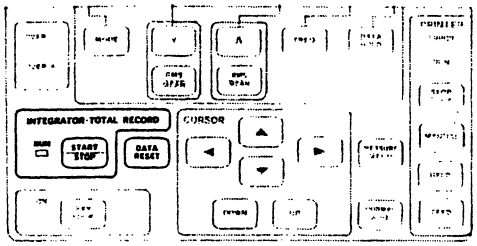
▲ ◄ ► ▼ : Cursor keys

Use them to move the cursor in the setting mode. The cursor moves only for setting; use ▲ and ▼ to change setting items, and ◄ and ► to move between digits.

UP • DOWN : UP/DOWN keys

To move to the next or previous page in the measurement and setting modes, and to change numerical settings in the setting mode.

④ Integration keys



START STOP : START/STOP key

Starts and stops processing in the integration, totalizing and plotting modes. This key works only in the measurement mode.

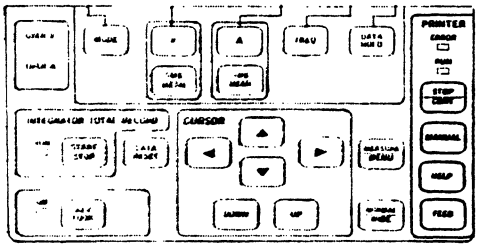
When pressed with the starting mode set to manual, the RUN indication lights and processing starts immediately. In the auto starting mode, the RUN indication flashes on and off showing that the unit has entered the standby condition. When the set time arrives, the RUN indication remains lit and processing is started automatically.

DATA RESET : DATE RESET key

Resets integration value, integration time, and instantaneous maximum and minimum values. Use it to clear old data before starting a new integration. The integrated value and the elapsed time are reset to 0. Instantaneous maximum and minimum values are set to the current values.

Reset is not possible when the RUN indication is lit or flashing. Be sure to press the START STOP key before to stop processing.

⑤ PRINTER keys



STOP CONT : STOP/CONT key

Use this key to stop and restart the printing operation (it does not work in the plotting mode).

This key stops printing compulsorily, even if data have been output only partially, after the current line is printed to the end.

The interval operation (RUN indication lit) is also interrupted by this key (the RUN indication goes out). Press it again to restart the interval operation. In case the set processing time runs out while operation is interrupted, however, printing cannot be restarted by pressing the STOP/CONT key.

If the ERROR indicator is lit, pressing this key will reset the printer.

MANUAL : MANUAL printing key

Use this key to print data measured within a specified period. The parameters to be printed can be selected at the printer page (M2 «PRINTER») of the menu. Manual printing is not possible when the RUN is lit or flashing, and during printer operation (see page 80).

HELP : HELP printing key

Prints out a list of settings. Help printing is not possible when the RUN is lit or flashing, and during printer operation (see page 77).

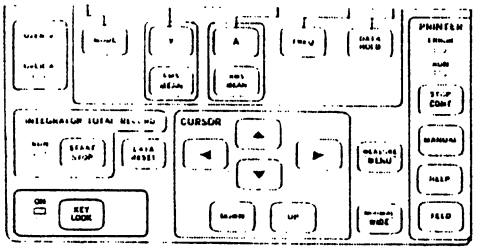
FEED : Paper FEED key

Press to advance the paper. One line is fed in each time this key is pressed. Paper feed is not possible when the RUN is lit or flashing, and during printer operation.

ERROR : Printer ERROR indicator

Lights to indicate a paper jam or paper empty condition, and other printer troubles. Proceed as explained under Notes on Operation, page 95. The MANUAL , HELP and FEED keys do not work when the ERROR indicator is lit.

⑥ KEYLOCK key

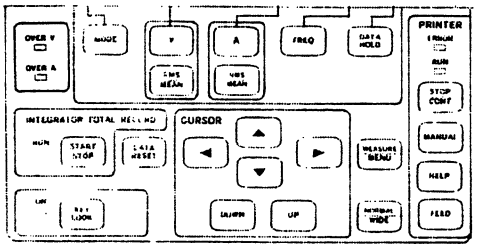


KEYLOCK : KEYLOCK key

Blocks all key entries. When pressed, the ON indicator lights. Press it again to turn it off and cancel the key lock.

This key also resets the RS-232C interface.

⑦ Input overload indicator lamps



OVER V : OVERvoltage indicator lamp

Lights to warn you that a signal beyond the internal operation level has been input. It is activated when the peak level goes beyond approx. 2.8 times the range.

OVER A : OVERcurrent indicator lamp

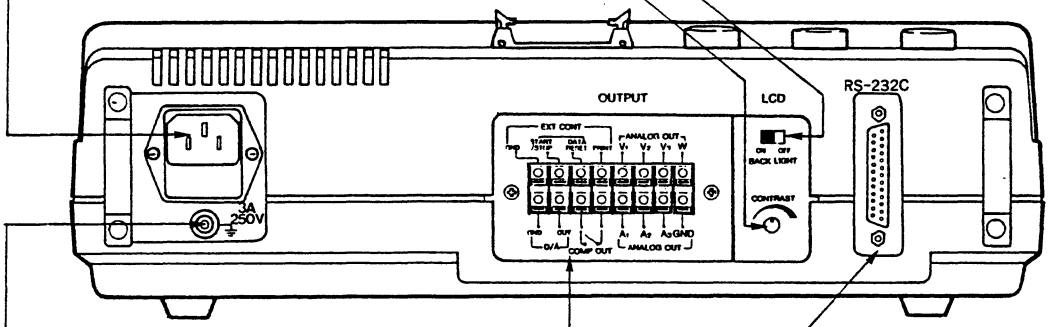
Lights to warn you that a signal beyond the internal operation level has been input. It is activated when the peak level goes beyond approx. 4.2 times the range.

2-3 Back Panel

AC power inlet
Accepts power voltages within AC 85 to 265 V (adjustment is automatic). When replacing the built-in fuse, use a 3-A, 250-V midget fuse with arc-extinguishing material.

LCD CONTRAST control
To adjust display contrast.

BACKLIGHT ON/OFF switch
Turn the backlight on to facilitate display reading in dark places.

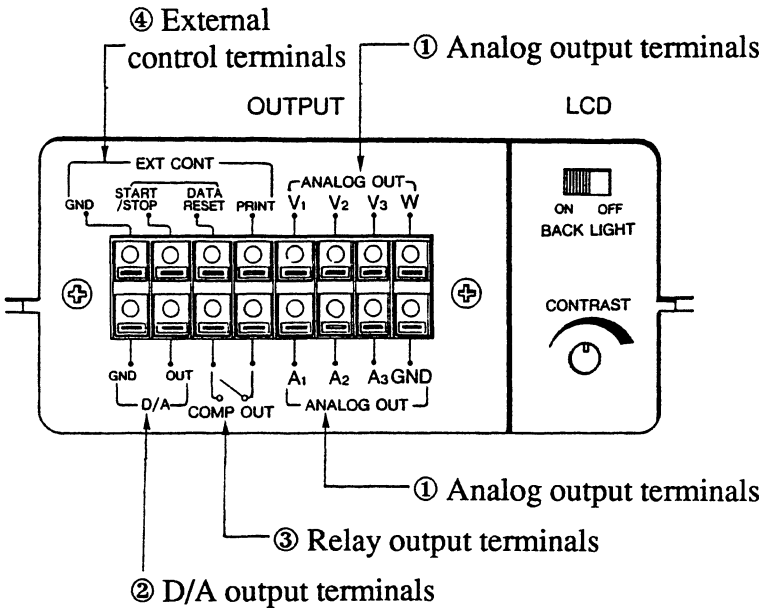


RS-232C Connector
Used for connecting an RS-232C cable.

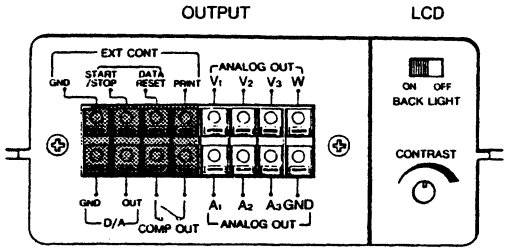
Ground terminal
For safety, ground this terminal when measuring.

Analog output/external control terminals
Deliver analog output signals, and permit the external control of the integrator and the printer.

Analog Output/External Control Terminals

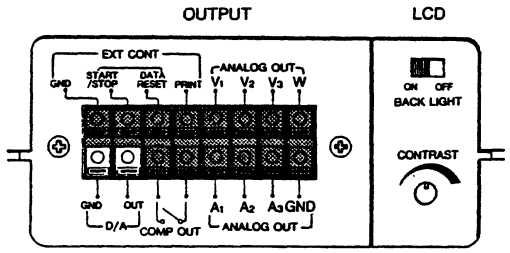


① Analog output terminals



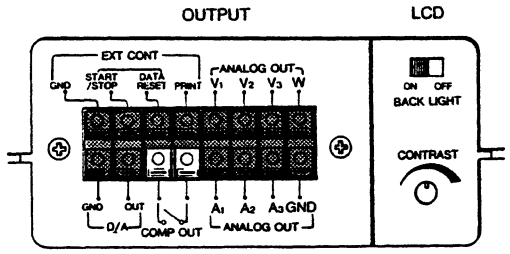
V1 to V3, A1 to A3 and W data can be obtained from these terminals, with the GND (lower right) terminal as reference, in the form of DC 2 V/f.s. voltage signals with regard to the range. (see page 64, Analog Output)

② D/A output terminals



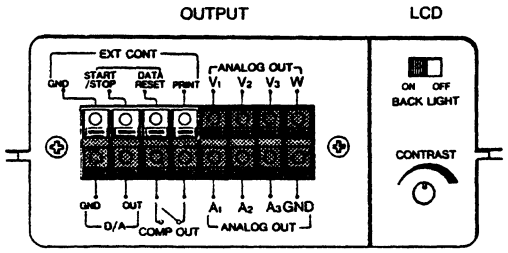
Any desired data selected from those calculated can be output as an analog signal of DC 2 V/f.s. with regard to the range. (see page 65, D/A Output)

③ Relay output terminals



These terminals are used by the comparator. The relay is turned on when the measured value exceeds the set value. Since their current capacity is very small, do not use them for current lines. (rating: 30 V, 0.3 A) (see page 63, Comparator Function)

④ External control terminals



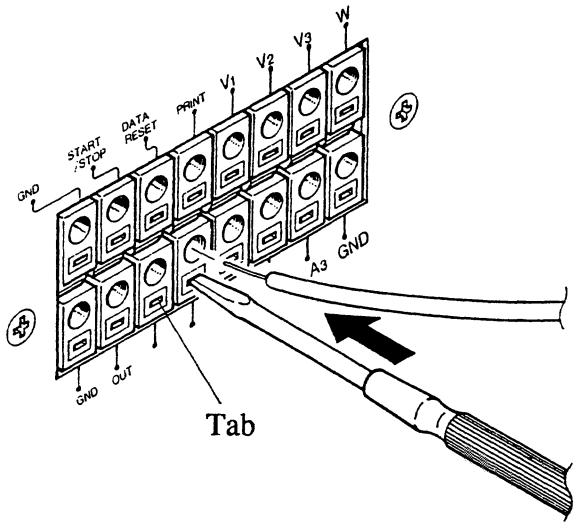
Use these terminals for external control of integration and plotting start/stop, data reset and manual printing. All three terminals are controlled by active low, with the left side GND terminal as reference. (see page 66, External Control)

2-4 Using the Analog Output/External Control Terminals

Highly safe one-touch lock-type connectors are used for these terminals. While using the direct connection method, not requiring banana plugs or other special connectors, they can be easily connected and removed at one touch.

*** Cable Connection Procedure**

- Peel off approx. 10 mm of the insulation at the end of the cable.
- Push in the terminal tab with a screwdriver, and insert the cable into the terminal hole.
- Release the tab. The cable will be locked.
- To remove, push the tab in and pull the cable out.



Push in the tab

Appropriate cable sizes		
	Single wire:	1.0-mm-dia. (AWG#18)
	Stranded:	0.75 mm^2
Applicable cable sizes		
	Single wire:	0.4- to 1.0-mm-dia. (AWG#26 to 18)
	Stranded:	0.3 to 0.75 mm^2 (AWG#22 to 20)
	Naked wire dia.:	0.18 or less
Standard peel-off length		10 mm

Chapter 3

THE LIQUID-CRYSTAL DISPLAY

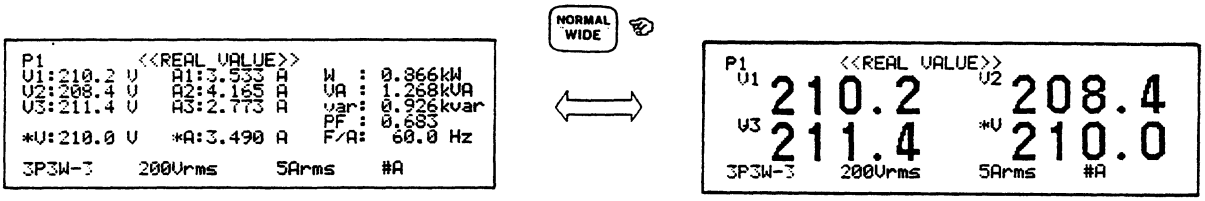
3-1 Measurement Displays

3-1-1 Display Configuration

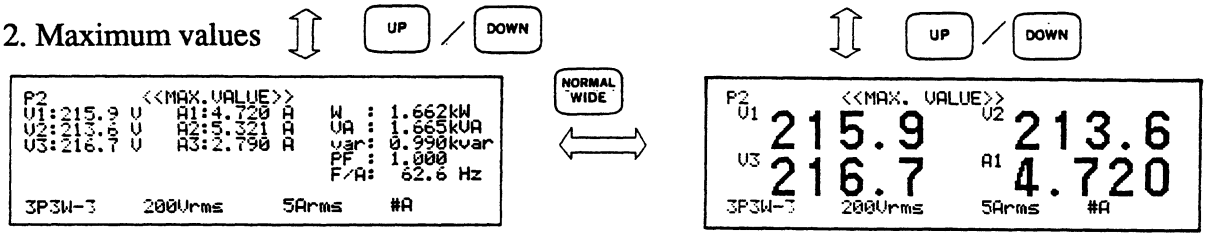
The measurement displays and their corresponding wide modes are shown below. They will be explained in detail from the next page on. For enlarge display setting, see page 56.

<Normal Display> <Wide Display>

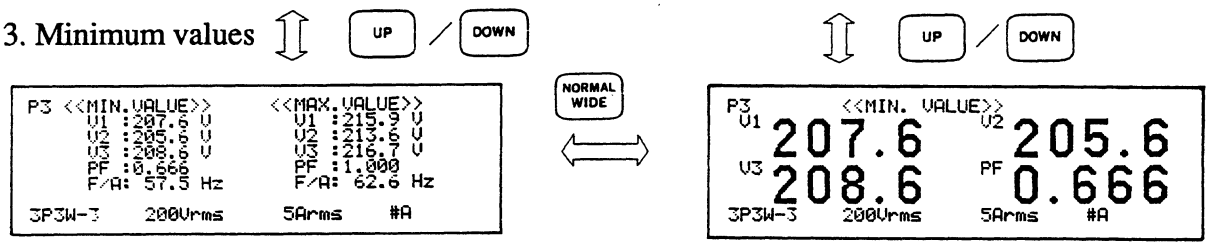
1. Instantaneous values



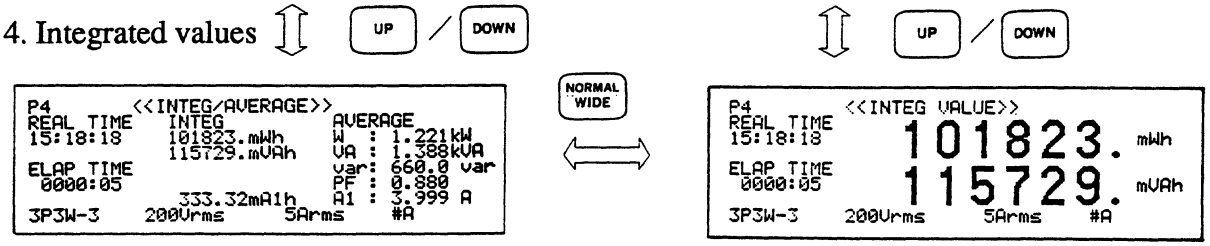
2. Maximum values



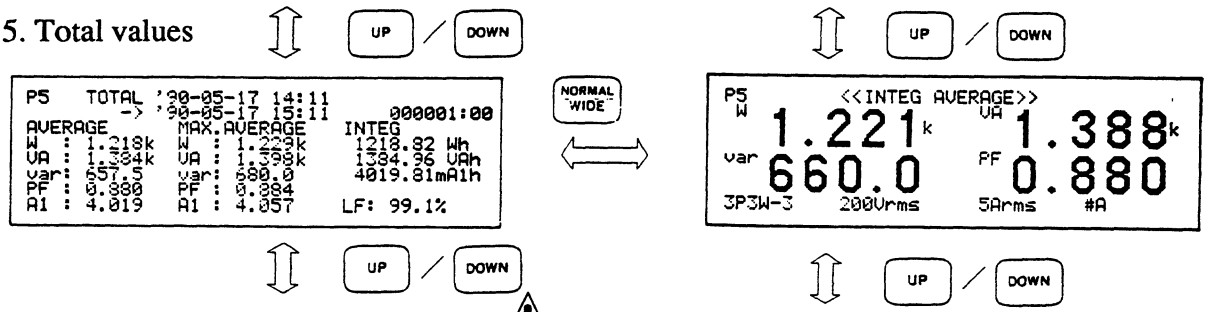
3. Minimum values



4. Integrated values



5. Total values



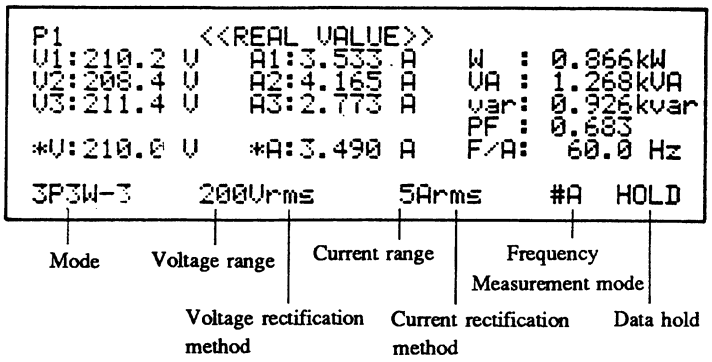
CAUTION

- **When the scaling and averaging functions (page 57) are activated, the "SC" and "AV" indications appear to the right of the display.**
- **Any kind of data from instantaneous values to integrated values can be selected for wide display. The P5 wide display shows the average values corresponding to the integrated values (P4) display.**

3-1-2 Display Description

P1: Instantaneous values

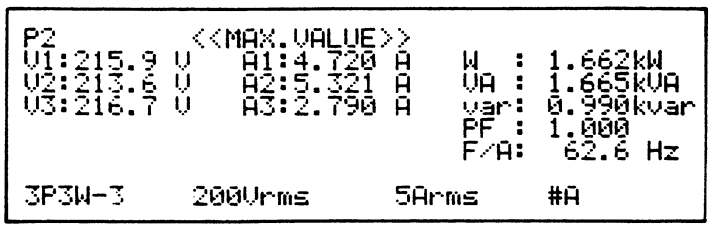
Shows the instantaneous value of all measured parameters, except the integrated values. There is no need to select parameters to be displayed. Measured voltage and current values are displayed only for channels slowing data and arithmetic expressions. Display for other channels is fixed to zero. *V (*A) indicates the average of voltages between lines (line currents) on a three-phase line. When using a measurement method other than the three-voltage, three-current, three-power method (3P3W-3 or 3P4W), the indication "0. ⎵⎵⎵ " (calculation suspended) is displayed. When the offset function (page 47) has been activated, active power is shown as "Wos".



V1: Channel 1 instantaneous voltage
V2: Channel 2 instantaneous voltage
V3: Channel 3 instantaneous voltage
*V: Average of V1, V2 and V3 voltages
A1: Channel 1 instantaneous current
A2: Channel 2 instantaneous current
A3: Channel 3 instantaneous current
*A: Average of A1, A2 and A3 voltages
W (Wos): Instantaneous active power (offset)
VA: Instantaneous apparent power
var: Instantaneous reactive power
PF: Instantaneous power factor
F/A(V): Current (voltage) instantaneous frequency

P2: Instantaneous maximum values

Shows the maximum instantaneous value of all measured parameters, except the integrated and average values. There is no need to select parameters to be displayed. Voltage and current are always displayed for three channels, regardless of the measurement mode. The frequency indication shows the maximum value and the detection mode. Since all readings are shown in the range at the time the maximum was detected, they will not change when switching ranges until a new maximum is detected. These data are backed up by the battery. To reset them to the current instantaneous values, press the DATA RESET key.



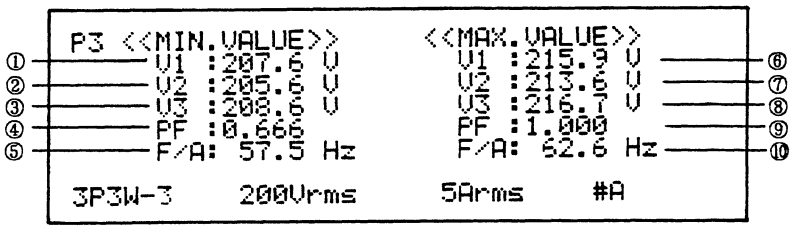
V1: Channel 1 instantaneous maximum voltage
V2: Channel 2 instantaneous maximum voltage
V3: Channel 3 instantaneous maximum voltage
A1: Channel 1 instantaneous maximum current
A2: Channel 2 instantaneous maximum current
A3: Channel 3 instantaneous maximum current
W (Wos): Instantaneous maximum active power (offset)
VA: Instantaneous maximum apparent power
var: Instantaneous maximum reactive power
PF: Instantaneous maximum power factor
F/A(V): Current (voltage) instantaneous maximum frequency

P3: Instantaneous minimum/maximum values

Shows the minimum and maximum instantaneous voltage (V), power factor (PF) and frequency (F) values. There is no need to select parameters to be displayed. Voltage is always displayed for three channels, regardless of the measurement mode.

Since all readings are shown in the ranges at the time the minimum and the maximum were detected, they will not change when switching ranges until a new value is detected (data update is performed independently for each channel).

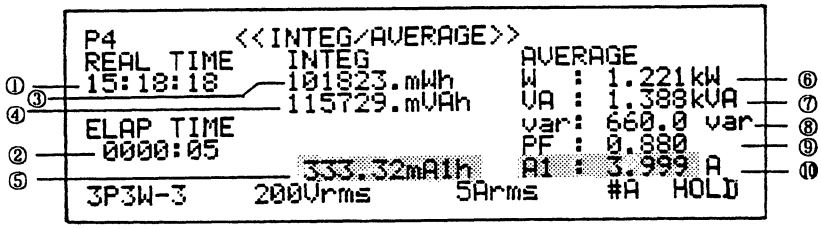
To reset these data to the current instantaneous values, press the DATA RESET key.



① Channel 1 instantaneous minimum voltage
② Channel 2 instantaneous minimum voltage
③ Channel 3 instantaneous minimum voltage
④ Instantaneous minimum power factor
⑤ Instantaneous minimum frequency (F/A: current, F/V: voltage)
⑥ Channel 1 instantaneous maximum voltage
⑦ Channel 2 instantaneous maximum voltage
⑧ Channel 3 instantaneous maximum voltage
⑨ Instantaneous maximum power factor
⑩ Instantaneous maximum frequency (F/A: current, F/V: voltage)

P4: Integrated/average values

Shows the results of integration performed according to the settings in menus M3-1 and M3-2 «INTEG». Active power (W) and apparent power (VA) are always displayed regardless of the setting. REAL TIME and integration ELAPsed time are also shown, as well as the average within the integration processing time for integrated parameters, reactive power (var.) and power factor (PF).

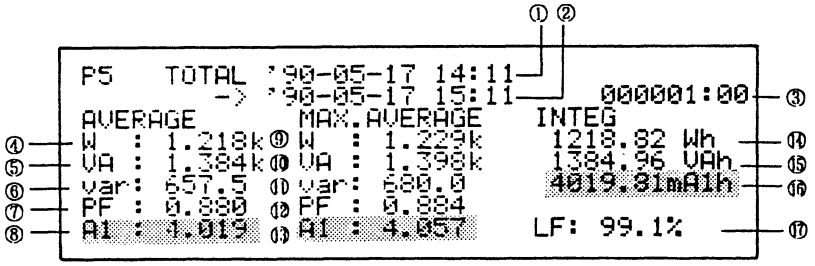


① Real time
② Integration elapsed time
③ Active power
④ Apparent power
⑤ Desired integration amount
⑥ Active power average within a specified period
⑦ Apparent power average within a specified period
⑧ Reactive power average within a specified period
⑨ Power factor average within a specified period
⑩ Average of desired integration parameter within a specified period

Items set from the menu (see page 51)

P5: Total values

Shows the results of totalization performed according to the settings in menus M3-1 and M3-2 «TOTAL», after processing has been finished. Besides totalization start/end times and total integration time, total integration amount, overall average, maximum average and load factor are also displayed. Only one parameter can be selected for integration; all others are fixed.



① Totalization start time
② Totalization end time
③ Total integration time
④ Overall average within a specified period (active power)
⑤ Overall average within a specified period (apparent power)
⑥ Overall average within a specified period (reactive power)
⑦ Overall average within a specified period (power factor)
⑧ Overall average within a specified period (desired integration parameter)
⑨ Maximum average within a specified period (active power)
⑩ Maximum average within a specified period (apparent power)
⑪ Maximum average within a specified period (reactive power)
⑫ Maximum average within a specified period (power factor)
⑬ Maximum average within a specified period (desired integration parameter)
⑭ Total active power
⑮ Total apparent power
⑯ Desired total integration amount
⑰ Load factor

Items set from the menu (see page 59)

3-2 Setting Displays

3-2-1 Display Configuration

0. Setting Menu

```
M0        << SETTING MENU >>

  0:SETTING MENU          6:REAL TIME
  1:WIDE DISPLAY          7:etc.
  2:PRINTER               8:RS-232C
  3:INTEG/TOTAL/RECORD
  4:FRQ,SCALING,D/A OUT
  5:COMPARATOR
```

M 1 – 2

DOWN

1. Wide Display

UP / DOWN

```
M1-1      << WIDE DISPLAY >>
  REAL VALUE SELECT (P1)
    1:V1 2:V2 3:V3 4:*V 5:A1 6:A2 7:A3
    8:*A 9:W 10:VA 11:var 12:PF 13:FRQ
                                1, 2, 3, 4
  MAX VALUE SELECT (P2)
    1:V1 2:V2 3:V3 4:A1 5:A2 6:A3 7:W
    8:VA 9:var 10:PF 11:FRQ    1, 2, 3, 4
```

M 1 – 2

UP / DOWN

```
M1-2      << WIDE DISPLAY >>
  MIN VALUE SELECT (P3)
    1:V1 2:V2 3:V3 4:PF 5:FRQ      1,2,3,4
  INTEG VALUE SELECT (P4)
    1:Wh 2:VAh 3:etc.                  1,2
  AVERAGE VALUE SELECT (P5)
    1:W 2:VA 3:var 4:PF 5:INTEG SEL
                                   1,2,3,4
```

2. Printer

UP / DOWN

M 1 – 2

UP

M 3 – 2

DOWN

```
M2        << PRINTER >>
  PRINT SEL    REAL VALUE      1:ON 2:OFF 1
               MAX VALUE       1:ON 2:OFF 1
               MIN VALUE       1:ON 2:OFF 1
               INTEG&AVERAGE   1:ON 2:OFF 1
  INTERVAL PRINT               1:ON 2:OFF 1
  INTERVAL TIME                     0000:30
```

3. Integrator Function Setting

UP / DOWN

M 3 – 2

MODE 1

UP / DOWN

```
M3-1      << INTEG/TOTAL/RECORD >>

  MODE          1:INTEG 2:TOTAL 3:RECORD  1
  START MODE            1:AUTO  2:MANUAL  2

  AUTO START TIME          00-01-01 00:00
  MEASURE TIME (TIMER)           0000:30
```

M 3 – 2

MODE 2

UP / DOWN

M 3 – 2

UP / DOWN

MODE 3

UP / DOWN

Integration Setting

```
M3-2      << INTEG >>
  STOP MODE          1:TIMER 2:MANUAL  1

  INTEG SELECT
     1:A1 2:A2 3:A3 4:*A 5:Wos          1
```

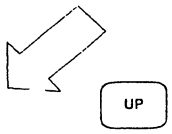
Totalization Setting

```
M3-2      << TOTAL >>

  REPEAT                               48
  INTEG SELECT
     1:A1 2:A2 3:A3 4:*A 5:Wos          1
  TOTAL GRAPH SELECT
     1:W 2:VA 3:var 4:PF 5:INTEG SEL
     6:NOSEL                         1,2
```

Plotting Setting

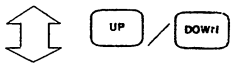
```
M3-2      << RECORD >>
  STOP MODE          1:TIMER 2:MANUAL  1
  RECORD SELECT
        1:V1 2:V2 3:V3 4:*V 5:A1 6:A2
        7:A3 8:*A 9:W 10:VA 11:var
        12:PF 13:FRQ 14:NOSEL       1, 2
  CHART SPEED (MINUTES/DIV)
        1:1/3 2:1 3:5 4:10 5:30 6:60  1
```

M 3 – 2



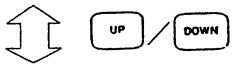
4. Frequency, Scaling, D/A Output

```
M4        << FRQ,SCALING,D/A OUT >>
  FRQ RANGE
     1:100Hz 2:1000Hz 3:10kHz 4:AUTO  4
  FRQ FILTER          1:ON    2:OFF   2
  SCALING
     PT:001.00   CT:001.00   SC:001.00
  D/A OUT     1:VA  2:var 3:PF  4:*V
            5:*A  6:Wos 7:FRQ         1
```



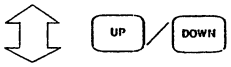
5. Comparator Function Setting

```
M5        << COMPARATOR >>
  COMPARATOR SELECT
    1:V1 2:V2 3:V3 4:*V 5:A1 6:A2 7:A3
    8:*A 9:W 10:VA 11:var 12:PF 13:FRQ
                                      9
  SETTING LEVEL                 100.0k
  WARNING BUZZER      1:ON   2:OFF     2
```



6. Real-time Setting

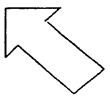
```
M6        << REAL TIME >>
  YEAR-MONTH-DAY                90-05-17
  HOUR:MINUTE:SECOND            11:09:03

  WEEK     1:SUN 2:MON 3:TUE 4:WED
           5:THU 6:FRI 7:SAT          5
```

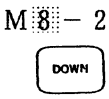


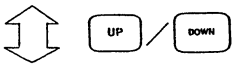
7. Others

```
M7        << etc. >>
  AVERAGE DISPLAY     1:ON   2:OFF    2
  WATT OFFSET         1:ON   2:OFF    2
       ZERO LEVEL                +0.000
  BUZZER KEY          1:ON   2:OFF    1
       INPUT OVER     1:ON   2:OFF    2
  SYSTEM RESET(Push UP or DOWN key)    *
```

M 8 – 2



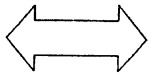


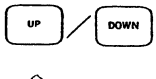


8. RS-232C

```
M8-1      << RS-232C >>
  BAUD RATE (BPS)
    1:300  2:600  3:1200  4:2400
    5:4800 6:9600                    6
  DATA BITS              1:7   2:8    2
  PARITY CHECK    1:OFF  2:ODD  3:EVEN  1
  STOP BIT        1:1    2:1.5  3:2     1
```

M 8 – 2






```
M8-2      << RS-232C >>
  DELIMITER
    TRANSMIT        1:CR  2:LF  3:CR/LF  1
    RECEIVE         1:CR  2:LF  3:CR/LF  3
```

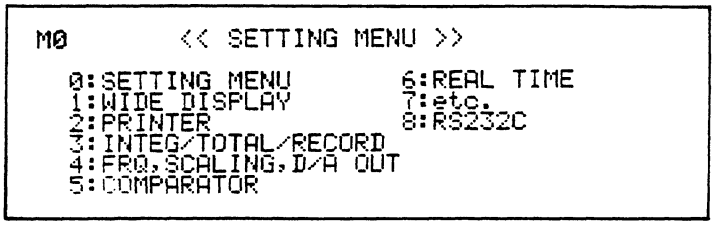
M 8 – 2


```
M0        << SETTING MENU >>
  0:SETTING MENU        6:REAL TIME
  1:WIDE DISPLAY        7:etc.
  2:PRINTER             8:RS-232C
```

Returns to M0.

3-2-2 Display Description

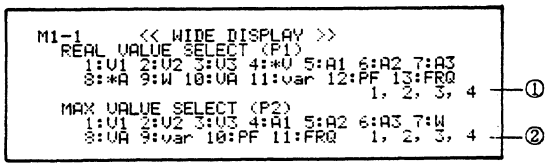
M0: Setting menu

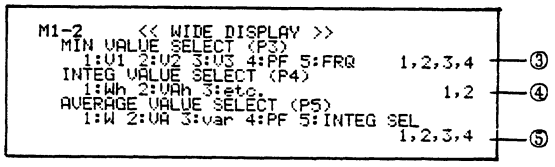


0: Setting menu
1: Wide display selection
2: Printer
3: Integration/totalization/plotting
4: Frequency, scaling, D/A output
5: Comparator
6: Real time
7: Others

This menu shows the setting modes. The digits at left represent page numbers. Use the [UP] and [DOWN] keys to change pages.

M1: Wide display selection

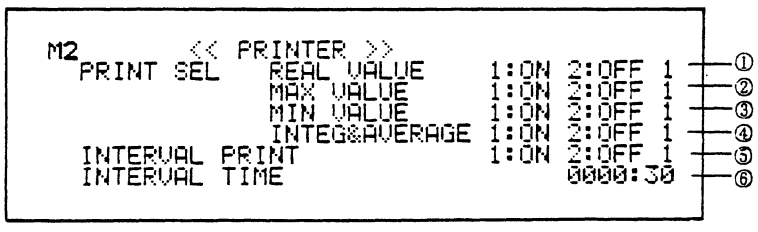




① Instantaneous value
② Instantaneous maximum value
③ Instantaneous minimum value
④ Integration amount
⑤ Average within a specified period

Sets the measurement display to wide mode. There are two sub-pages, covering all measurement displays. Four kinds of data (two for integrated values) can be selected for each item. The same kind of data can be selected twice, but no items can be left blank. The "etc." setting of INTEG VALUE and "INTEG SEL" setting of AVERAGE VALUE show the integration parameters set in the M3-2 «INTEG» menu (for setting procedures, see page 51).

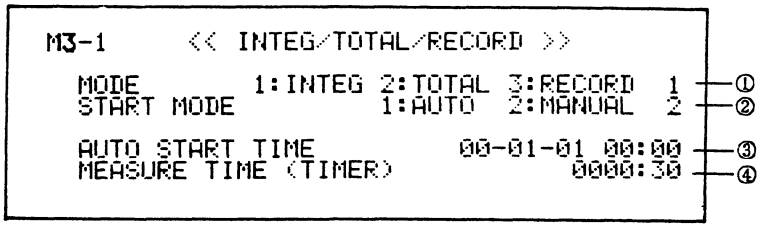
M2: Printer



① to ④ Printed parameter selection
① Instantaneous value
② Instantaneous maximum value
③ Instantaneous minimum value
④ Integrated value, average within a specified period
⑤ Interval printing on/off
⑥ Interval time (hours:minutes)

Sets the printer (for setting procedures, see page 75).

M3: Integration/totalization/plotting

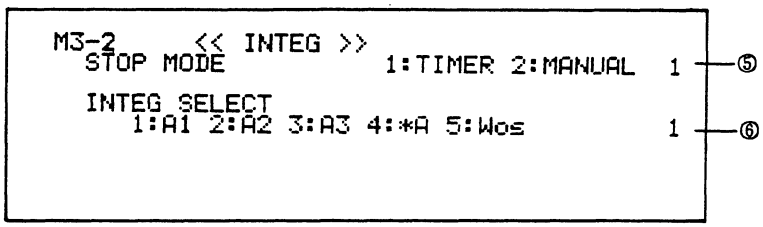


① Integration/totalization/plotting mode setting
② Start mode setting (auto/manual)
③ Start time setting [year (last two digits)-month-day hours:minutes]
④ Timer adjustment [hours:minutes]

Sets the integrator function.

«INTEG»

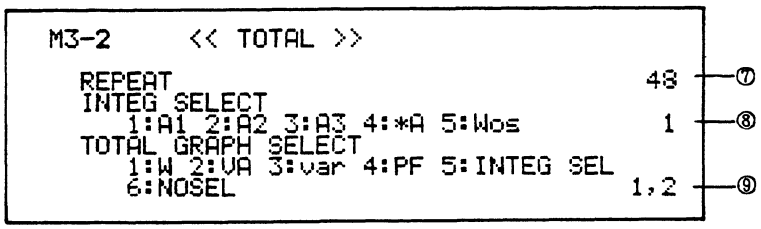
This sub-page is used to set the integrator function. It is valid only when "MODE" is set to "1" in menu M3-1 (for setting procedures, see page 51).



⑤ Integration stop mode setting (timer/manual)
⑥ Integrated parameter setting
A1 ... Channel 1 instantaneous current
A2 ... Channel 2 instantaneous current
A3 ... Channel 3 instantaneous current
*A ... Average current of channels 1 to 3
Wos .. Active power, including the offset

«TOTAL»

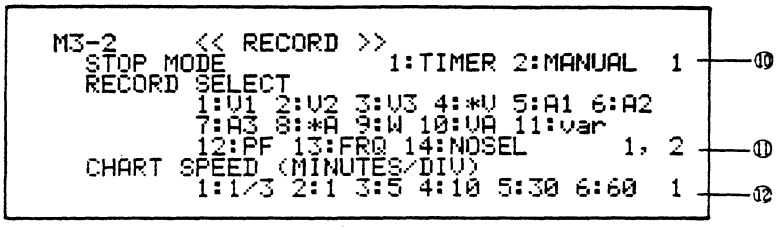
This sub-page is used to set the totalization function. It is valid only when "MODE" is set to "2" in menu M3-1 (for setting procedures, see page 59).



⑦ Number of repeats of timer operation
⑧ Integrated parameter setting (see ⑥)
⑨ Totalization graph setting
W: Active power average within a specified period
VA: Apparent power average within a specified period
var: Reactive power average within a specified period
PF: Power factor average within a specified period
INTEG SEL: Average within a specified period of parameter selected by ⑧
NOSEL: No selection

«RECORD»

This sub-page is used to set the plotting function. It is valid only when "MODE" is set to "3" in menu M3-1 (for setting procedures, see page 91).



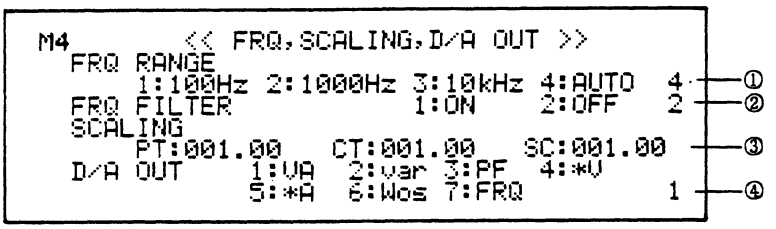
⑩ Plotting stop mode (timer/manual)

⑪ Plotted parameter (instantaneous value)

NOSEL indicates no selection

⑫ Time-axis range

M4: Frequency, scaling, D/A output



① Frequency range

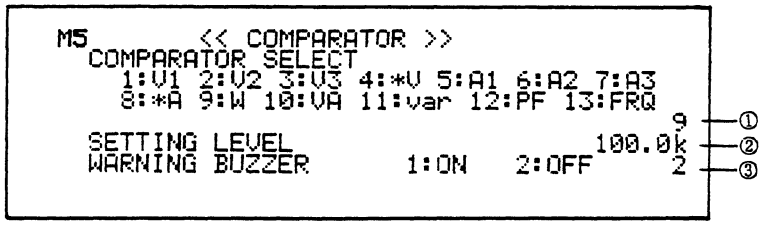
② Frequency filter on/off

③ PT ratio, CT ratio, scaling

④ D/A output parameter (instantaneous value)

For setting procedures of ① and ②, see page 50. For ③ see page 57, and for ④ see page 65.

M5: Comparator



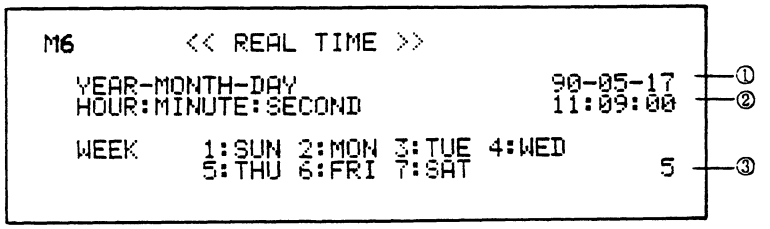
① Compared parameter (instantaneous value)

② Compared value

③ Comparator warning buzzer on/off

For setting procedures, see page 63.

M6: Real time



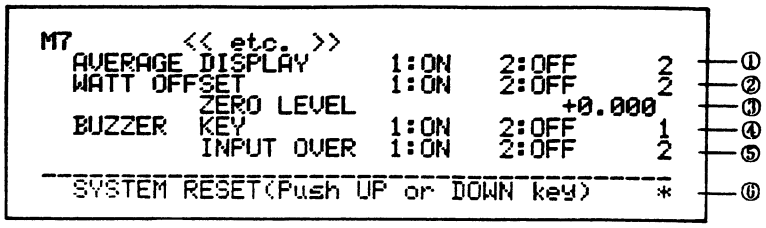
① Date [year (last two digits)-month-day]

② Time [hours:minutes:seconds]

③ Day of the week

For setting procedures, see page 68.

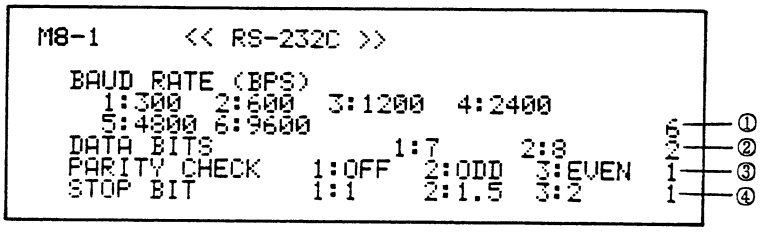
M7: Others



① Display averaging on/off
② Active power offset display on/off
③ Offset value
④ Key buzzer on/off
⑤ Overload warning buzzer on/off
⑥ System reset

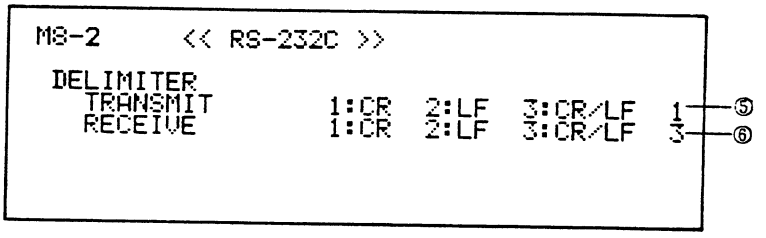
For setting procedures of ①, see page 57. For ② and ③ see page 47, for ④ ⑤ ⑥ see page 69.

M8: RS-232C



① Transfer speed
② Data length
③ Parity
④ Stop bits

For setting procedures, see page 104.



⑤ Transmission delimiter
⑥ Reception delimiter

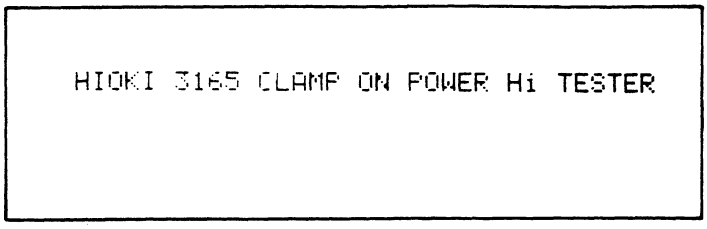
For setting procedures, see page 104.

Chapter 4

MEASUREMENT

4-1 Preparations

4-1-1 Turning the Power On



Initial Message

- Connect the power cord to the back panel AC power inlet and press the POWER switch on the front panel lower right to the ON (⎓ I) position.
- When power is turned on, the unit performs a self-check, paper is fed in one line into the printer, and the initial message appears on the LCD.
- If during self-check the unit finds out that settings or measured values backup was not performed appropriately, the SYSTEM ERR message is displayed together with the corresponding error code, and operation is interrupted. To restart operation, you can press any key, but in this case the setting or measured value indicated by the error code will be reset. For details on reset, see page 70.

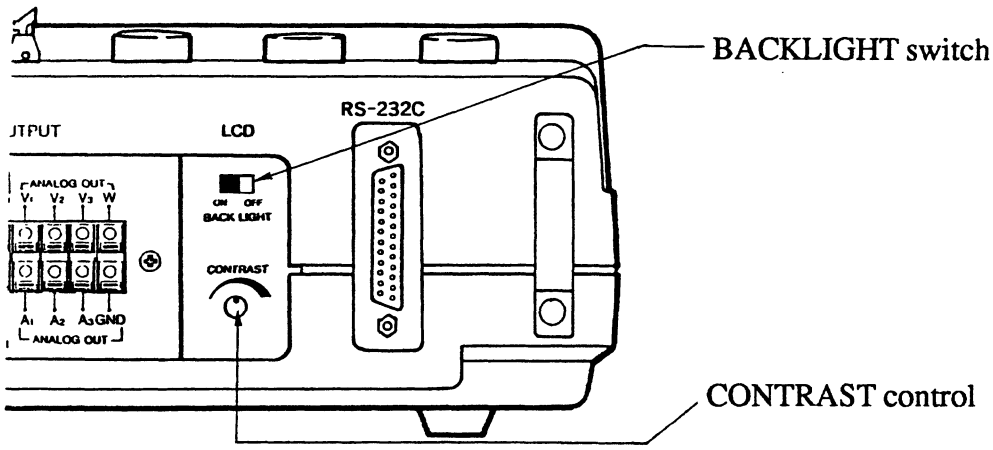
Table 4-1 Error Codes and their Meaning

Error Code	Meaning
0	Mode, voltage/current range, voltage, current rectification method, frequency measurement mode
1	Setting menu 1 (wide display)
2	Setting menu 2 (printer)
3	Setting menu 3 (integration/totalization/plotting)
4	Setting menu 4 (frequency, scaling, D/A output)
5	Setting menu 5 (comparator)
6	Setting menu 6 (real time)
7	Setting menu 7 (others)
8	Setting menu 8 (RS-232C)
10	Maximum/minimum values, integrated values, average within a specified period, total values

* In case a backup error occurs, settings other than those indicated might also be affected. Perform a system reset, or check the setting menus again.

- When self-check is completed, the display returns to the measurement mode. Let the unit warm up for about 10 minutes before measuring.
- When power is turned, the unit is set according to previous measurement conditions and data kept by the backup function. To change them, perform a data reset or a system reset as necessary.

4-1-2 Adjusting the Display



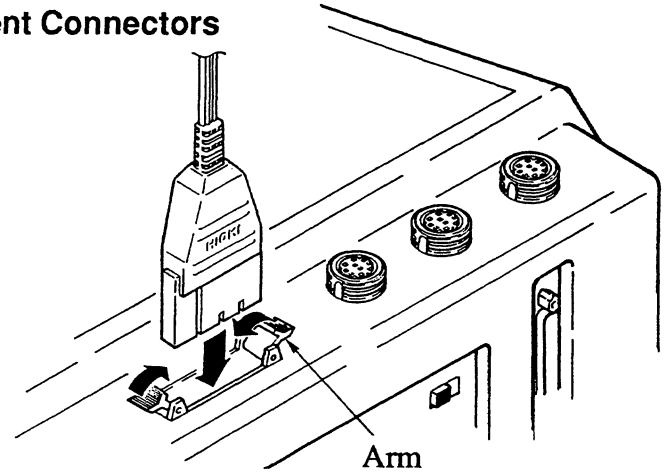
- You will find a CONTRAST control and a BACKLIGHT switch on the back panel.
- Adjust the CONTRAST control for optimum display readability.
- When working in a poorly illuminated place, turn ON the BACKLIGHT switch.

4-1-3 Connecting the Voltage and Current Connectors

Voltage connector

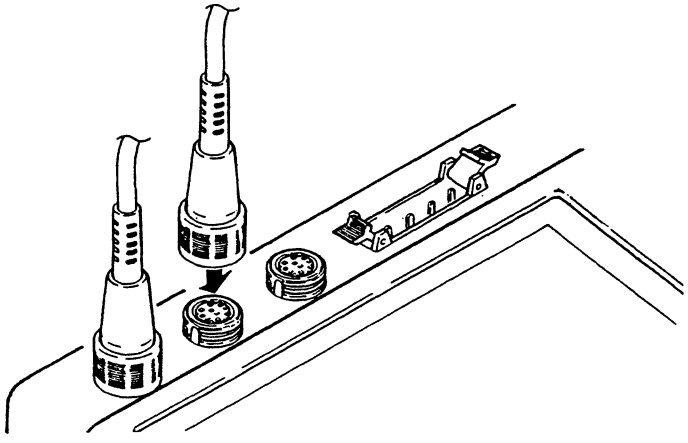
⚠ CAUTION

Be sure to insert the connector in the correct position.



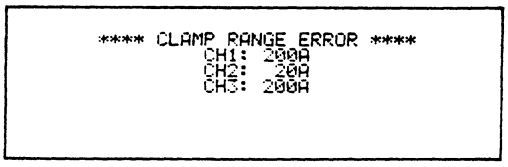
- Insert the attached voltage cable (9178) into the connector, then lock it securely with the arms.

Current sensor

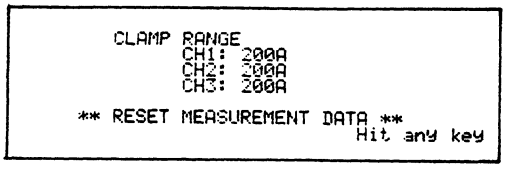


- Connect a clamp-on sensor of the Hioki 9270 series to the current connector. Push the connector in until you hear a click and it is securely locked.
- Since the range cannot be selected independently for each channel, do not use sensors of different ratings (or 9272 sensors set to different ranges) together.

Display 1

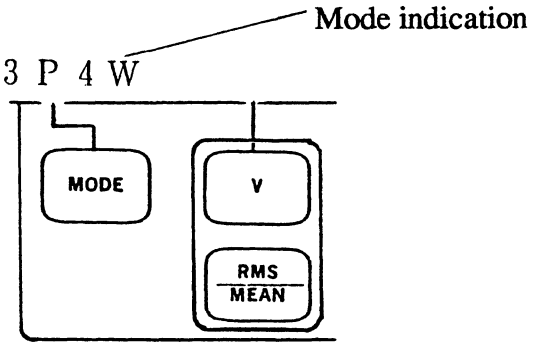


Display 2



- If sensors of different ratings are connected, the display will look as shown in Display 1 above, indicating that sensor connection is not proper.
- In this condition, the unit will not accept any operations, and any ongoing processings will be interrupted.
- If the printer is operating, it will stop after printing the contents of its buffer (max. 256 characters).
- Reconnect sensors to make ranges match, and the display will look as shown in Display 2 above, indicating that the error condition has been released. Press any key to return to the normal display.
- If the printer stopped during operation, the remaining data will be printed out.
- In case no sensor is connected, the current range will remain that of the last sensor connected. If a sensor of different rating is then connected, Display 2 above will appear. Press any key to return to the normal display.

4-1-4 Selecting the Measurement Mode



- Use the [MODE] key to select the measurement mode. Mode changes in the following sequence as the key is pressed repeatedly.

→ 1P2W → 1P3W → 3P3W-2 → 3P3W-3 → 3P4W →

- When the [MODE] key is pressed, the display goes out for approx. 1 second. This does not happen, however, in the data hold mode.

Meaning of Mode Codes

1P2W: Single-phase two-wire
1P3W: Single-phase three-wire
3P3W-2: Three-phase three-wire (two-voltage, two-current, two-power measurement method)
3P3W-3: Three-phase three-wire (three-voltage, three-current, three-power measurement method)
3P4W: Three-phase four-wire

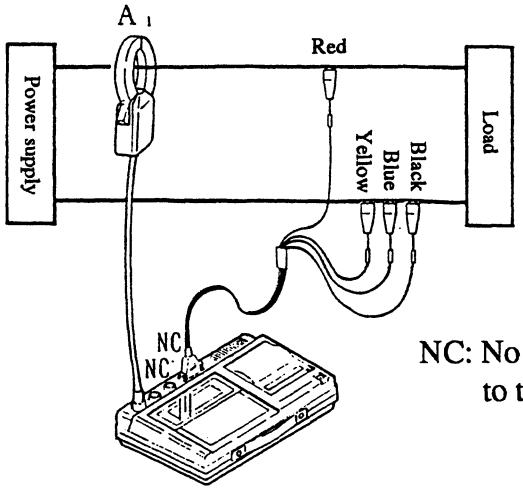
⚠ CAUTION

This single unit permits measurement of single-phase two-wire to three-phase four-wire lines. However, it cannot be used as three single-phase power meters, because channels are not independent.

4-1-5 Connections

- This section includes connection diagrams for each mode. Since voltage and current polarity (phase) affects power measurement, be sure to perform connections correctly.
- Always connect sensors so that their arrows point in the direction of the load.

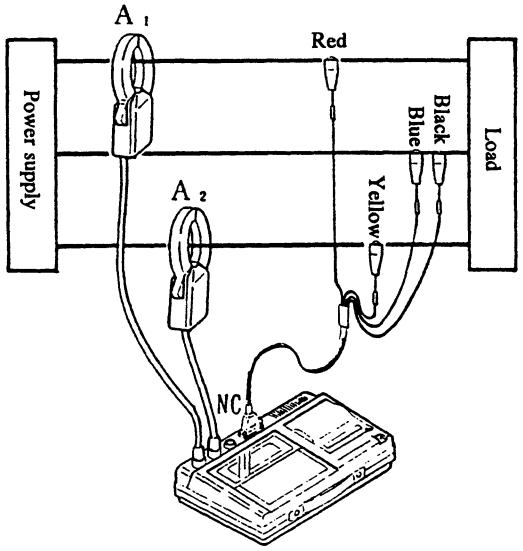
(1) Single-phase two-wire lines



NC: No sensor connected to the main unit.

- Set the measurement mode to "1P2W" with the [MODE] key.
- Connect a clamp sensor to the A1 connector. Do not connect sensors to the A2 and A3 connectors.
- Connect the red and black voltage cables to the measured conductor, and the remaining yellow and blue cables together with the black cable.
- Clamp the A1 sensor to the conductor to which you connected the red voltage cable, and make your reading.

(2) Single-phase three-wire lines

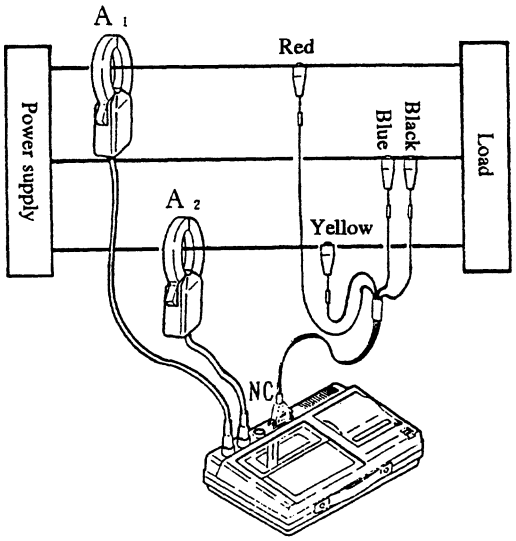


- Set the measurement mode to "1P3W" with the [MODE] key.
- Connect clamp sensors to the A1 and A2 connectors. Do not connect a sensor to the A3 connector.
- Connect the red, yellow and black voltage cables to the measured conductors, and the remaining blue cable together with the black cable.
- Clamp the A1 sensor to the conductor to which you connected the red voltage cable, and the A2 sensor to the conductor to which you connected the yellow voltage cable, then make your reading.

(3) Three-phase three-wire lines

- Connection for measurement of three-phase three-wire lines depends on the measurement method used.

① Two-voltage, two-current, two-power method (3P3W-2)

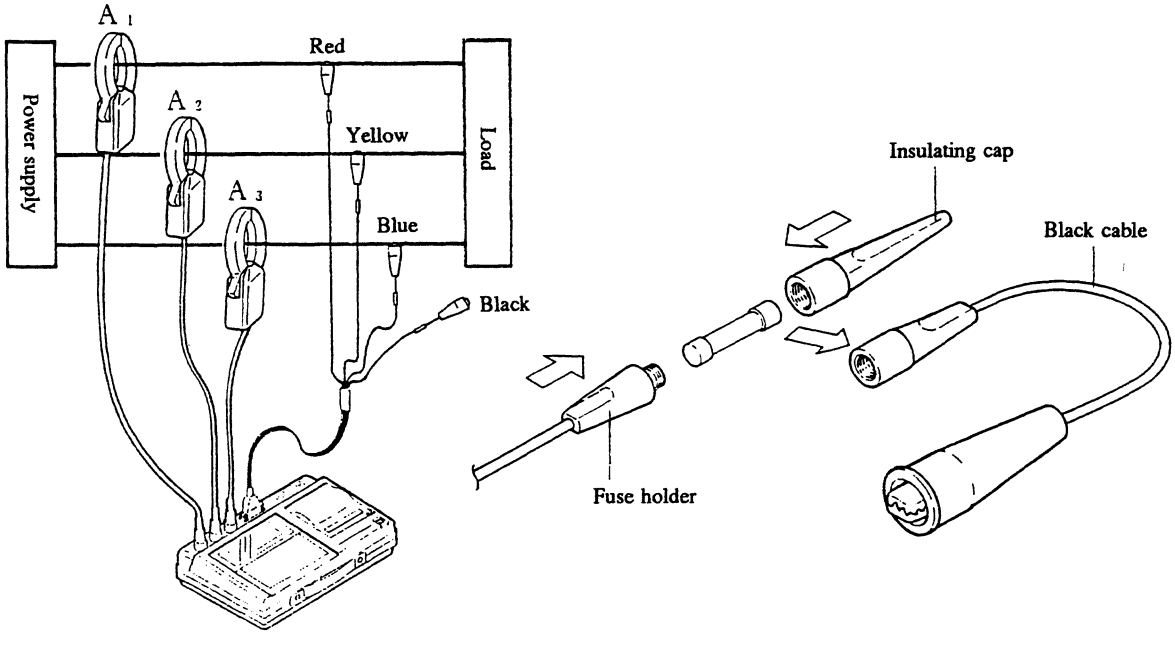


- Set the measurement mode to "3P3W-2" with the [MODE] key.
- Connect clamp sensors to the A1 and A2 connectors. Do not connect a sensor to the A3 connector.
- Connect the red, yellow and black voltage cables to the measured conductors, and the remaining blue cable together with the black cable.
- Clamp the A1 sensor to the conductor to which you connected the red voltage cable, and the A2 sensor to the conductor to which you connected the yellow voltage cable, then make your reading.

② Three-voltage, three-current, three-power method (3P3W-3)

⚠ NOTE

Be sure not to lose the cap.

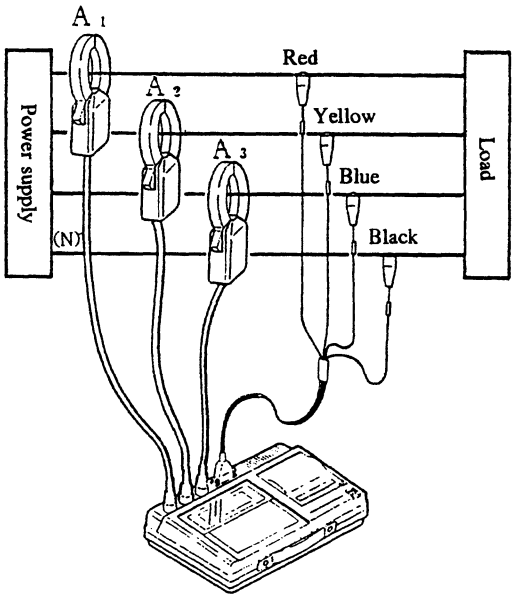


- Set the measurement mode to "3P3W-3" with the MODE key.
- Connect clamp sensors to the A1, A2 and A3 connectors.
- Connect the red, yellow and blue voltage cables to the measured conductors, and let the remaining black cable free. For safety, detach the part of the cable after the fuse holder and cover it with the provided cap.
- Clamp the A1 sensor to the conductor to which you connected the red voltage cable, the A2 sensor to the conductor to which you connected the yellow voltage cable, and the A3 sensor to the conductor to which you connected the blue voltage cable, then make your reading.

⚠ CAUTION

Active power measurement will give the same results regardless of which method is used. When measuring unbalanced loads, however, apparent power and other calculated parameters may differ if there is a large unbalance between phases. In those cases, the three-voltage, three-current, three-power measurement method gives more accurate readings.

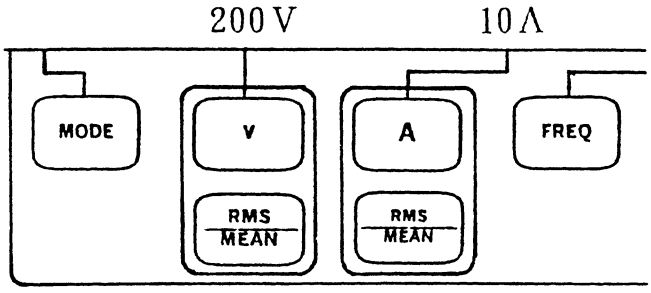
(4) Three-phase four-wire lines



- Set the measurement mode to "3P4W" with the MODE key.
- Connect clamp sensors to the A1, A2 and A3 connectors.
- Connect the black voltage cable to the neutral (N) line, and the remaining three cables to the measured conductors.
- Clamp the A1 sensor to the conductor to which you connected the red voltage cable, the A2 sensor to the conductor to which you connected the yellow voltage cable, and the A3 sensor to the conductor to which you connected the blue voltage cable, then make your reading.

4-2 Measurement Procedures

4-2-1 Voltage and Current Measurement



- Set the voltage and current ranges with the [V] and [A] keys. They will be shown on the display.
- The voltage range can only be set manually. It changes in the following sequence.

→ 400V → 200V → 100V → [V]

- Current ranging can be performed either manually or automatically. Range configuration depend on the sensor used, as follows.

  20-A sensor (9270, 9272 in the 20-A range)

→ AUTO → 20A → 10A → 5A → 2A → [A]

  200-A sensor (9271, 9272 in the 200-A range)

→ AUTO → 200A →100A → 50A → 20A

- Sensor ratings are detected by the unit, which automatically selects the range configuration.
- When set to "AUTO", range will be automatically set according to the input level.
- Range switching level are as follows.

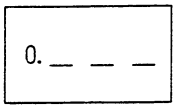
  ① The next higher range is selected when:
  - The A1, A2 or A3 reading reaches 150% of the range, or more.
  - The "OVER A" indication lights up.

  ② The next lower range is selected when:
  - All A1, A2 and A3 readings fall under 20% of the range.

- To cancel the "AUTO" mode, press the [A] key.
- When the [V] or [A] key is pressed, the display goes out for approx. 1 second. This does not happen, however, in the data hold mode.

✪ Average Voltage and Current

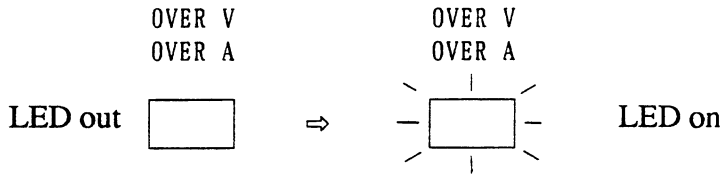
- Voltage between lines and line current in a three-phase line are displayed as "*V" and "*A" respectively.
- Since average values are obtained by calculation from the data of channels 1 to 3, averaging can only be performed with the three-voltage, three-current, three-power measurement method.
- With all other methods, the display will look as follows.



No calculation performed

✪ Input Overload Indications

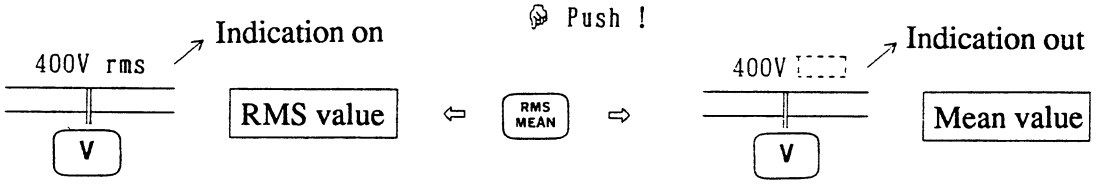
- When a voltage or current input peak goes beyond the internal operation level, a LED lights up as a warning.
- In this condition, correct measurement is not possible. Turn up the range without delay until the LED goes out.



- Overload detection levels are as follow.
  - Voltage ... Approx. 2.8 times the range (peak value)
  - Current ... Approx. 4.2 times the range (peak value)
- This warning is issued even when only one channel has been overloaded.

✪ RMS/Mean Value Switching

- The rectification method for voltage and current measurement can be switched between the RMS and mean value methods.
- Switching is performed with the [RMS MEAN] keys located below the [V] and [A] keys.
- When "rms" is shown to the right of the range indication, the true RMS value is displayed. If nothing is shown, the mean rectified RMS value is displayed.



◎ Related Functions

- PT and CT ratio setting (page 57, Scaling Function)
- Analog output (page 64, Analog Output)
- Display of instantaneous minimum voltage and instantaneous maximum voltage/current values (page 54, Instantaneous Maximum and Minimum Values)
- Comparator function (page 63, Comparator Function)
- Current integration and totalization, voltage/currentt plotting (page 51, Integrated Power Measurement) (page 59, Totalization Processing) (page 91, Plotting)
- Display of average values within a specified period during integration (only A) (page 54, Average Value Within a Specified Period)

Note

True RMS and RMS (Mean Values)

Alternating currents are normally expressed as True RMS values. An True RMS value is defined by the equation below, being the DC value equivalent to the actual amount of work done.

$$\text{True RMS value} = \sqrt{\text{Mean of squared instantaneous values}}$$

Therefore, for a sine wave it will be equal to the maximum value × 0.707.

On the other hand, the mean value is defined as the average of instantaneous values within a half period. For a sine wave, it is equal to the maximum value × 0.637.

The proportion between True RMS and mean values for a sine wave is then

$$\text{True RMS value/Mean value} \approx 1.11$$

In this unit, the "RMS" function displays the true RMS value.
In the "MEAN" function, the measurement subject is assumed to be a perfect sine wave, and the value calculated by the formula "mean" rectified value × 1.11" is displayed.
Therefore, "RMS" is usually used in measuring lines containing harmonics, because when there is distortion in the measurement subject, deforming the sine wave, the "MEAN" value contains error compared to the "RMS" value.

Range Configuration Tables

With the 9272 (20-A range) or 9270 sensor

Current \ Voltage		2.000 A	5.000 A	10.00 A	20.00 A
100.0 V	1P2W	200.0 W	500.0 W	1.000 kW	2.000 kW
	1P3W	400.0 W	1.000 kW	2.000 kW	4.000 kW
	3P3W-2	400.0 W	1.000 kW	2.000 kW	4.000 kW
	3P3W-3	400.0 W	1.000 kW	2.000 kW	4.000 kW
	3P4W	600.0 W	1.500 kW	3.000 kW	6.000 kW
200.0 V	1P2W	400.0 W	1.000 kW	2.000 kW	4.000 kW
	1P3W	800.0 W	2.000 kW	4.000 kW	8.000 kW
	3P3W-2	800.0 W	2.000 kW	4.000 kW	8.000 kW
	3P3W-3	800.0 W	2.000 kW	4.000 kW	8.000 kW
	3P4W	1.200 kW	3.000 kW	6.000 kW	12.00 kW
400.0 V	1P2W	800.0 W	2.000 kW	4.000 kW	8.000 kW
	1P3W	1.600 kW	4.000 kW	8.000 kW	16.00 kW
	3P3W-2	1.600 kW	4.000 kW	8.000 kW	16.00 kW
	3P3W-3	1.600 kW	4.000 kW	8.000 kW	16.00 kW
	3P4W	2.400 kW	6.000 kW	12.00 kW	24.00 kW

Table 4-2

With the 9272 (200-A range) or 9271 sensor

Current \ Voltage		20.00 A	500.0 A	100.0 A	200.0 A
100.0 V	1P2W	2.000 kW	5.000 kW	10.00 kW	20.00 kW
	1P3W	4.000 kW	10.00 kW	20.00 kW	40.00 kW
	3P3W-2	4.000 kW	10.00 kW	20.00 kW	40.00 kW
	3P3W-3	4.000 kW	10.00 kW	20.00 kW	40.00 kW
	3P4W	6.000 kW	15.00 kW	30.00 kW	60.00 kW
200.0 V	1P2W	4.000 kW	10.00 kW	20.00 kW	40.00 kW
	1P3W	8.000 kW	20.00 kW	40.00 kW	80.00 kW
	3P3W-2	8.000 kW	20.00 kW	40.00 kW	80.00 kW
	3P3W-3	8.000 kW	20.00 kW	40.00 kW	80.00 kW
	3P4W	12.00 kW	30.00 kW	60.00 kW	120.0 kW
400.0 V	1P2W	8.000 kW	20.00 kW	40.00 kW	80.00 kW
	1P3W	16.00 kW	40.00 kW	80.00 kW	160.0 kW
	3P3W-2	16.00 kW	40.00 kW	80.00 kW	160.0 kW
	3P3W-3	16.00 kW	40.00 kW	80.00 kW	160.0 kW
	3P4W	24.00 kW	60.00 kW	120.0 kW	240.0 kW

Table 4-3

Notes

- Measurement is possible up to 150% of the voltage and current ranges, and up to 125% of the power ranges.
- The analog output is delivered at DC 2.0 V/f.s. with regard to the f.s. value of each range.
- 3P3W-2 stands for two-voltage, two-current, two-power measurement method, and 3P3W-3.for three-voltage, three-current, three-power measurement method.

4-2-2 Power Measurement

- The power range is determined by the combination of the voltage and current ranges and the measurement mode as shown in Tables 4-2/3.
- Active power (W), reactive power (var) and apparent power (VA) are always displayed in the same range.

✪ Offset Function

- An offset can be applied to active power measurement readings.
- This is useful to observe the difference between active power values under two different operating conditions. The offset setting does not affect power factor and reactive power calculation.
- Set the offset at the setting mode.

✪ Menu Setting

- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the «etc.» item on the 7th page (M7).
- Using the [▲] and [▼] keys, move the cursor to the "WATT OFFSET" position, then select 1:ON with the [UP] and [DOWN] keys.
- Now enter the offset value. Move the cursor to "ZERO LEVEL" with the [▼] key, then use the [◄] , [►] , [UP] and [DOWN] keys to set the value.
- "ZERO LEVEL" can be set to any four digits from ±0.000 mW to 9999 MW.
- Press the [MEASURE MENU] key again to return to the measurement mode. This completes the procedure.

[Example]

To set an offset of 1.000 kW.

0 0 0 0 . ⋯ Initial setting
↓ [UP]
0 0 0 0 . k ⋯ Unit conversion
↓ [◄] Press four times.
0 0 0 0 . k ⋯ Move the cursor.
↓ [DOWN]
0 0 0 0 0 k ⋯ Decimal point setting
↓ [◄]
0 . 0 0 0 k ⋯ Move the cursor.
↓ [UP]
1 . 0 0 0 k ⋯ Setting completed

- The "Wos" indication will appear on the measurement display, showing that an offset has been applied to active power .
- Internally, the following calculation is performed: Wos = W-(ZERO LEVEL).

- If "ZERO LEVEL" is set to a large value, the result might overflow the display depending on the measured value (W). In that case, an error message will be displayed as shown below. Change "ZERO LEVEL" to an appropriate value.
- Integration can be applied to Wos as it is to W.

*** Observe that this process does not consist of the addition of the ZERO LEVEL.**

Overflow indication

Set the offset value within the following ranges according to the measurement mode.

PT=CT=SC=1, 200-A sensor

Mode	Minimum Value	Maximum Value
1P2W	± 0.001 kW (± 000.1 W)	± 100.0 kW (± 10.00 kW)
1P3W 3P3W-2 3P3W-3	± 0.001 kW (± 000.1 W)	± 200.0 kW (± 20.00 kW)
3P4W	± 0.0001 kW (± 000.1 W)	± 300.0 kw (± 30.00 kW)

Values applied when using a 20-A sensor are shown between brackets ( ).

When scaling is applied, values in the table should be multiplied by the scaling ratio. If a value beyond the above ranges is set, a wrong offset integration value may be obtained. If a value below the ranges is set, it may be fixed to 0 (zero).

⚠ CAUTION

The power calculation circuit in this product uses an auto-zeroing circuit. Therefore, if the line being measured includes a frequency which is an integral multiple of the auto-zero frequency (approximately 5 kHz), this may produce an uncertainty in the displayed measurement value.

❂ Related Functions

- SC coefficient setting (page 57, Scaling Function)
- Active power (W) analog output (page 64, Analog Output)
- Reactive power (var), apparent power (VA) and active power (Wos) D/A output (page 65, D/A Output)
- Display of instantaneous maximum values (page 54, Instantaneous Maximum and Minimum Values)
- Comparator function (page 63, Comparator Function)
- Active (W) and apparent (VA) power integration
- Active (W), apparent (VA) and reactive (var) power totalization and plotting (page 59, Totalization Processing) (page 91, Plotting)
- Display of average values within a specified period during integration (subject to selection for Wos) (page 54, Average Value Within a Specified Period)

4-2-3 Power Factor Measurement

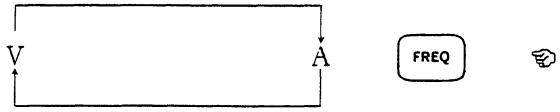
- The power factor is calculated from the apparent (VA) and active (W) power data and displayed as "PF".
- In case active power is larger than apparent power, the power factor is fixed to 1.000.
- If active power is remarkably larger than apparent power, check the following.
  - Distortion in the measured line, causing a difference in apparent power due to rectification method switching.
  - An unbalanced line is being measured, so the reading changes when the connection is altered in the two-voltage, two-current, two-power method (3P3W-2).

  When there is distortion in the measured line, use real RMS value measurement. For unbalanced lines, use the three-voltage, three-current, three-power (3P3W-3) measurement method.
- If apparent power is 0 VA, the "8. ⎵⎵⎵" (unable to calculate) indication will be shown.

◎ Related Functions

• D/A output	(page 65, D/A Output)
• Display of instantaneous minimum and maximum values	(page 54, Instantaneous Maximum and Minimum Values)
• Comparator function	(page 63, Comparator Function)
• Totalization and plotting	(page 59, Totalization Processing) (page 91, Plotting)
• Display of average values within a specified period during integration	(page 54, Average Value Within a Specified Period)

4-2-4 Frequency Measurement



- Use the [FREQ] key to choose whether frequency measurement is to be performed in the voltage or current mode. The selected mode is shown on the display as "V" or "A".
- A difference in reading stability may appear between both modes, especially when measuring lines controlled by inverters, etc. Select the mode according to the actual conditions.
- Frequency is displayed as follows.

F／A 55.0 Hz

Detection mode

- After the "F", which stands for frequency, the detection mode is shown. In the instantaneous minimum/maximum value displays (P2 and P3), the mode at the time those values were detected is displayed. This may not coincide with the current measurement mode.

❂ Frequency Range Setting

- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the Q, SCALING, D/A OUT item on the 4th page (M4).
- Using the [▼] key, move the cursor to the "FRQ RANGE" position, then select the desired range with the [UP] and [DOWN] keys.
- Press the [MEASURE MENU] key again to return to the measurement mode. This completes the procedure.
- When auto ranging is used, a "#" is shown to the left of the measurement mode indication.

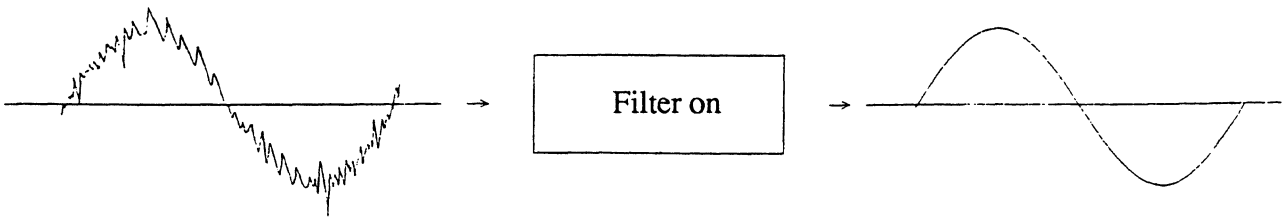
100 Hz	
1000 Hz	
10kHz	AUTO
V	#V
A	#A

❂ Filtering Function

- Correct measurement might not be possible when the signal is distorted. This can be solved by using the filter.

❂ Menu Setting

- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the Q, SCALING, D/A OUT item on the 4th page (M4).
- Using the [▲] and [▼] keys, move the cursor to the "FRQ FILTER" position, then select "1:ON" with the [UP] and [DOWN] keys.
- Press the [MEASURE MENU] key again to return to the measurement mode. This completes the procedure.
- The filter attenuates high-frequency components, permitting accurate frequency measurement of waveforms containing many harmonics (cutoff frequency is approx. 100 Hz).



- However, since there are many kinds of inverters and other control devices, this may not allow for accurate measurement in some cases.
- Correct measurement cannot be achieved either if the input level is too small compared to the range. Use input levels 10% or more above the range.

✪ Related Functions

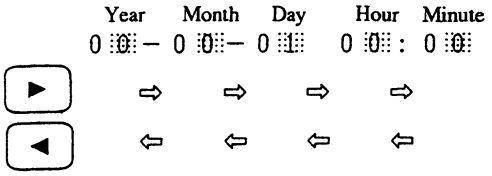
- D/A output (page 65, D/A Output)
- Comparator function (page 63, Comparator Function)
- Plotting (page 91, Plotting)

4-2-5 Integrated Power Measurement

- This operation integrates active (W) and apparent (VA) power.
- One among A1, A2, A3, *A and Wos can be selected as integration input.
- The start mode can be set to automatic or manual.
- If auto start is used, the start time can be specified.
- Timer and manual stop modes are available.
- When using the timer, time can be set freely between 1 minute and 1000 hours.
- When the W reading is negative, minus integration is performed.

✪ Menu Setting

- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the «INTEG/TOTAL/RECORD» item on the M3-1 page.
- Using the [▼] key, move the cursor to the "MODE" position, then select "1" (INTEG) with the [UP] and [DOWN] keys.
- Press the [▼] key to move the cursor to "START MODE", then select "AUTO" or "MANUAL" with the [UP] and [DOWN] keys.
- If you selected "AUTO", move the cursor to "AUTO START TIME" with the [▼] key and set the start time. Use the [◄] and [►] keys to move the cursor to the year, month, day, hour and minute positions.



  Move the cursor to the desired position, then adjust the digit with the [UP] and [DOWN] keys.
- Move the cursor to the "MEASURE TIME (TIMER)" position to set the integration time. Move the cursor with the [◄] and [►] keys, and use the [UP] and [DOWN] keys to adjust the digits.

Example: Setting the integration time to 1 hour 30 minutes.

Press the [►] key three times	0 0 0 0 : 0 0
Press the [UP] key once	0 0 0 0 : 0 0
Press the [►] key	0 0 0 1 : 0 0
Press the [UP] key three times	0 0 0 1 : 3 0
Setting completed	Hours Minutes

* "MEASURE TIME" can be set to "0000:00" on the menu, but it is taken as 1 minute for internal processing.

- Move the cursor to M3-1 with the [▲] key, then press the [UP] or [DOWN] key to obtain the M3-2 «INTEG» menu.
- Use the [▼] key to move the cursor to "STOP MODE", then select "TIMER or "MANUAL" with the [UP] and [DOWN] keys.
  If "TIMER" is selected, integration will be completed within the time set at "MEASURE TIME". In the "MANUAL" mode, however, integration should be stopped manually (it is compulsorily stopped after 4650 hours, or approx. 6 months).
- Move to "INTEG SELECT" with the [▼] key and use the [UP] and [DOWN] keys to select the parameter to be integrated. *A can be integrated in the 3P3W-3 and 3P4W modes. In all other modes, a 0 (zero) is obtained. Wos can be integrated when offset is turned on. When it is off, a 0 (zero) is obtained.
- Press the [MEASURE MENU] key again to return to the measurement mode. This completes the procedure.

✪ Operation of the Integrator

Integrated power is displayed on the 4th page (P4 «INTEG/AVERAGE») in the measurement mode. Integration is started by pressing the [START STOP] key on the control panel.
If "START MODE" has been set to 1 (AUTO) in the M3-1 menu of the setting mode, the RUN indicator will flash on and off and the unit will stand by until the "AUTO START TIME". When the set time is reached, the RUN indicator will remain lit and integration will be started.
In case "START MODE" is set to 2 (MANUAL), integration will start immediately when the [START STOP] key is pressed (the RUN indicator lights).

* Processing is interrupted for approx. four seconds during power rise and range changes. When integration starts, adding integration is performed with the former integrated value as a reference.
* To clear the integrated value or change settings, press the [DATA RESET] key before starting. Integration stops automatically at the "MEASURE TIME" if the "STOP MODE" has been set to 1 (TIMER) in the M3-2 menu of the setting mode. If set to 2 (MANUAL), it must be stopped by pressing the [START STOP] key. This option can also be used with the "TIMER" setting. When integration is completed, the RUN indicator goes out.
* When stop mode is set to "MANUAL", integration is compulsorily stopped after 4650 hours, or approx. 6 months).

⚠ CAUTION

If the clamp sensor range is changed during integration, measurement is compulsorily terminated.

Integrated values are displayed up to six digits (999999.M). If this limit is surpassed, "9␣␣␣␣␣ M" is shown to indicate a display overflow. When the result is a number of more than six digits, digits are deleted in sequence from the least significant one.

1000000Wh → 1000.00kWh

Deleted

* If the voltage or current range is changed during measurement, the number of displayed digits may be reduced.
* When the measurement display is in the data hold condition, data are updated at the time of integration start/stop or interval printing, then frozen again.
* If you have changed the integrated parameter, press the [DATA RESET] key to clear the data before starting integration.
* When data (W, VA, INTEG SEL) input to the integrator are beyond their range, an accurate integration is not possible. Integrated values and averages within a specified period are likely to exceed accuracy specifications.

◎ Related Functions

- Integrated value printing

  If interval printing is turned on, printing starts simultaneously with integration. When integration is completed, the printer stops after printing the last data (page 81, Interval Printing).
- External integrator control

  Integration start and stop can be controlled through the external control terminal on the back of the unit (page 66, External Control).
- Power failure processing

  If a power failure occurs during integration, operation is resumed when power supply is restored. In this case, failure and restoration times will be printed (page 135, Power Failures).

4-2-6 Instantaneous Maximum and Minimum Values

- The instantaneous maximum and minimum values within the measurement period can be displayed.
- These values are shown on the 2nd (P2) and 3rd (P3) pages in the measurement mode. They can also be displayed in wide mode (page 56, Wide Display Function).
- Since data are backed up by a battery, they are not erased when power is turned off or a power failure occurs.
  Press the [DATA RESET] key to display the current instantaneous values.
- Since maximum and minimum values are displayed in the range at the time they were detected, readings will not change when selecting another range until new values are detected.
- The frequency measurement mode shown to the right of the slash (/) also corresponds to the mode set when values were detected, and it may not coincide with the current mode indication.

* Measurement of instantaneous minimum/maximum values is based on data obtained prior to scaling processing. Therefore, be sure to reset the data upon changing the mode or PT, CT, and SC.

To clear the data

☞ [DATA RESET] ——→ Data are reset.

4-2-7 Average Value Within a Specified Period

- Average values within a specified period can be displayed for active power (W), apparent power (VA), reactive power (var) and power factor (PF) on any integration or totalization menu.
- Moreover, average values can be displayed in the same way for parameters set for integration in the «INTEG» or «TOTAL» mode on page M3-2.
- During totalization processing, the maximum average within each measurement time unit is retained and displayed as "MAX AVERAGE".
- Observe, however, that the totalization display is updated only after processing has been completed.
- Average values on the «INTEG/AVERAGE» display can be shown in wide mode on page P5 «INTEG AVERAGE». Wide display is not possible, however, for averages on the «TOTAL» page. For details, see page 56.

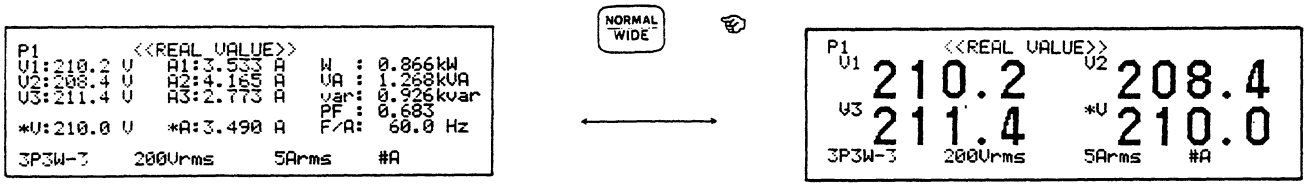
Chapter 5

VARIOUS FUNCTIONS

5-1 Display Functions

5-1-1 Wide Display Function

- All readings except those on the totalization display can be shown enlarged when there is no need of displaying all parameters.
- Since the number of items displayed is limited, they must be selected.



✪ Menu Setting

- Press the MEASURE MENU key to switch the display to setting mode. Change pages with the UP and DOWN keys and call the «WIDE DISPLAY» item on the 1st (M1-1) page.
- Setting is performed independently for each page.
  Select the menu to be set (M1-1 or M1-2), then move the cursor to the desired parameter with the ▲ and ▼ keys.
- Four parameters (two for the integration display) can be selected for each menu.
- Move the cursor horizontally using the ◄ and ► keys, and adjust the digits with the UP and DOWN keys.
- Press the MEASURE MENU key again to return to the measurement mode. This completes the setting procedure.
- Select a page with the UP and DOWN keys and press the NORMAL WIDE key to alternate between normal and wide display modes.
- Average values in the integration mode are displayed on the 5th (P5) page «INTEG AVERAGE» in the wide mode.
  Data in the "P5 TOTAL" menu cannot be displayed in the wide mode.

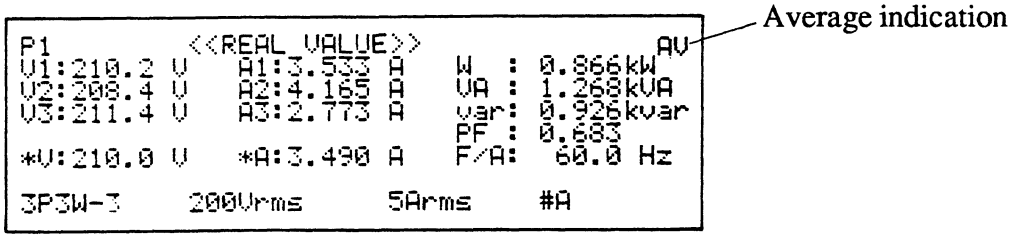
5-1-2 Averaging Function

- In case displayed values are unstable and difficult to read, you can obtain an average of instantaneous values.
- This function calculates the arithmetic mean of eight instantaneous values, and displays it. This unit uses a sampling rate of approx. 1 second, so data are updated once each 8 seconds approx. The number of averaging operations cannot be selected by the user.

* After changing modes, old data is retained until it is replaced with new data. Therefore, the value on unused channels may be other than zero.

✪ Menu Setting

- Press the [MEASURE MENU] key to switch the display to setting mode. Change pages with the [UP] and [DOWN] keys and call the «etc.» item on the 7th (M7) page.
- Move the cursor to the "AVERAGE DISPLAY" position with the [▲] and [▼] keys, then select "1:ON" with the [UP] and [DOWN] keys.
- Press the [MEASURE MENU] key again to return to the measurement mode. This completes the setting procedure.
- During averaging, the "AV" indication is shown to the right of the adjustment display.
- To cancel this function, follow the procedure above, selecting the "OFF" setting on the "AVERAGE DISPLAY" menu.



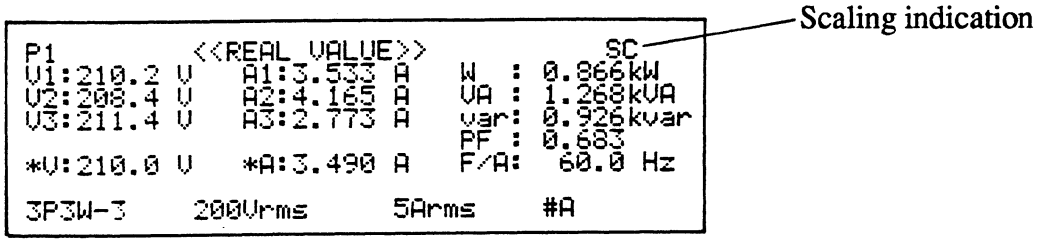
5-1-3 Scaling Function

- When using an external power (PT) or current (CT) transformer, the PT or CT ratio can be set to permit direct reading of the primary voltage or current.
- Power and electric energy can also be given any desired coefficient (SC coefficient).
- PT, CT ratios and the SC coefficient are set in the setting mode.

✪ Menu Setting

- Press the [MEASURE MENU] key to switch the display to setting mode. Change pages with the [UP] and [DOWN] keys and call the «FRQ, SCALING, D/A OUT» item on the 4th (M4) page.
- Move the cursor to the "SCALING" position with the [▲] and [▼] keys, then adjust the digits with the [UP] and [DOWN] keys.
- CT and PT ratios can be set freely within 0.01 to 10000, and the SC coefficient within 0.0001 to 10000, using the [UP], [DOWN], [◄] and [►] keys.
- Press the [MEASURE MENU] key again to return to the measurement mode. From that point, numbers will be displayed multiplied by their respective coefficients.

- When the PT and CT ratios and the SC coefficient are set to values other than 1, the "SC" indication is shown to the right of the measurement display.
- When the PT and CT ratios are set, voltage and current, as well as all other data calculated from them (W, var, VA) are multiplied by their respective coefficients for display.
- Parameters multiplied by the SC coefficient (when set) are: W (Wos), VA, var, Wh (Wosh) and VAh.



Example: Setting the SC coefficient to 0.0001

0 0 1 . 0 0 ··· Default SC coefficient

⇩ ◄ · ►

0 0 1 . 0 0 ··· Move the cursor.

⇩ DOWN

0 1 0 0 0 ··· Move the decimal point.

⇩ ►

0 . 0 0 0 ··· Move the cursor.

⇩ DOWN

0 . 0 0 0

⇩ ► Press three times.

0 . 0 0 0 ··· Move the cursor.

⇩ UP

0 . 0 0 0

* This coefficient can be set to "0", but in that case a value of 1 will be used for internal processing. The setting procedure is the same for the PT and CT ratios. ("SC" is not displayed on the screen at this time.)

* The decimal point can be displayed by pressing the DOWN key when the digit at the cursor position is "0". Once a position is used for the decimal point, no digits can be displayed on that position by pressing the UP key unless the decimal point is moved elsewhere. When the decimal point is moved, a "0" is displayed in its previous position. The decimal point can be displayed at one of the three lower positions for PT and CT ratios, and at one of the five lower positions for the SC coefficient.

* When performing integration after the PT or CT ratios, or the SC coefficient has been changed, be sure to clear data with the DATA RESET key.

* In case scaled data exceed the display limit (9999.M) due to PT/CT ratio and SC coefficient settings, the "8.␣␣␣" (scaling overflow) indication will be displayed.

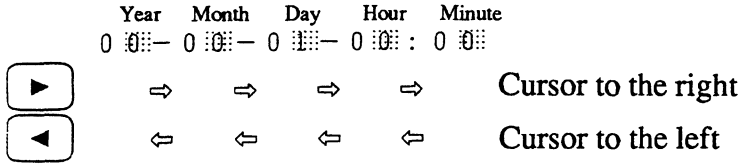
5-2 Special Functions

5-2-1 Totalization Processing

- This function repeatedly integrates measured values within any desired period, and from the obtained data calculates total integrated amount, total average within a specified period, maximum average within a specified period, and load factor.

✪ Menu Setting

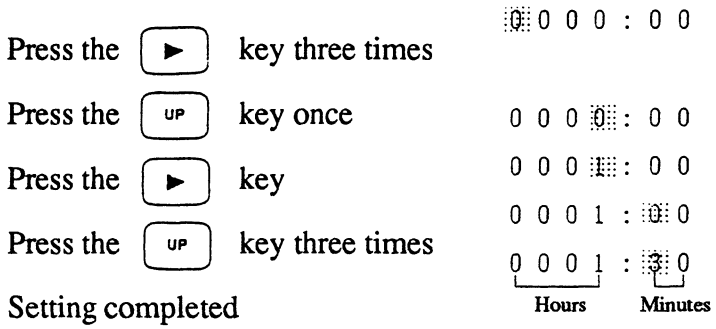
- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the M3-1 «INTEG/TOTAL/RECORD» item.
- Move the cursor to the "MODE" position with the [▼] key, then select "2" (TOTAL) with the [UP] and [DOWN] keys.
- Move the cursor to the "START MODE" position with the [▼] key, then select AUTO or MANUAL with the [UP] and [DOWN] keys.
- If you selected "AUTO", move the cursor to "AUTO START TIME" with the [▼] key and set the start time. Use the [◄] and [►] keys to move the cursor to the year, month, day, hour and minute positions.



Move the cursor to the desired position, then adjust the digit with the [UP] and [DOWN] keys.

- Move the cursor to the "MEASURE TIME (TIMER)" position to set the integration time. Move the cursor with the [◄] and [►] keys, and use the [UP] and [DOWN] keys to adjust the digits.

Example: Setting the integration time to 1 hour 30 minutes.



* "MEASURE TIME" can be set to "0000:00" on the menu, but it is taken as 1 minute for internal processing.

* The setting range is from 1 minute to 1000 hours. During the totalization processing, this integration within a specified period is repeated for the set number of times.

- Use the [▲] key to move the cursor to M3-1, then press the [UP] or [DOWN] key to proceed to the M3-2 «TOTAL» menu.
- Move the cursor to "REPEAT" with the [▼] key to set the number of repeats. Use the [◄] and [►] keys to move the cursor, and the [UP] and [DOWN] keys to adjust the digits.

Example: Setting to 24 repeats

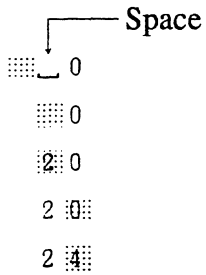
Press the [►] key once.

Press the [UP] key twice.

Press the [►] key once.

Press the [UP] key four times.

Setting completed

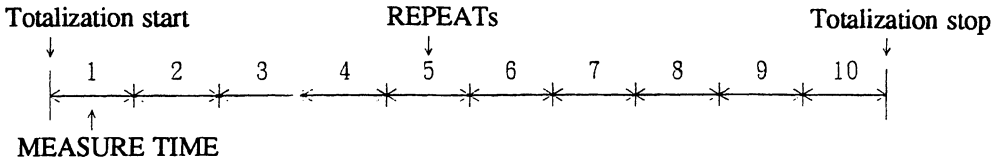


* The setting range is within 1 to 100 repeats. Figures are taken up and down automatically.

- Move to "INTEG SELECT" with the [▼] key, then use the [UP] and [DOWN] keys to select the parameter to be integrated. *A can be integrated in the 3P3W-3 and 3P4W modes. In all other modes, a 0 (zero) is obtained. Wos can be integrated when offset is turned on. When it is off, a 0 (zero) is obtained.
- Move to "TOTAL GRAPH SELECT" with the [▼] key and select the parameters to be totalized. Up to two parameters can be selected; when printing only one, set the other one to "NOSEL" (6). If graph printout is not required, set both to "NOSEL". Move the cursor with the [◄] and [►] keys, and make your settings with the [UP] and [DOWN] keys.
  The printed totalization graph contains the averages within the specified period for the selected parameters.
- Press the [MEASURE MENU] key again to return to the measurement mode. This completes the setting procedure.

✪ On the Totalization Processing Operation

- Totalization is started by pressing the [START STOP] key on the control panel. If "START MODE" has been set to 1 (AUTO) in the M3-1 menu of the setting mode, the RUN indicator will flash on and off and the unit will stand by until the "AUTO START TIME". When the set time is reached, the RUN indicator will remain lit and totalization will be started.
  In case "START MODE" is set to 2 (MANUAL), totalization will start immediately when the [START STOP] key is pressed (the RUN indicator lights).
- When totalization starts, former integration and instantaneous maximum/minimum values are cleared and measurement is started anew.
- One measurement is performed within the period set as "MEASURE TIME", and it is repeated for the number of times specified by "REPEAT". Each time a measurement operation is finished, the integrated and instantaneous maximum/minimum values are cleared before resuming measurement (see the figure below).



- Totalization processing ends automatically after data are read in for the set number of repeats (the RUN indicator goes out). It can also be stopped manually pressing the START STOP key.
- When totalization is finished, totalization times, total integration time, total integrated amount, overall average, maximum average and load factor (LF) are displayed on the 5th page (P5) in the measurement mode.

Totalization times	Totalization start and stop times
Total integration time	Time from the start to the end of totalization
Total integrated amount	Amount integrated during the total integration time
Overall average	Average within the total integration time
Maximum average	Maximum average within the specified time detected during repeat measurement
Load factor (LF)	

* Processing is interrupted for approx. four seconds during power rise and range changes.

⚠ CAUTION

If the clamp sensor range is changed during totalization, measurement is compulsorily terminated.

* When the measurement display is in the data hold condition, data are updated at totalization start and stop times, when the "MEASURE TIME" runs out, and at the time of or interval printing, then frozen again.

* When data (W, VA, INTEG SEL) input to the integrator are beyond their range, an accurate integration is not possible. Integrated values, averages a within a specified period and totalization data are likely to exceed accuracy specifications.

✪ Related Functions

- Printing of totalized values
  If interval printing is turned on, printing starts simultaneously with totalization. When totalization is completed, the printer stops after printing all totalization data (totalization times, total integration time, etc.) (page 86, Interval Printing).

- External totalization control
  Totalization start and stop can be controlled through the external control terminal on the back of the unit (page 66, External Control).

- Power failure processing
  If a power failure occurs during totalization, operation is resumed when power supply is restored. In this case, failure and restoration times will be printed (page 135, Power Failures).

Note

The Load Factor

The load factor was developed as a way of analyzing electric power demand. It expresses load variation over a specified period as a percentage. Depending on the period studied, it is called day load factor, month load factor, year load factor, etc. The load factor is calculated as the proportion of the average power to the maximum power within the specified period.

$$\text{Load factor} = \frac{\text{Average power}}{\text{Maximum power}} \times 100\ [\%]$$

As it should be evident from the above equation, the load factor gives a measure of demand stability. Therefore, larger load factor values indicates higher system efficiency, making this parameter a yardstick of power cost reduction.

On the other hand, a low load factor indicates that there are fluctuations in power demand, requiring a large supply over certain periods. During low-demand periods, installations are unproductive. This results in an extremely low efficiency, and consequently higher power costs.

For this reason, the power load is considered an important parameter, closely related to the calculation of electrical rates.

5-2-2 Comparator Function

- This function compares data measured or obtained by calculation with a set number (threshold level), turns relay output on/off and issues a buzzer warning.
- Comparison is applied to instantaneous values.
- Comparator precision is 1 count.

✪ Menu Setting

- Press the [MEASURE MENU] key to switch the display to setting mode. Change pages with the [UP] and [DOWN] keys and call the 5th (M5) page, «COMPARATOR».
- First, set the parameter. Move the cursor to the "COMPARATOR SELECT" position with the [▲] and [▼] keys, then select one parameter among the 13 available with the [UP] and [DOWN] keys.

* If W offset is set to "ON" in menu No. 7 «etc.», Wos data are compared by the 9 "W" setting.

- Set the threshold level.
  Move the cursor to "SETTING LEVEL", select digits with the [◄] and [►] keys, and adjust them with the [UP] and [DOWN] keys.
  This level can be set to any value within 0.000m to 9999.M, but be sure to include a decimal point.

* The decimal point can be displayed by pressing the [DOWN] key when the digit at the cursor position is "0". Once a position is used for the decimal point, no digits can be displayed on that position by pressing the [UP] key unless the decimal point is moved elsewhere. When the decimal point is moved, a "0" is displayed in its previous position. The decimal point can be displayed at any of the four lower positions.

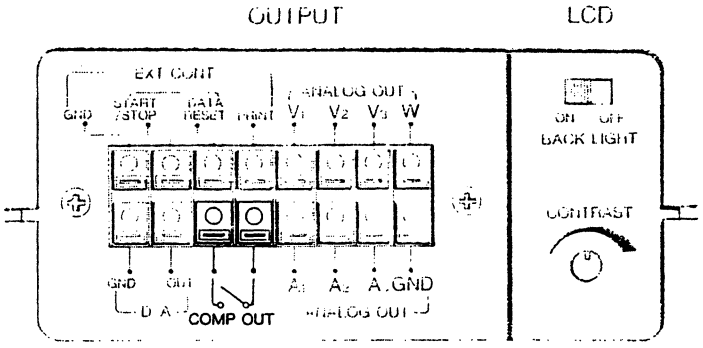
Example: Setting the threshold level to 10.00 m.

```
1 0 0. 0 k   ···  Default value
   ⇩   [◄] · [►]
1 0 0  0 k   ···  Move the cursor.
   ⇩   [DOWN]
1 0 0. 0 0 k ···  Move the decimal point.
   ⇩   [►]        Press three times.
1 0. 0 0 k   ···  Move the cursor.
   ⇩   [DOWN]     Press twice.
1 0. 0 0
```

- Finally, turn the buzzer warning on or off. When on, an intermittent buzzer sounds while the measured value exceeds the threshold level.
- Press the [MEASURE MENU] key again to return to the measurement mode. This completes the setting procedure.

- The "COMP OUT" relay output terminals on the back panel are switched from the brake condition to the make condition when the measured value exceeds the threshold level.
- Since these terminals are not protected against current, do not use them for control of current lines (rating: 30 V, 0.3 A).

Back panel



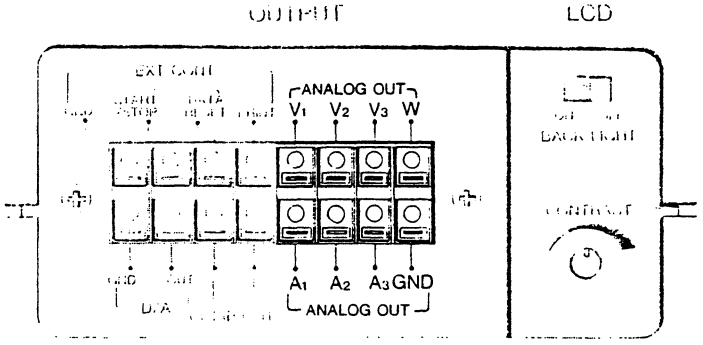
5-2-3 Analog Output

- Voltage (V1 to V3), current (A1 to A3) and active power (W) can be obtained simultaneously as analog outputs.
- Output terminals are on the back panel.
- Output level is equal to DC 2 V/f.s. with regard to each range.
  - A 1-V output is obtained when measuring a 200-V line in the 400-V range.
  - A 0.5-V output is obtained when measuring a 50-A line in the 200-A range.
- The analog terminals are not affected at all by display processing (e.g. HOLD, AVERAGE, etc.).
- Output impedance of these output terminals is 1Ω or less.

⚠ CAUTION

The internal circuit is provided with a simple protection circuit, but be careful not to apply an input by mistake; it may result in unit damage.
Also, take care not to short-circuit the output terminals.

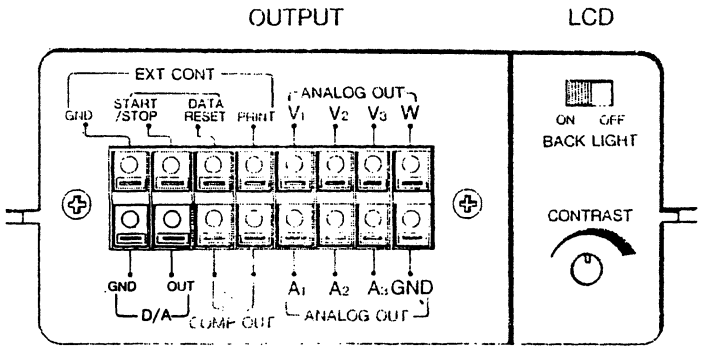
Back panel



5-2-4 D/A Output

- This function supplies an analog output of data calculated by digital processing.
- One of the following data can be selected for output: apparent power (VA), reactive power (var), power factor (PF), average voltage (*V), average current (*A), active power (w/offset) (Wos), and frequency (FRQ).
- Output rate is DC 2 V/f.s. Negative output is not possible (when Wos is negative, a 0-V output is obtained).
- Like for displayed values, D/A output is possible up to 125% of the range for VA, var and Wos, up to 150% for *V and *A, 100% for PF, and 99.9% for FRQ. However, if a display overflow occurs (the "9.___" indication is displayed) output will be approx. DC 3.2 V.

Back panel



✪ Menu Setting

- Press the [MEASURE MENU] key to switch the display to setting mode. Change pages with the [UP] and [DOWN] keys and call the 4th (P4) page, «FRQ, SCALING, D/A OUT».
- Move the cursor to the "D/A OUT" position with the [▲] and [▼] keys, then select one parameter with the [UP] and [DOWN] keys.
- Press the [MEASURE MENU] key again to return to the measurement mode. This completes the setting procedure.

* Values present immediately before entering the setting mode are retained and output even after the setting mode is entered. Therefore, the output does not change until you return to the measurement mode, even if the setting mode is changed.

- The D/A output is not affected by the data hold function.
- The D/A OUT terminals are on the back panel, on the lower left of the output terminal board.
- The output impedance of these terminals is approx. 50 Ω.
- D/A OUT settings can be checked through the help printout function (page 77, Help Printout).

⚠ CAUTION

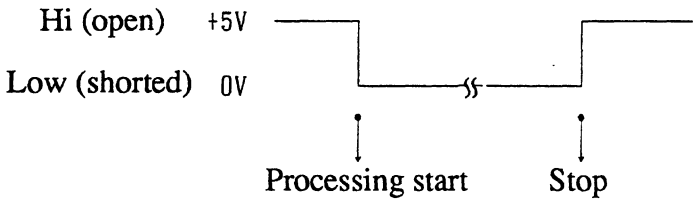
The internal circuit is provided with a simple protection circuit, but be careful not to apply an input by mistake; it may result in unit damage.
Also, take care not to short-circuit the output terminals.

5-2-5 External Control

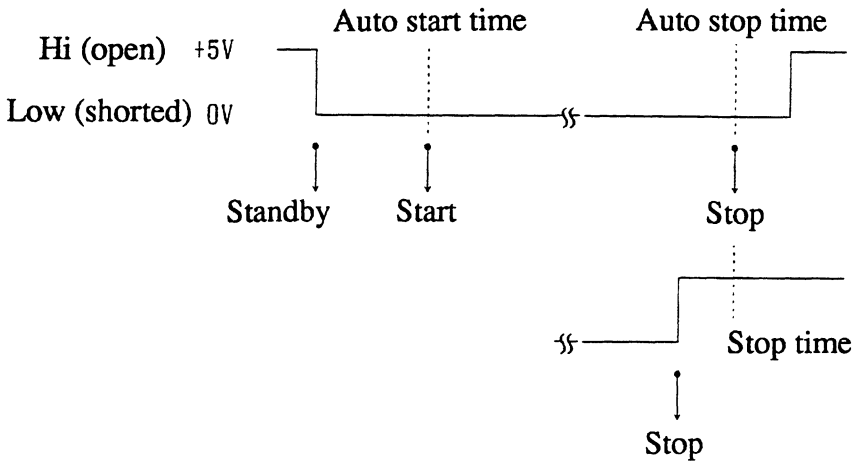
- The integrator and printing functions of this unit can be externally controlled.
- Control signal input terminals are provided on the back panel. They are all controlled by active low.
- Since each control terminal is equipped with a filter to suppress chattering, apply the control signal continuously for at least 500 ms.
- External control is not possible in the key lock status (when ON is lit).

◎ EXT INTEG START/STOP Terminal

- This terminal is equivalent to the START STOP key on the control panel. It is used to start and stop integration, totalization and plotting operations.
- In case processing start and stop are set to manual, the unit will operate as follows.



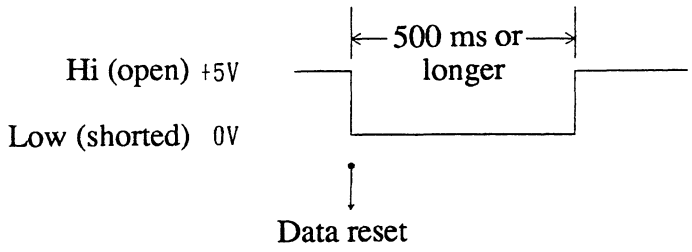
- If start and stop are set to automatic, the unit will enter the processing standby mode when a low level is input, then start at the set time. If the signal returns to high level before the set time is reached, the standby mode is cancelled. When a high level is received during operation, processing will stop as if the START STOP key had been pressed, even if it is before the auto stop time.



- Control signals are not accepted during printer operation.

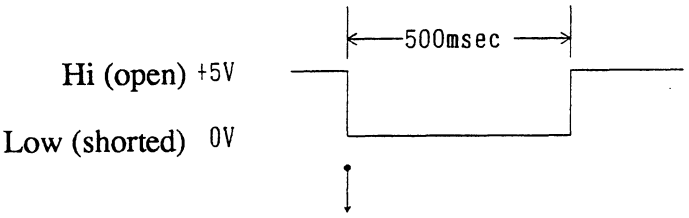
❂ EXT DATA RESET Terminal

- This terminal is equivalent to the DATA RESET key. It is used to clear integrated data and instantaneous maximum/minimum values.
- The clear function is activated by one pulse of at least 500 ms, but inputs are ignored during integration processing, just like for key operation.

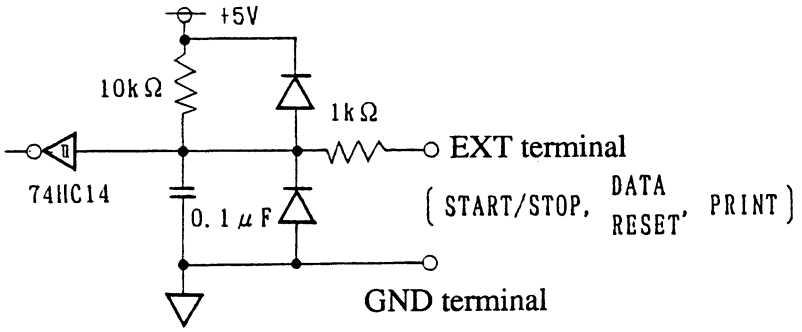


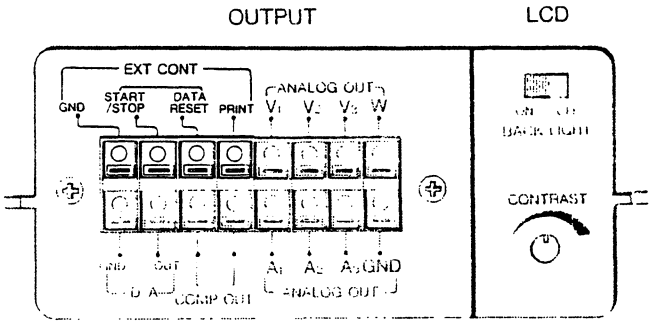
EXT PRINT Terminal

- This terminal is equivalent to the MANUAL key on the control panel. It is used to start manual printout from an external device.
- As for key operation, control signals are not accepted during integration processing when interval printing is set to "ON".



The external control input circuit has the following configuration.





5-3 Other Functions

5-3-1 Real Time

- This unit is provided with a clock function to permit real-time control of integration, totalization and plotting operations, and printout of maximum/minimum value detection times.
- In the measurement mode, the real time is displayed only on the integration display (P4).

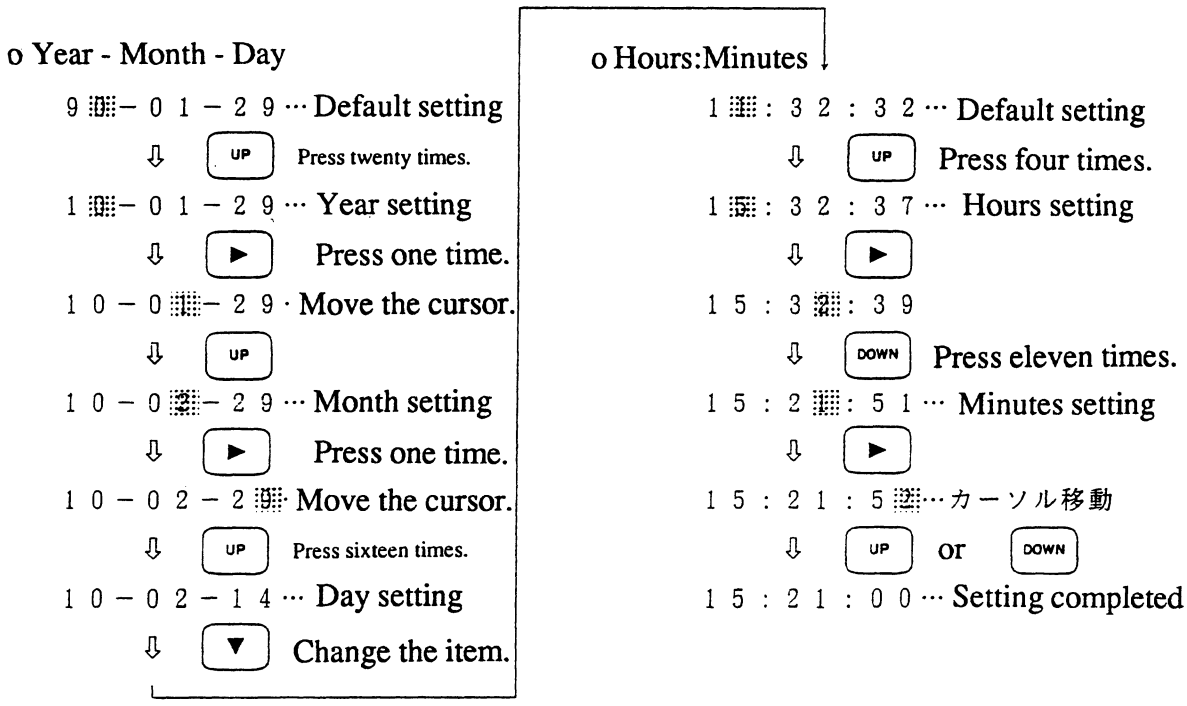
✪ Real-time Setting

- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the 6th (M6) page, «REAL TIME».
- Each item has an upper setting limit. Use the [◄] and [►] keys to select items, and adjust them in sequence.
- First, enter the year, the month and the day.
  For the year, enter the two last digits. Setting range is 1990 to 2089.
  Thanks to the calendar function, the month and day can only be set to existing dates.
- Use the [▲] and [▼] keys to move the cursor, then enter the hours and minutes.

* Time is entered and displayed in the 24-hour system.

- Set the day of the week and the seconds. This completes the setting procedure.
- To set the seconds, move the cursor to the seconds position and press the [UP] or [DOWN] key to reset the reading to "00". When doing so, any existing seconds will be discarded.

Example: Setting to February 14, 2010, 3 hours 21 minutes p.m.



5-3-2 Beeper On/Off

Use the following procedure to turn the key entry and input overload warning beeps on/off.

◎ Menu Setting

- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the 7th (M7) page, «etc.».
- Move the cursor to the "BUZZER KEY" or "INPUT OVER" position with the [▲] and [▼] keys, then select "2" to turn the buzzer off.
- Press the [MEASURE MENU] key again to return to the measurement mode. This completes the setting procedure.

5-3-3 System Reset

This procedure initializes the unit by resetting all menu settings and data, except the real time.

◎ Reset Procedure

- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the 7th (M7) page, «etc.».
- Move the cursor to the "SYSTEM RESET" position with the [▲] and [▼] keys.
- With the cursor blinking on the "*" mark, press the [UP] or [DOWN] key to reset all settings and data. Then the unit will return to the measurement mode.
- If executed during printer operation, printing will be stopped compulsorily.

◎ Default Settings of All Menus

Default settings of items set with the soft keys are as follows.

( ) ... When a 20-A sensor is used

- Measurement mode 3P3W-3
- Voltage range 400 Vrms
- Current range 200 Arms (20 A)
- Frequency measurement mode A
- Data hold OFF

Default Settings of the Setting Displays

0. Setting menu

```
M0        << SETTING MENU >>

  0:SETTING MENU          6:REAL TIME
  1:WIDE DISPLAY          7:etc.
  2:PRINTER               8:RS-232C
  3:INTEG/TOTAL/RECORD
  4:FRQ,SCALING,D/A OUT
  5:COMPARATOR
```

1. Wide display selection

```
M1-1      << WIDE DISPLAY >>
  REAL VALUE SELECT (P1)
    1:U1 2:U2 3:U3 4:*U 5:A1 6:A2 7:A3
    8:*A 9:W 10:VA 11:var 12:PF 13:FRQ
                                1, 2, 3, 4
  MAX VALUE SELECT (P2)
    1:U1 2:U2 3:U3 4:A1 5:A2 6:A3 7:W
    8:VA 9:var 10:PF 11:FRQ   1, 2, 3, 4
```

→

```
M1-2      << WIDE DISPLAY >>
  MIN VALUE SELECT (P3)
    1:U1 2:U2 3:U3 4:PF 5:FRQ      1,2,3,4
  INTEG VALUE SELECT (P4)
    1:Wh 2:VAh 3:etc.                  1,2
  AVERAGE VALUE SELECT (P5)
    1:W 2:VA 3:var 4:PF 5:INTEG SEL
                                     1,2,3,4
```

2. Printer

```
M2        << PRINTER >>
  PRINT SEL    REAL VALUE      1:ON 2:OFF 1
               MAX VALUE       1:ON 2:OFF 1
               MIN VALUE       1:ON 2:OFF 1
               INTEG&AVERAGE   1:ON 2:OFF 1
  INTERVAL PRINT               1:ON 2:OFF 1
  INTERVAL TIME                     0000:30
```

3. Integration/Totalization/Plotting

```
M3-1      << INTEG/TOTAL/RECORD >>

  MODE          1:INTEG 2:TOTAL 3:RECORD  1
  START MODE              1:AUTO  2:MANUAL  2

  AUTO START TIME              00-01-01 00:00
  MEASURE TIME (TIMER)               0000:30
```

→

```
M3-2      << INTEG >>
  STOP MODE              1:TIMER 2:MANUAL  1

  INTEG SELECT
     1:A1 2:A2 3:A3 4:*A 5:Wos              1
```

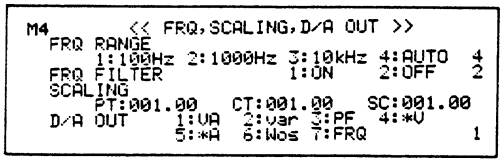
↓

```
M3-2      << TOTAL >>

  REPEAT                                   48
  INTEG SELECT
     1:A1 2:A2 3:A3 4:*A 5:Wos             1
  TOTAL GRAPH SELECT
     1:W 2:VA 3:var 4:PF 5:INTEG SEL
     6:NOSEL                            1,2
```

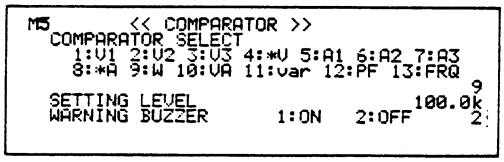
↘

```
M3-2      << RECORD >>
  STOP MODE              1:TIMER 2:MANUAL  1
  RECORD SELECT
        1:U1 2:U2 3:U3 4:*U 5:A1 6:A2
        7:A3 8:*A 9:W 10:VA 11:var
        12:PF 13:FRQ 14:NOSEL       1, 2,
  CHART SPEED (MINUTES/DIV)
        1:1/3 2:1 3:5 4:10 5:30 6:60  1
```

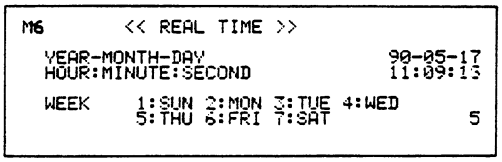
4. Frequency, scaling, D/A output



5. Comparator

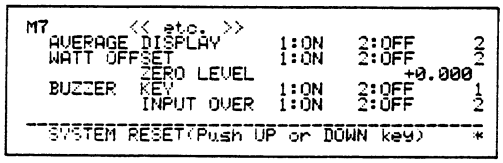


6. Real time

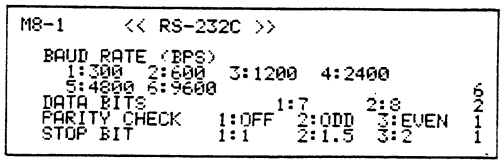


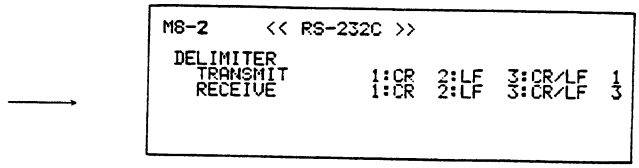
* The real time is not reset. The clock keeps running since the product is delivered from the factory.

7. Others



8. RS-232C





5-3-4 Battery Backup

- This unit is equipped with a built-in battery to back up all menu settings, integrated data and instantaneous maximum/minimum values in case of power failure. Therefore, when power is turned on the unit is set just as it was before turning power off.
- This function also keeps integrated values, so if adding integration is not desired data must be cleared pressing the [DATA RESET] key.
- Data are also protected in case a power failure occurs during interval printing. When power supply is restored, failure and restoration times are printed, then data printout will restart from the beginning (page 135). Backup is not performed for manual and help printing.

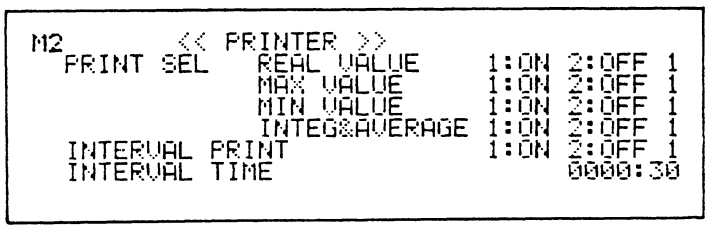
Chapter 6

THE PRINTER

6-1 Specifications

Printing method	Thermal, serial dot
No. of characters	32 chars./line
Character size	7 × 5 dot, 2.4 × 1.2 mm
Printing width	66.6 mm
Paper feed pitch	2.8 mm
Printing speed	Appro. 0.6 line/s
Service life	Approx. 500.000 lines (with head replacements)
Paper	9223 black printing thermal paper Size: 80 mm × 30 m rolls Core inner dia.: 12 mm Max. core dia.: 53 mm Red strap on last 3 m of paper
Functions	Help printout Manual printing Integration printing Totalization printing Plotting Printing by real-time control Time interval printing Printing controlled by external signal Printing stop and warning indication upon detecting a paper empty or paper jam condition Printing of power failure and restoration times
Control keys	STOP/CONTinue key MANUAL printing key HELP printout key 1-line paper FEED key
Indicators	RUN indicator: Lights during interval printing ERROR indicator: Indicates paper empty, paper jam and trouble conditions.

6-2 Setting

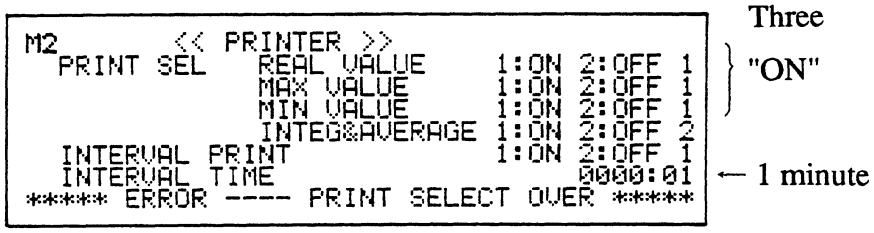


- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the 2nd (M2) page, «PRINTER».
- Select parameters to be printed.
  Printing of the following four parameters can be turned on/off.
  ① REAL VALUE (instantaneous values)
  ② MAX VALUE (maximum instantaneous values)
  ③ MIN VALUE (minimum instantaneous values)
  ④ INTEG & AVERAGE (Integration elapsed time, integrate amount, average within a specified period)
- Move the cursor to "PRINT SEL REAL VALUE" with the [▼] key, and turn printing on or off with the [UP] and [DOWN] keys.
- Move the cursor to "MAX VALUE" with the [▼] key, and turn printing on or off with the [UP] and [DOWN] keys.
- Move the cursor to "MIN VALUE" with the [▼] key, and turn printing on or off with the [UP] and [DOWN] keys.
- Move the cursor to "INTEG & AVERAGE" with the [▼] key, and turn printing on or off with the [UP] and [DOWN] keys.
- Interval printing setting
  Move the cursor to "INTERVAL PRINT" with the [▼] key, and make your selection with the [UP] and [DOWN] keys. When set to "ON", interval printing is used for integration and totalization. When "OFF", interval printing is not performed.
- Interval time setting
  Move the cursor to "INTERVAL PRINT" with the [▼] key, and adjust the interval time between 1 minute and 1000 hours.
  Move the cursor with the [◄] and [►] keys, and adjust digits with the [UP] and [DOWN] keys.

Example: Setting the interval time to 1 hour 30 minutes.

Press the [►] key three times.	0000:00
Press the [UP] key once.	0000:00
Press the [►] key once.	0001:00
Press the [UP] key three times.	0001:00
Setting completed	0001:30

* Though "INTERVAL TIME" can be set to "0000:00" on the display, a value of 1 will be used for internal processing.
* If more than three parameters are selected for printing with interval printing on, the ERROR----PRINT SELECT OVER message appears on the bottom line of the display. In this case, return to "PRINT SEL" are redo your setting, or change the "INTERVAL TIME" setting. Other menus cannot be displayed while this message is shown.



Error Message

6-3 Help Printout

Prints out the unit settings.
This can be started from either the setting and measurement display by pressing the HELP key, except when the printer RUN indicator is lit or blinking.

In the integration mode, the help printout will look like this.

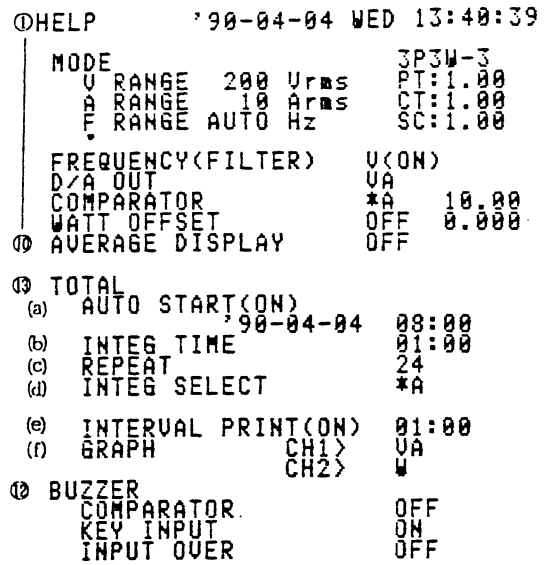
Printing Sample 1

```
①HELP       '90-04-04 WED 13:42:09

② MODE                        3P3W-3
③   V RANGE   200 Vrms        PT:1.00
④   A RANGE    10 Arms        CT:1.00
⑤   F RANGE AUTO Hz           SC:1.00

⑥ FREQUENCY(FILTER)    V(ON)
⑦ D/A OUT              VA
⑧ COMPARATOR           *A     10.00
⑨ WATT OFFSET          OFF    0.000
⑩ AVERAGE DISPLAY      OFF

⑪ INTEGRATOR
  (a) AUTO START(ON)
                  '90-04-04   08:00
  (b) TIMER(ON)               24:00
  (c) SELECT                  *A

  (d) INTERVAL PRINT(ON)      01:00

⑫ BUZZER
  (a) COMPARATOR              OFF
  (b) KEY INPUT               ON
  (c) INPUT OVER              OFF
```

① Printed data and respective dates and times (year-month-day, day of the week, hours:minutes:seconds)
② Connection mode
③ Voltage range, rectification method, PT ratio
④ Current range, rectification method, CT ratio
⑤ Frequency ranges and the SC coefficient
⑥ Frequency detection mode and filter on/off
⑦ D/A output parameters
⑧ Compared parameter and threshold level
⑨ Power offset on/off and offset value
⑩ Display averaging on/off.
⑪ Integration mode
  a. Auto start on/off and set time
  b. Timer on/off and integration time
  c. Selected integrated parameters, except active power and apparent power
  d. Interval printing on/off and set time
⑫ Buzzer
  a. Buzzer on/off during comparator operation
  b. Buzzer on/off when making key entries.
  c. Buzzer on/off when there is an input overload.

In the totalization mode, the printout will look as follows.

Printing Sample 2



Items ① to ⑩ and ⑫ are the same as in the integration mode.

⑬ Totalization mode

a. Auto start on/off and set time

b. Integration time

c. Number of integration repeats

d. Selected integrated parameters, except active power and apparent power

e. Interval printing on/off and set time

f. Item selected at the totalization graph, channels 1 and 2

In the plotting mode, the following printout is obtained.

Printing Sample 3

```
① HELP        '90-04-04 WED 13:44:36
   MODE                        3P3W-3
     V RANGE   200 Vrms        PT:1.00
     A RANGE    10 Arms        CT:1.00
     F RANGE AUTO Hz           SC:1.00

   FREQUENCY(FILTER)    V(ON)
   D/A OUT              VA
   COMPARATOR           *A     10.00
   WATT OFFSET          OFF    0.000
⑩  AVERAGE DISPLAY      OFF

⑭  RECORD
(a)  AUTO START(ON)
                '90-04-04    08:00
(b)  TIMER(ON)               24:00
(c)  CHART SPEED             10min/div
(d)  SELECT          CH1)    *A
                     CH2)    PF
⑫  BUZZER
     COMPARATOR              OFF
     KEY INPUT               ON
     INPUT OVER              OFF
```

Items ① to ⑩ and ⑫ are the same as in the integration mode.

⑭ Plotting mode

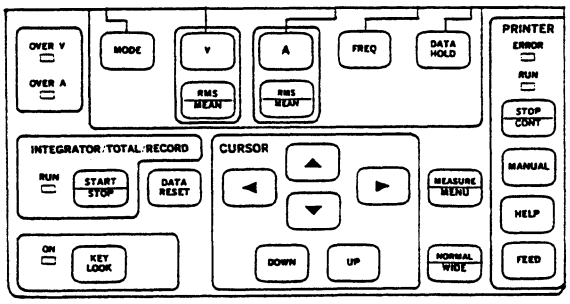
a. Auto start on/off and set time

b. Timer on/off and set time

c. Paper feed speed

d. Parameters selected for channels 1 and 2

- Key Operation



Key / Condition	HELP	MANUAL	START/STOP	STOP/CONT
Help printing	Inoperative	Inoperative	Inoperative	Prints the current line, then stops.

Fig. 6-1

6-4 Manual Printing

Prints the instantaneous values at the time the [MANUAL] key is pressed. Operation of this key is only accepted when the display is in measurement mode. No printing is performed if the printer RUN indicator is lit or blinking, and during printer operation.

Parameters to be printed should be selected at the M2 «PRINTER» setting menu "PRINT SEL" item (the manual printing function can be used regardless of the "INTERVAL PRINT" setting).

```
M2          << PRINTER >>
  PRINT SEL    REAL VALUE      1:ON 2:OFF 1
               MAX VALUE       1:ON 2:OFF 1
               MIN VALUE       1:ON 2:OFF 1
               INTEG&AVERAGE   1:ON 2:OFF 1
  INTERVAL PRINT               1:ON 2:OFF 1
  INTERVAL TIME                     0000:30
```

Manual printing gives a printout as shown below.

Printing Sample 4

```
①——MANUAL      '90-04-04 WED 13:12:03
  (a) U1:210.7   A1: 1.91   W   : 0.683k
      U2:208.4   A2: 2.15   VA  : 0.798k
      U3:210.6   A3: 2.52   var: 0.413k
      *U:209.9   *A: 2.19   PF  : 0.856
                 F/V: 60.0 Hz

      MAX.VALUE
          U1 :  214.8      04-04 12:01:36
          U2 :  212.4      04-04 12:01:35
          U3 :  214.8      04-04 12:01:35
          A1 :   8.58      04-04 12:26:01
          A2 :   9.87      04-04 12:26:02
  (b)     A3 :   2.54      04-04 12:13:17
          W  : 2.359k      04-04 12:01:18
          VA : 2.541k      04-04 12:01:23
  ②       var: 1.661k      04-04 12:01:24
          PF :  1.000      04-04 11:52:36
          F/V:  60.1 Hz    04-04 12:38:41

      MIN.VALUE
          U1 :  205.0      04-04 12:48:31
          U2 :  202.9      04-04 12:48:30
  (c)     U3 :  205.0      04-04 12:48:30
          PF :  0.588      04-04 12:31:14
          F/V:   59.9 Hz   04-04 12:46:14

  (d)—ELAPSED TIME    INTEG.VALUE
                00:05  Wh  : 132329.■
                   (e) VAh : 150806.■
                       *Ah :  417.18■

  (f)—AVERAGE VALUE
          W  : 1.587k     PF : 0.877
          VA : 1.809k     *A : 5.006
          var: 867.3
```

① Printout description, date and time (year-month-day day of the week hours:minutes:seconds)

② Parameters selected at "PRINT SEL" on the M2 «PRINTER» setting menu

a. Instantaneous values (* indicates average, and F/V shows that frequency detection is performed in the voltage mode)

b. Instantaneous maximum values and corresponding dates and times (month-day hours:minutes:seconds)

c. Instantaneous minimum values and corresponding dates and times (month-day hours:minutes:seconds)

d. Integration elapsed time (hours:minutes)

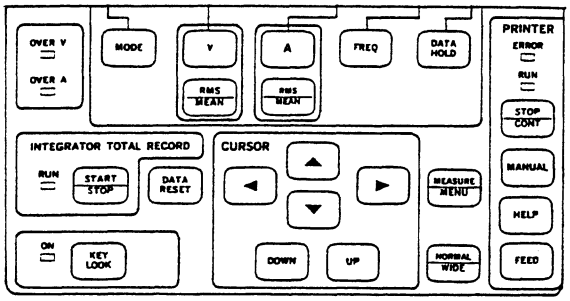
e. Integrated values

f. Average values within a specified period

* When Data Hold is Used

If you pressed the [DATA HOLD] key to freeze data on the display, that data will be displayed.

- Key Operation



Key / Condition	HELP [HELP]	MANUAL [MANUAL]	START/STOP [START STOP]	STOP/CONT [STOP CONT]
Manual printing	Inoperative	Inoperative	Inoperative	Prints the current line, then stops.

Fig. 6-2

6-5 Interval Printing

During operation in the integration or totalization mode, measurement data can be printed at interval of any desired length. Interval printing starts simultaneously with integration or totalization if the "INTERVAL PRINT" item on the M2 «PRINTER» setting menu is turned "ON". After that, printing is repeated at intervals of the length set at "INTERVAL TIME", and stops together with integration or totalization.

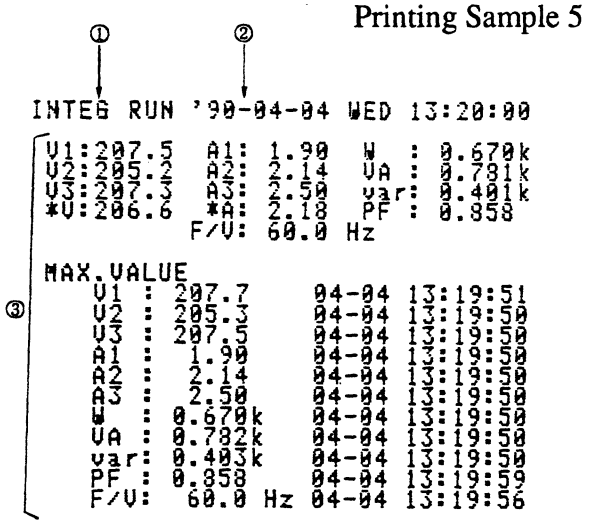
For setting details, refer to page 75.

```
M2          << PRINTER >>
  PRINT SEL    REAL VALUE      1:ON 2:OFF 1
               MAX VALUE       1:ON 2:OFF 1
               MIN VALUE       1:ON 2:OFF 1
               INTEG&AVERAGE   1:ON 2:OFF 1
  INTERVAL PRINT               1:ON 2:OFF 1
  INTERVAL TIME                     0000:30
```

6-5-1 Interval Printing in the Integration Mode

1) Press the START STOP key with the unit in the integration mode (see page 51), and interval printing will start, as shown by the RUN indicator, simultaneously with integration (the LED will light). The following printout will be obtained.

Printing Sample 5



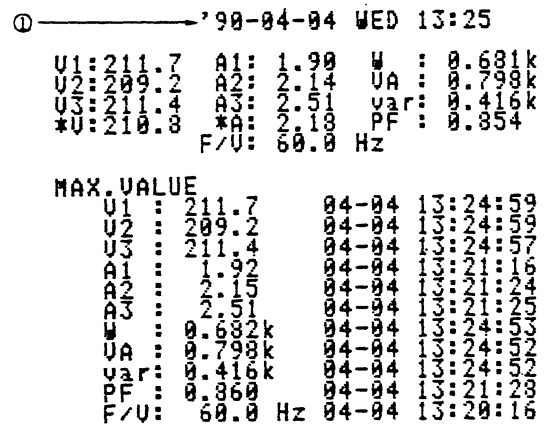
① Integration start message

② Integration start date and time (year-month-day day of the week hours:minutes:seconds)

③ Parameters selected at "PRINT SEL" on the M2 «PRINTER» setting menu.

2) When the unit reaches the interval time, a printout as shown below is obtained.

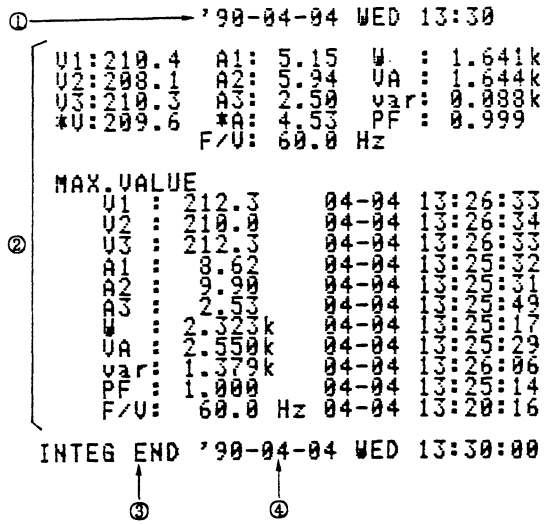
Printing Sample 6



① Printout date and time (year-month-day day of the week hours:minutes)
Interval printing is repeated until integration is completed.

3) When integration is finished (the LED goes out), the printer RUN indicator goes out and the last data are printed as shown below.

Printing Sample 7



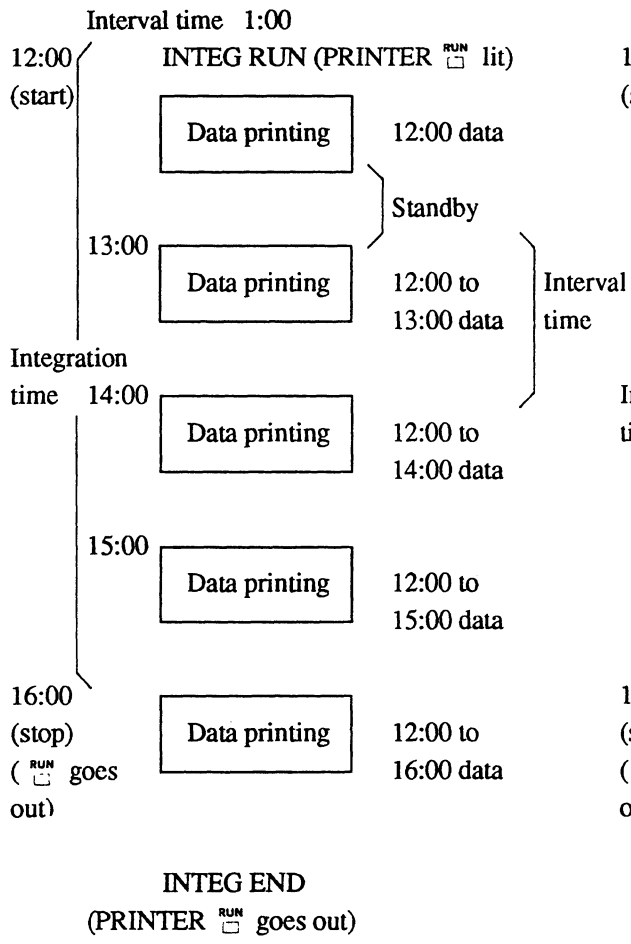
① Printout date and time (year-month-day day of the week hours:minutes)
② Last measurement data
③ Integration end message
④ Integration stop date and time (year-month-day day of the week hours:minutes:seconds)

* During integration standby (RUN indicator blinking), the setting menu cannot be accessed by pressing the [MEASURE MENU] key. To change any settings, leave the standby condition.
  During interval operation the [MANUAL] , [HELP] and [FEED] keys are inoperative.
* The [START STOP] key is inoperative during printer operation.
* When Data Hold is Used
  If you pressed the [DATA HOLD] key before starting integration (before the LED lights up), new data will be held and printed when it is started.
  Held values are updated for printing once each interval while the RUN indicator is lit.

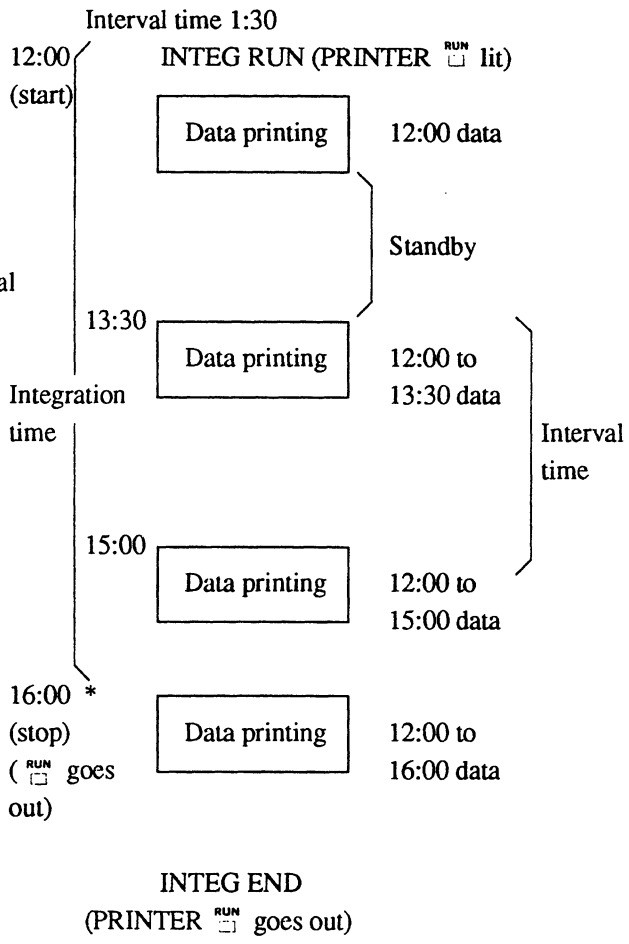
4) The relation between integration and interval times
Printing intervals may differ according to integration and interval time settings. An example is shown below.

Integration start 12:00
Integration time 4:00

(1) If the integration time is divisible by the interval time



(2) If the integration time is not divisible by the interval time

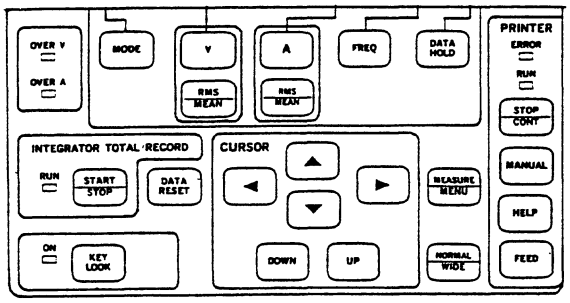


* In case (1), since the integration time is divisible by the interval time, printing intervals are all the same. In case (2), integration ends before the interval time is reached, so the last printing interval gets shorter.

5) To stop interval printing
Press the [STOP CONT] key. For details on the operation of this key, see Table 6-3.

6) Operation of printer-related keys
Table 6-3 shows how key entries are processed during the interval operation.

- Key Operation



Key / Condition	HELP [HELP]	MANUAL [MANUAL]	START/STOP [START STOP]	STOP/CONT [STOP CONT]	STOP/CONT [STOP CONT] *1
Standby	Inoperative	Inoperative	Prints data read in until the key was pressed, then "END".	Printing is not possible even when the printing time has been reached. *2	Prints when the printing time is reached.
Manual printing	Inoperative	Inoperative	Inoperative	Prints the current line, then stops. Printing is not possible even when the printing time has been reached. *2	Prints when the printing time is reached.

Fig. 6-3

*1 When printing has been stopped with the [STOP CONT] key.
*2 The [MANUAL], [HELP] and [FEED] keys are operative.

6-5-2 Interval Printing in the Totalization Mode

1) Press the [START/STOP] key with the unit in the totalization mode (see page 59), and interval printing will start, as shown by the RUN indicator, simultaneously with totalization (the LED will light). The following printout will be obtained.

Printing Sample 8

```
          ①          ②
TOTAL RUN '90-04-04 WED 14:05:00
 V1:210.0  A1: 6.57  W  : 1.901k
 V2:207.8  A2: 7.36  VA : 1.984k
 V3:210.0  A3: 2.50  var: 0.568k
 *V:209.3  *A: 5.48  PF : 0.958
          F/V: 60.0 Hz
③ ELAPSED TIME     INTEG.VALUE
          00:00     Wh  :      0.m
                    VAh :      0.m
                    *Ah :   0.00m
 AVERAGE VALUE
    W  :   0.0      PF : 0.
    VA :   0.0      *A : 0.000
    var:   0.0
```

① Totalization start message
② Totalization start date and time (year-month-day day of the week hours:minutes:seconds)
③ Parameters selected at "PRINT SEL" on the M2 «PRINTER» setting menu.

2) When the unit reaches the interval time, a printout as shown below is obtained.

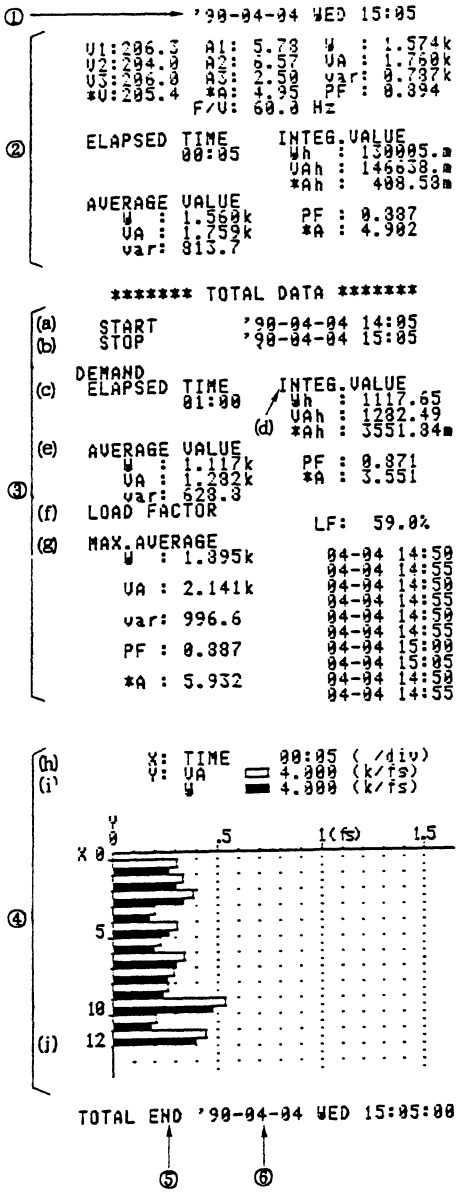
Printing Sample 9

```
①————————→'90-04-04 WED 14:35
 V1:208.7  A1: 1.92  W  : 0.679k
 V2:206.3  A2: 2.15  VA : 0.791k
 V3:208.5  A3: 2.51  var: 0.404k
 *V:207.8  *A: 2.19  PF : 0.859
          F/V: 60.0 Hz
 ELAPSED TIME     INTEG.VALUE
          00:05     Wh  :  63945.m
                    VAh :  75026.m
                    *Ah :  208.26m
 AVERAGE VALUE
    W  : 767.3      PF : 0.852
    VA : 900.3      *A : 2.499
    var: 470.7
```

① Printout date and time (year-month-day day of the week hours:minutes)
Interval printing is repeated until totalization is completed.

3) When totalization is finished (the LED goes out), the printer RUN indicator goes out and the last data are printed as shown below.

Printing Sample 10



① Printout date and time (year-month-day day of the week hours:minutes)

② Last measurement data

③ Totalization data

(a) Totalization start time (year-month-day hours:minutes)

(b) Totalization end time (year-month-day hours:minutes)

(c) Total integration time

(d) Total integrated amounts

(e) Overall average values

(f) Load factor

(g) Maximum average within the integration time, and start/end dates and times (month-day, hours:minutes)

④ Graph

(h) (Integration) time corresponding to one division on the X axis

(i) Data displayed on the Y-axis and scaling

Example: The white bar for the first data indicates approx. 0.3, namely 0.3×4 kVA = 1.2 kVA.

* If f.s. overflows due to scaling, the "8.␣␣␣" indication is printed.

(j) Integration repeats

⑤ Integration end message

⑥ Totalization stop date and time (year-month-day day of the week hours:minutes:seconds)

* During totalization standby (RUN ␣ indicator blinking), the setting menu cannot be accessed by pressing the [MEASURE MENU] key. To change any settings, leave the standby condition. During interval operation the [MANUAL] , [HELP] and [FEED] keys are inoperative.
* The [START STOP] key is inoperative during printer operation.
* When Data Hold is Used

If you pressed the [START STOP] key before starting totalization (before the LED lights up), new data will be held and printed when it is started.

Held values are updated for printing once each interval while the RUN ␣ indicator is lit. When the RUN ␣ indicator is out, they are updated at the interval determined by the "MEASURE TIME" setting. When totalization stops, data hold is momentarily released, and current data are held and printed.

* Other three graph styles are available

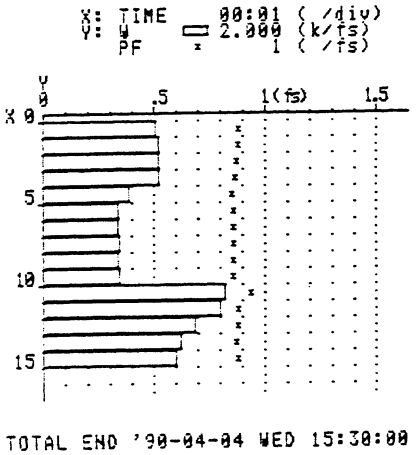
① Two-channel printing including PF (power factor) **Printing Sample 11**

② One-channel printing of a parameter other than PF **Printing Sample 12**

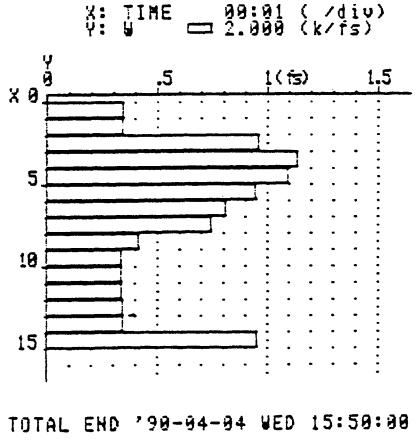
③ One-channel printing of PF **Printing Sample 13**

(With PF graphing, both channels are regarded as one channel.)

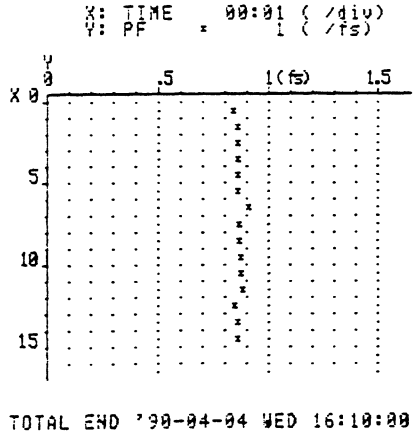
Printing Sample 11



Printing Sample 12



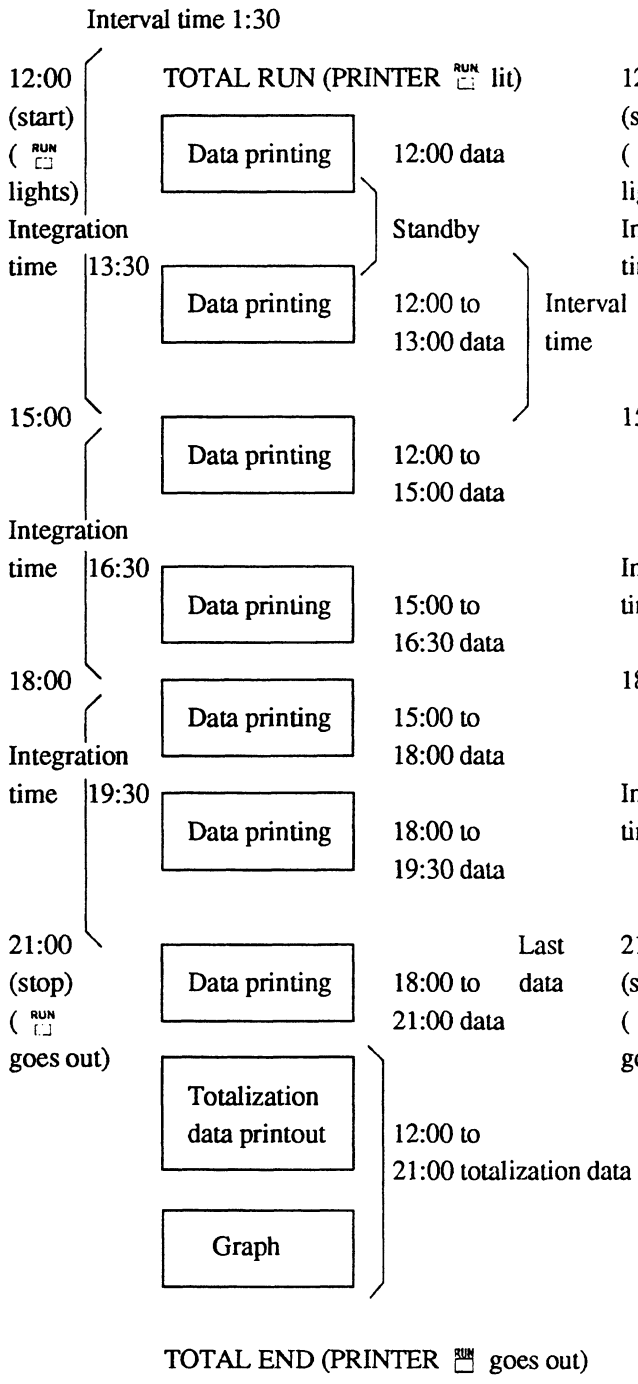
Printing Sample 13



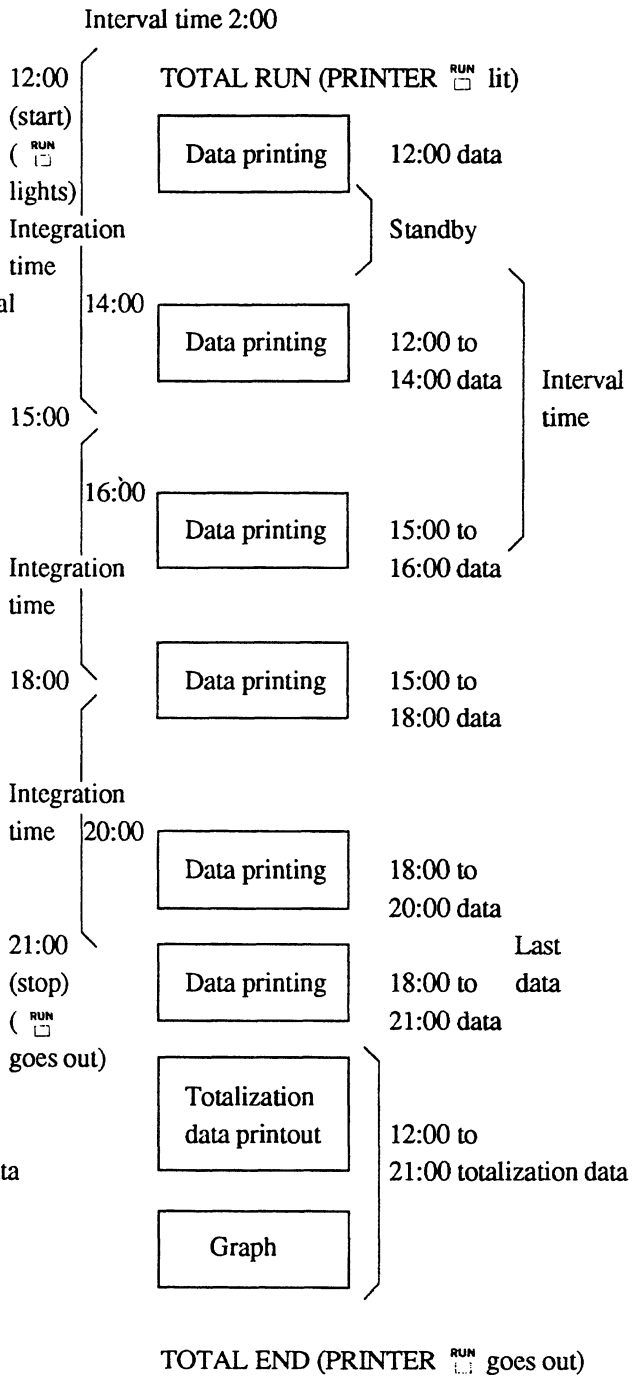
4) The relation between totalization and interval times
Printing intervals may differ according to totalization and interval time settings. An example is shown below.

Totalization start	12:00
Totalization time	3:00
No. of repeats	3

(1) If the integration time is divisible by the interval time



(2) If the intergration time is not divisible by the interval time



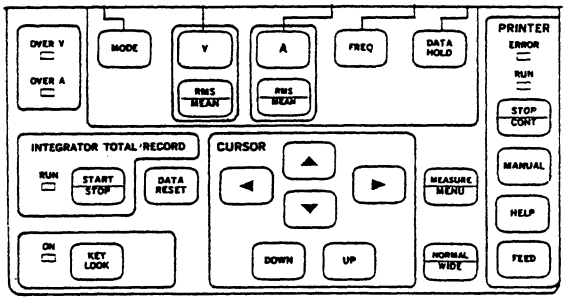
* In case (1), since the integration time is divisible by the interval time, printing intervals are all the same. In case (2), integration ends before the interval time is reached, so the last printing interval gets shorter.

5) To stop interval printing

Press the [STOP CONT] key. For details on the operation of this key, see Table 6-4.

6) Operation of printer-related keys

Table 6-4 shows how key entries are processed during the interval operation.



Key / Condition	HELP [HELP]	MANUAL [MANUAL]	START/STOP [START STOP]	STOP/CONT [STOP CONT]	STOP/CONT [STOP CONT] *1
Standby	Inoperative	Inoperative	Prints data read in until the key was pressed, totalization data, the graph, and then "END".	Printing is not possible even when the printing time has been reached. *2	Prints when the printing time is reached.
Manual printing	Inoperative	Inoperative	Inoperative	Prints the current line, then stops. Printing is not possible even when the printing time has been reached. *2	Prints when the printing time is reached. *3

Fig. 6-4

*1 When printing has been stopped with the [STOP CONT] key.

*2 The [MANUAL], [HELP] and [FEED] keys are operative.

*3 Only in case printing is stopped during printing of the last data (including totalization data and the graph), they are printed again from the beginning (printing is not performed after pressing the [MANUAL] and [HELP] keys in *2 above).

6-6 Plotting

- Instantaneous levels are plotted on up to two channels.

✪ Menu Setting

- Press the [MEASURE MENU] key to switch the display to setting mode.
- Change pages with the [UP] and [DOWN] keys and call the M3-1 page, «INTEG/TOTAL/RECORD».
- Move the cursor to "MODE" with the [▼] key, and select "3" (RECORD) with the [UP] and [DOWN] keys.
- Move the cursor to "START MODE" with the [▼] key, and select "AUTO" or "MANUAL" with the [UP] and [DOWN] keys.
- If you selected "AUTO", move the cursor to "AUTO START TIME" with the [▼] key and set the start time. Use the [◄] and [►] keys to move the cursor to the year, month, day, hour and minute positions.

	Year	Month	Day	Hour	Minute	
	0 0 –	0 1 –	0 1	0 0 :	0 0	
[►]	⇨	⇨	⇨	⇨		Cursor to the right
[◄]	⇦	⇦	⇦	⇦		Cursor to the left

  Move the cursor to the desired position, then adjust the digit with the [UP] and [DOWN] keys.
- Move the cursor to the "MEASURE TIME (TIMER)" position to set the plotting time. Move the cursor with the [◄] and [►] keys, and use the [UP] and [DOWN] keys to adjust the digits.

Example: Setting the plotting time to 1 hour 30 minutes.

Press the [►] key three times	0 0 0 0 : 0 0
Press the [UP] key once	0 0 0 0 : 0 0
Press the [►] key once	0 0 0 1 : 0 0
Press the [UP] key three times	0 0 0 1 : 3 0
Setting completed	0 0 0 1 : 3 0 (Hours / Minutes)

* "MEASURE TIME" can be set to "0000:00" on the menu, but it is taken as 1 minute for internal processing.

- Use the [▲] key to move the cursor to M3-1, then press the [UP] or [DOWN] key to access the M3-2 «RECORD» menu.
- Use the [▼] key to move the cursor to "STOP MODE", then select "TIMER" or "MANUAL" with the [UP] and [DOWN] keys. If "MANUAL" is selected, operation should be stopped manually.

- Move to "RECORD SELECT" with the [▼] key and select the parameters to be plotted. Up to two parameters can be selected; when printing only one, set the other one to "NOSEL" (14).

*** If both parameters are set to NOSEL, a printout like Printing Sample 14 is obtained.**

Printing Sample 14

```
REC RUN    '90-04-04 WED 18:00:00
         CH1.CH2 NO SELECT

REC END    '90-04-04 WED 18:10:00
```

* If W offset is set to "ON" in menu No. 7 «etc.», Wos data are plotted by the 9 "W" setting.

- Move the cursor to "CHART SPEED" with the [▼] key to adjust paper feed speed.
- Press the [MEASURE MENU] key to return the display to measurement mode. This completes de setting procedure.
- Plotting is started by pressing the [START STOP] key on the control panel. If "START MODE" has been set to 1 (AUTO) in the M3-1 menu of the setting mode, the RUN indicator will flash on and off and the unit will stand by until the "AUTO START TIME". When the set time is reached, the RUN indicator will remain lit and plotting will start.
- If "START MODE" is set to "MANUAL" and the set time has already passed, the RUN indicator will light and printing will start upon pressing the [START STOP] key (the printer indicator will light).
- In case "STOP MODE" in the M3-2 menu of the setting mode is set to 1 (TIMER), plotting is executed for the period of time specified by "MEASURE TIME", then it stops automatically. If the above setting is 2 (MANUAL), plotting should be stopped with the [START STOP] key. This is also possible when set to "TIMER".

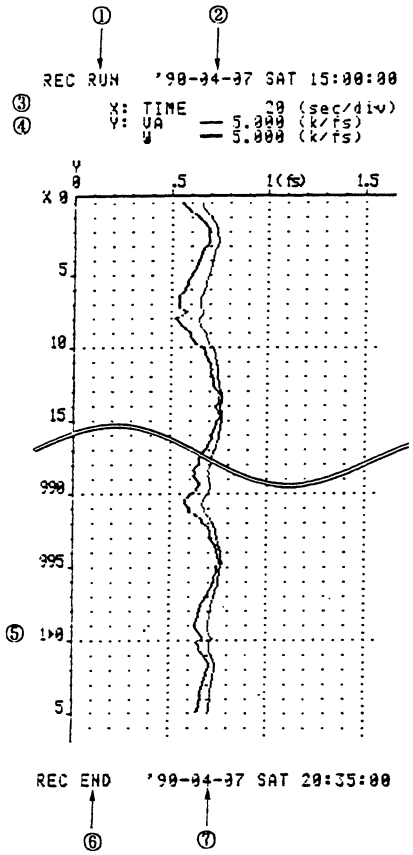
* If the printer runs out of paper during plotting, the operation is finished. Load paper, press the [START STOP] key and start again (see page 96).

⚠ CAUTION

If the clamp sensor range is changed during plotting, operation will be compulsorily terminated.

The plotting function produces printouts like the following.

Printing Sample 15



① Plotting start message

② Plotting start date and time (year-month-day day of the week hours:minutes:seconds)

③ Time corresponding to one division on the X axis (paper feed speed)

④ Data displayed on the Y-axis and scaling

Example: Since a value of approx. 0.65 is shown for VA at the start,
VA = 0.65 × 5 kVA = 3.25 kVA.

* If f.s. overflows due to scaling, the "8.␣␣␣" indication is printed.

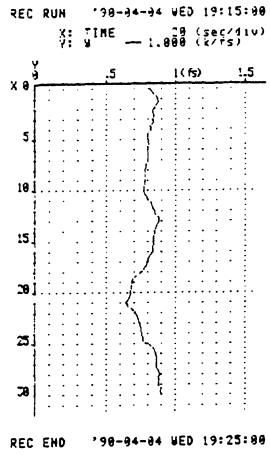
⑤ Only multiples of five are printed on both axes. After reaching 1000, the ▶ mark is used to indicate two digits, so "1 ▶ 0" stands for 1000 and "2 ▶ 0" for 2000.

⑥ Plotting end message

⑦ Plotting stop date and time (year-month-day day of the week hours:minutes:seconds)

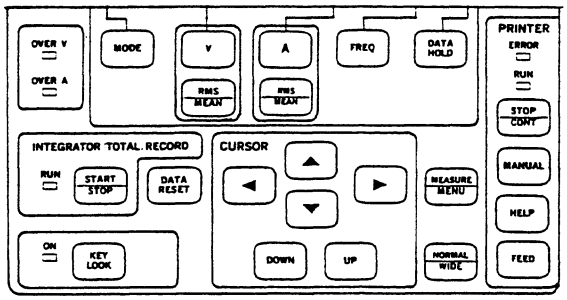
* If auto start is used, the setting menu cannot be accessed during plotting standby (RUN ␣ indicator blinking) by pressing the [MEASURE MENU] key. The [MANUAL] , [HELP] and [FEED] keys are inoperative as well.
* The [START STOP] key is inoperative during printer operation.
* When Data Hold is Used
  Data can be plotted regardless of the data hold condition.
* Each division on the plot consist of 8 dots. The position of each dot is determined by sampling the parameter at an interval resulting from dividing by eight the time required to feed one division. Therefore, the plot may not be clear for particularly fluctuating lines.
* Depending on printing start timing, the X axis may get out of position.

*** In case plotting is performed for only one channel, a printout like the following is obtained.**



Printing Sample 16

Table 6-5 shows how key entries are processed during the plotting operation.



Key / Condition	HELP	MANUAL	START/STOP	STOP/CONT
	HELP	MANUAL	START STOP	STOP CONT
Standby	Inoperative	Inoperative	Prints data read in until the key was pressed, and then "END".	Inoperative
Plotting	Inoperative	Inoperative	Inoperative	Inoperative

Fig. 6-5

✪ Related Functions

- External control of the plotting operation
  Plotting start/stop can be controlled through the back panel external control terminals (page 66, External Control).

- Power failure processing
  If a power failure occurs during plotting, operation is restarted when power supply is restored. In this case, failure and restoration times will be printed (page 135, Power Failures).

6-7 Printing Time

To obtain a record of data in the shortest possible time to save printing paper, set the maximum, integrated and average values as parameters to be printed, and adjust printing interval to 1 minute. In that case, paper length used for one printout is 72.8 mm (2.6 mm/line × 28 lines), so approx. 412 (30 m ÷ 72.8 mm) printouts can be obtained with a 30-m paper roll. In the plotting mode, approx. 11538 (30 m ÷ 2.6 mm) printouts can be obtained (since the Y axis is also printed, this number is actually closer to 11530).
The last 3 meters of the 30-m paper roll have a red strap to indicate that little paper is left. Data printing times for each interval time, and plotting times for each chart speed are given below. Use them as reference to prevent a paper empty condition.

Data printout		Plotting	
Interval Time	Printing Time	Chart speed	
1 minute	Approx. 6 hours 52 minutes	1/3 minute	Approx. 64 hours
5 minutes	Approx. 34 hours 20 minutes	1 minute	Approx. 192 hours 10 minutes
10 minutes	Approx. 68 hours 40 minutes	5 minutes	Approx. 960 hours 50 minutes
15 minutes	Approx. 103 hours	10 minutes	Approx. 1921 hours 40 minutes
30 minutes	Approx. 206 hours	30 minutes	Approx. 5765 hours
1 hour	Approx. 412 hours	60 minutes	Approx. 11530 hours

(maximum, integrated and average values are printed out 412 times).

6-8 Notes on Operation

✪ If the Printer Suddenly Stops

If printer operation stops during printing, or it does not work when printing is attempted, check the following.

(1) Did a paper jam occur?
(2) Is there paper left? (is paper passing through the paper detector? see 6-9 Loading the Paper.

If trouble has not been caused by neither of the above, the circuit or the printer may be faulty. Refer service to authorized personnel.

✪ Cautions on Paper Handling

Since the paper used for this unit is thermal type, observe the following.

- Do not store it in places subject to high temperature and/or humidity.
- Do not expose it to sunlight or a fluorescent lamp light for long periods.
- Do not use organic-solvent type glue.
- Do not put it contact with vinyl chloride film or other plastics for long periods.
- Protect it against water and scratches.
- To keep a record for a long time, it is advisable to make a copy.

✪ Detection of Paper Empty and Paper Jam

Paper-empty detection is performed after each line (including blank lines). Paper-jam detection is performed all the time during the printing operation.

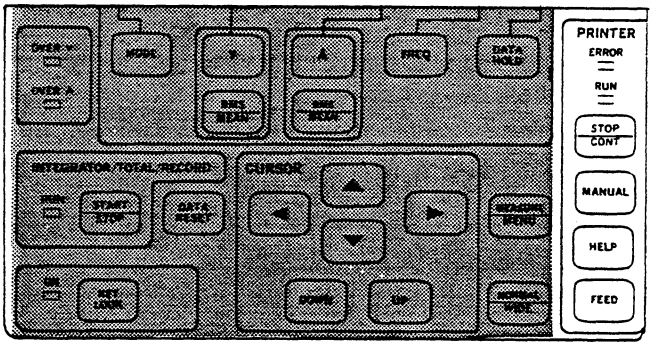
When these conditions are detected, the unit operates as follows, depending on the current mode.

- Help and Manual Printing
  Printing operation stops, and the "ERROR" LED lights (data are not stored).
- Integration/Totalization/Plot Printing
  Printing operation stops, and the "ERROR" LED lights (data are not stored).

* Data are kept only when the error condition is detected while the last totalization data (including the graph) are being printed.

In either case, integration, totalization and plotting are normally performed.

To cancel the "ERROR" condition, load paper into the unit (see page 97, "Loading the Paper") and press the [STOP CONT] key. The "ERROR" LED will go out.

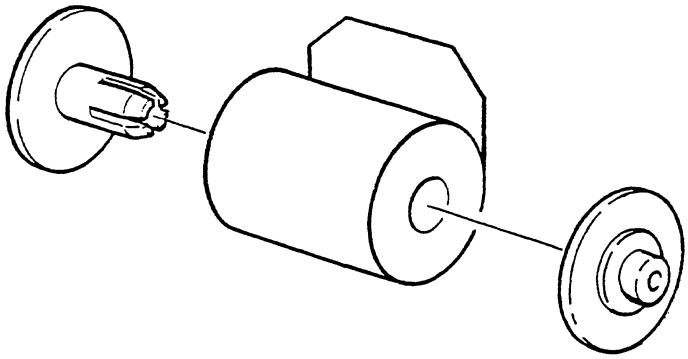


After the "ERROR" condition is released, the unit will operate as follows.

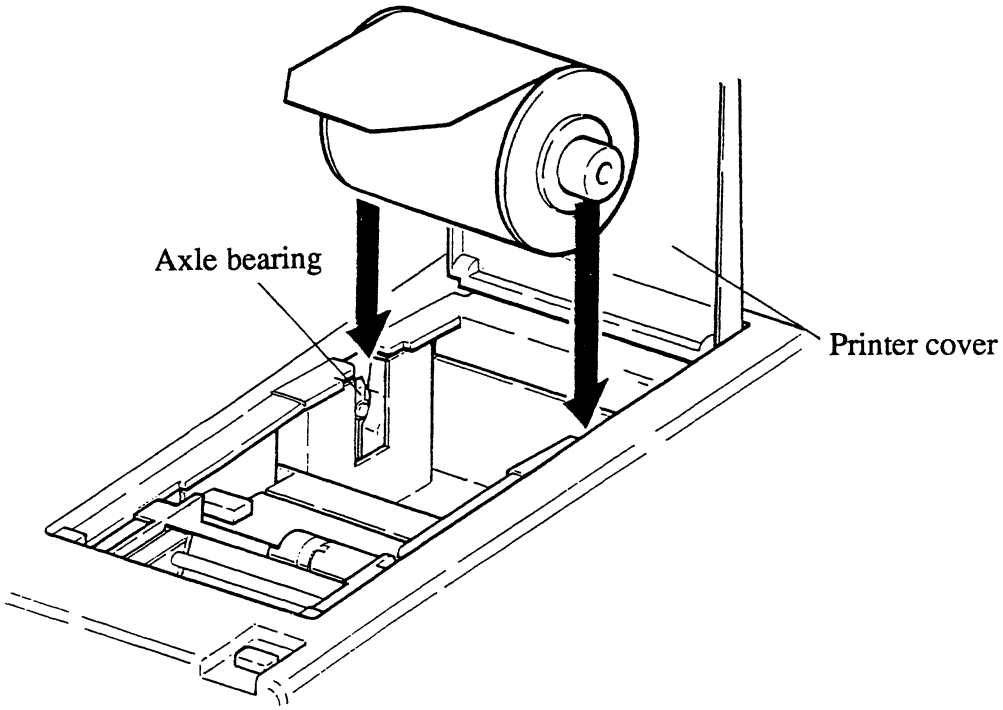
- Help and Manual Printing
  Press the [HELP] or [MANUAL] key to restart printing.
- Integration and Totalization Printing
  Printing will restart when the printing time is reached. In case printing time comes before paper has been loaded, those data will not be printed.
  * Last totalization data can be printed from the start by pressing the [START STOP] key.
- Plot Printing
  Press the [STOP CONT] key to start plotting anew.

6-9 Loading the Paper

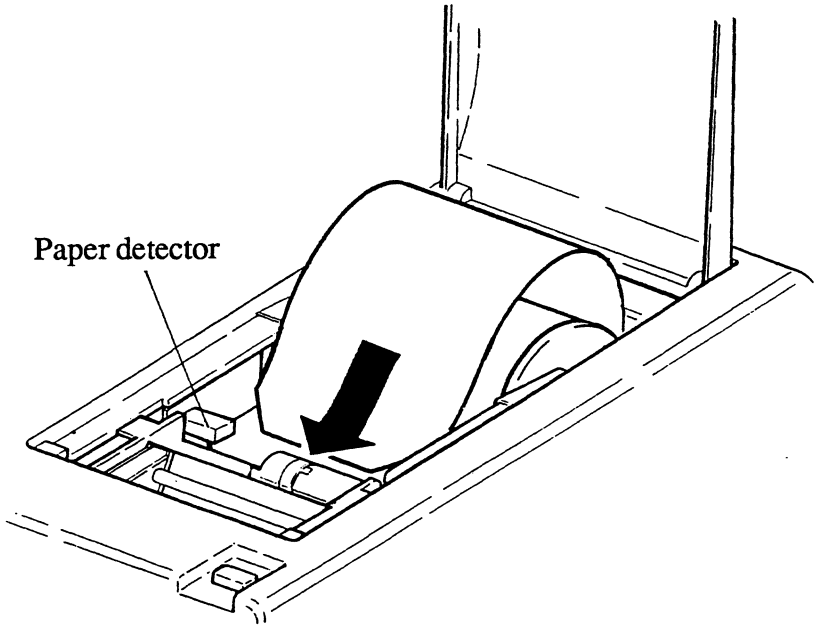
Insert the axles from both sides of the paper roll.



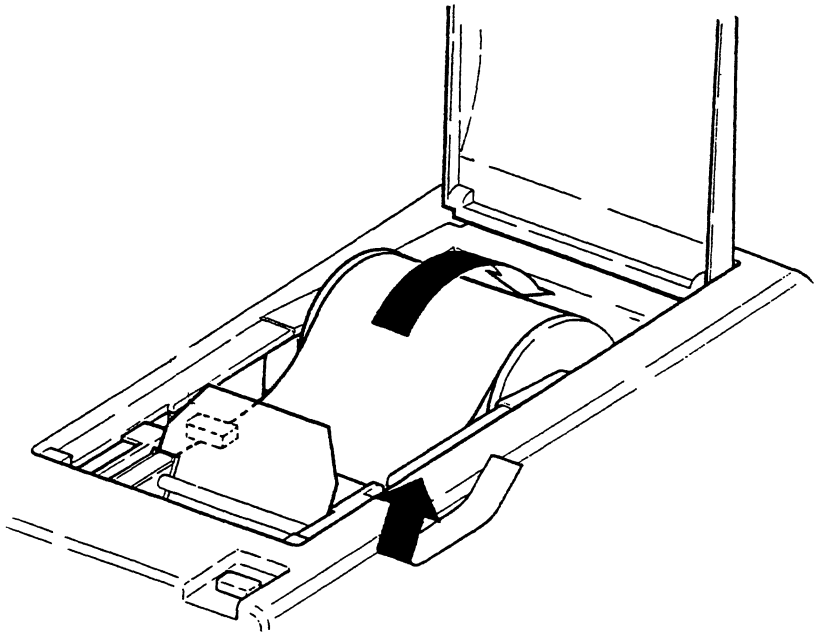
Open the printer cover and install the roll so that both axles fit firmly into the axle bearings.



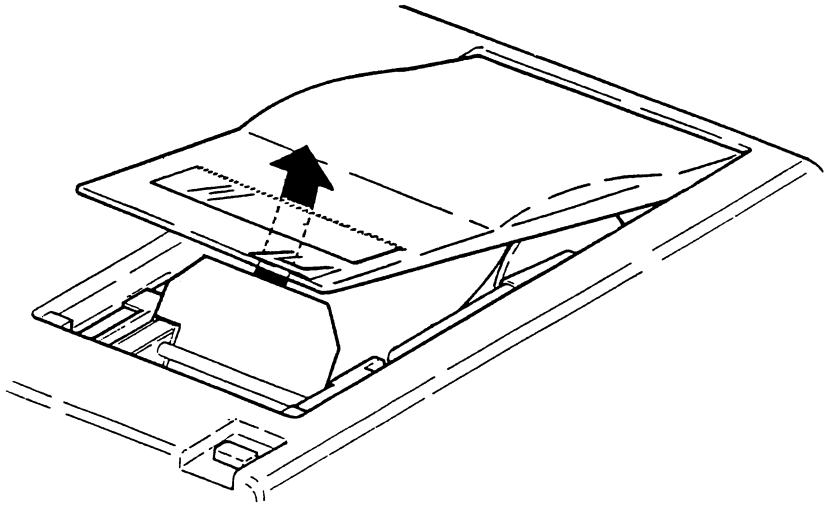
Pull the paper end and insert it into the printer bottom slot. You can cut the paper as shown to facilitate this procedure.



Press the [FEED] key, then remove any paper slackness by turning the roll back.



Pull out the paper and pass it through the paper cutter.



Chapter 7

RS-232C

7-1 RS-232C Interface Specifications

7-1-1 General specifications

Transfer system: Start-stop transmission
Transfer speeds: 300, 600, 1200, 2400, 4800, and 9600 baud
Stop bits: 1, 1.5, or 2 bits
Parity: Even, odd, or none
Date length: 7 or 8 bits
Delimiter: CR, LF, or CR/LF (set independently on sending and receiving ends)
(Conforms to EIA RS-232C, CCITT V.24, and JIS X5101 standards)

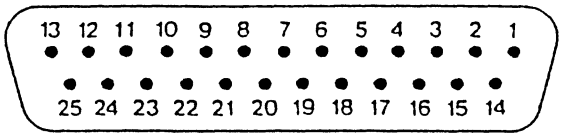
7-1-2 Electrical characteristics

	Data signal	Control signal
Input voltage level	0 1	ON +5V ~ +15V OFF –15V ~ –5V
Output voltage level	0 1	ON +5V ~ +15V OFF –15V ~ –5V

7-1-3 Connectors used

On host device: DB-25ST-N-S1 (mfd by JAE) or equivalent
On cable: DB-25P (mfd by JAE) or equivalent

7-1-4 I/O connector signal assignments and signal functions

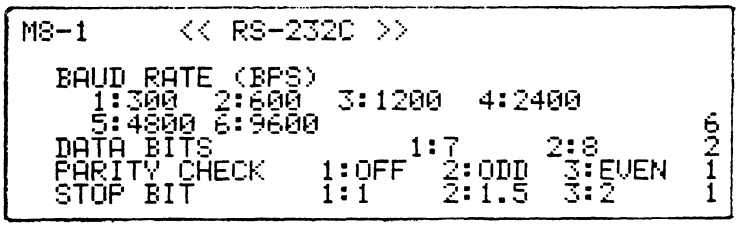


RS-232C interface connector pin assignments (on 3165)

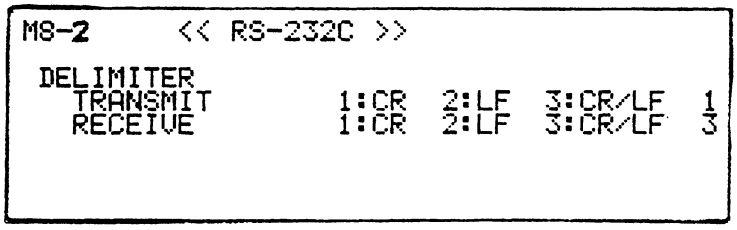
Pin No.	Symbol				Signal direction	Signal name
	RS-232C	JIS X5101	CCITT V.24	Other		
1	A A	(F G)	101	G N D		Frame ground or cable shield *1
2	B A	S D	103	T X D	3165 →	Send data
3	B B	R D	104	R X D	3165 ←	Receive data
4	C A	R S	105	R T S	3165 →	Request to send
5	C B	C S	106	C T S	3165 ←	Clear to send
6						(Not used)
7	A B	S G	102	G N D		Signal ground
8	C F	C D	109	D C D	3165 ←	Data channel receive carrier detect
9						(Not used)
10						(Not used)
11						(Not used)
12						(Not used)
13						(Not used)
14						(Not used)
15						(Not used)
16						(Not used)
17						(Not used)
18						(Not used)
19						(Not used)
20	C D	E R	108/2	D T R	3165 →	Data terminal ready
21						(Not used)
22						(Not used)
23						(Not used)
24						(Not used)

*1 Pin 1 is connected to the chassis of the 3165.
See page 144 for a connection example.

7-2 Setting Communication Conditions



- Press the [MEASURE MENU] key to switch display to the set-up mode.
- Using the [UP] or [DOWN] key, switch to page 8 (M8-1, «RS232C») of the set-up display.
- Set the transfer speed
  Move the cursor to "BAUD RATE(BPS)" with the [▼] key, then select one of the six possible settings with the [UP] or [DOWN] key.
- Set the data length
  Move the cursor to "DATA BITS" with the [▼] key, then select 7 bits or 8 bits with the [UP] or [DOWN] key.
- Set the parity check type
  Move the cursor to "PARITY CHECK" with the [▼] key, then select OFF, ODD, or EVEN with the [UP] or [DOWN] key.
- Set the number of stop bits
  Move the cursor to "STOP BITS" with the [▼] key, then select 1, 1.5, or 2 with the [UP] or [DOWN] key.



- Move the cursor to the "1" in "M8-1", then press the [UP] or [DOWN] key to switch display to page M8-2 of the «RS232C» display.
- Set the send delimiter
  Move the cursor to "TRANSMIT" with the [▼] key, then select CR, LF, or CR/LF with the [UP] or [DOWN] key.
- Set the receive delimiter
  Move the cursor to "RECEIVE" with the [▼] key, then select CR, LF, or CR/LF with the [UP] or [DOWN] key.

* The [KEYLOCK] key resets the RS-232C interface. Be careful to avoid pressing this key during RS-232C communication.

7-3 Program Codes

The program codes shown starting on the next page make it possible to control all aspects of operation other than turning the power on/off or changing the RS-232C communication conditions.

The program codes are composed of letters of the alphabet, numerals, and the symbols "+", "-", ":", and ".". An error will result if any other character is used. When sending a group of program codes to the 3165 in succession, separate each code from the one following with a comma (","). (Any spaces included between a code and a comma are ignored.)
Upon receiving and processing each program code, the 3165 outputs one of the following two messages.

ALL RIGHT	Indicates that a valid program code was received and processed.
ERROR ON nn	Indicates that an error was detected in the nnth program code received. Subsequent codes are ignored.

Processing of each code takes place from the time that code is received until one of the above messages is output. If any other code is received while processing of an earlier code is still in progress, the later code is ignored.
When using one of the data output specification codes ("Q" or "E"), the error message indicated above is output if any error is detected; otherwise, the specified data is output.

A maximum of 100 bytes of program code can be processed at one time. Codes exceeding this limit are ignored.

The program codes fall into two groups as indicated below: codes that are used in the measurement mode, and codes that are used in the setup mode. Before using any code, first use the "X" code to switch the 3165 to the appropriate mode of operation.

* For details on the "X" code, see "10) Switching between the measurement and setup modes" in section 7-3-1, "Basic functions."

Codes usable in the measurement mode

7-3-1	Basic functions
7-3-9	Data output specification

Codes usable in the setup mode

7-3-2	Wide display
7-3-3	Printer
7-3-4	Integration, summary, and recording
7-3-5	Frequency measurement, scaling, and D/A output
7-3-6	Comparator
7-3-7	Real time meter
7-3-8	Reset and miscellaneous other functions

Some codes are subject to other conditions besides the mode of operation, see "List of Operation Control Codes" on page 122 for details.

7-3-1 Basic functions

1) Mode selection

Code	Type of wiring
MD 1	1P2W
MD 2	1P3W
MD 3	3P3W-2
MD 4	3P3W-3
MD 5	3P4W

2) Voltage range selection

Code	Voltage range
VR 1	100V
VR 2	200V
VR 3	400V

3) Current range selection

Code	Current range	
	20A sensor	200A sensor
AR 1	2A	20A
AR 2	5A	50A
AR 3	10A	100A
AR 4	20A	200A

4) Current auto-range ON/OFF selection

Code	Function
AA 1	Current auto-range ON
AA 2	Current auto-range OFF

5) Voltage RMS/average measurement selection

Code	Function
VM 1	True RMS measurement
VM 2	Average rectified RMS measurement

6) Current RMS/average measurement selection

Code	Function
AM 1	True RMS measurement
AM 2	Average rectified RMS measurement

7) Current/voltage selection for frequency measurement

Code	Function
F 1	Current frequency measurement
F 2	Voltage frequency measurement

8) Display data hold selection

Code	Function
DH 1	Display data hold ON
DH 2	Display data hold OFF

9) Key lock selection

Code	Function
KL 1	Key lock ON
KL 2	Key lock OFF

*This code does not reset the RS-232C interface.

10) Measurement/setup mode selection

Code	Function
X 1	Setup mode display
X 2	Measurement mode display

* Some program codes are effective only in one or the other of the setup and measurement modes. Before sending such codes to the 3165, use this code to select the appropriate mode.

11) Normal/wide display selection

Code	Function
WD 1	Wide display
WD 2	Normal display

12) Measurement mode page selection

Code	Normal display	Wide display
P 1	Instantaneous value display	Instantaneous value display
P 2	Maximum value display	Maximum value display
P 3	Minimum/maximum value display	Minimum value display
P 4	Integral/average display	Integral display
P 5	Summary display	Average display

* The setup mode does not have selectable pages.

13) Start integration/summarization/recording

IS

14) Stop integration/summarization/recording

IR

15) Data reset

DR

16) Manual print

PM

* Do not use the PM code in combination with other codes. If this code is sent immediately after selecting a mode or range, at least 2 seconds must elapse before measurement data can be established. Measurements taken after less than 2 seconds will not be correct.

17) Help print

PH

18) Paper feed

PF

19) Printer stop/continue

PR

* This code has the same function as pressing the STOP CONT key on the front panel. For details on the STOP CONT key, see Chapter 6, "Printer."

7-3-2 Wide display

Selection of wide display parameters

DSm:nnnn

m - Number of page to display ($1 \leq m \leq 5$)
n - Parameter to be displayed
Note:When displaying integrals (when m=4), the format is DS4:nn.

	Instantaneous value	Maximum value	Minimum value	Integral	Average
n \ m	1	2	3	4	5
1	V1	V1	V1	Wh	w
2	V2	V2	V2	VAh	VA
3	V3	V3	V3	etc*	var
4	*V	A1	PF		PF
5	A1	A2	FRQ		INTEG SEL *
6	A2	A3			
7	A3	W			
8	*A	VA			
9	W	var			
A	VA	PF			
B	var	FRQ			
C	PF				
D	FRQ				

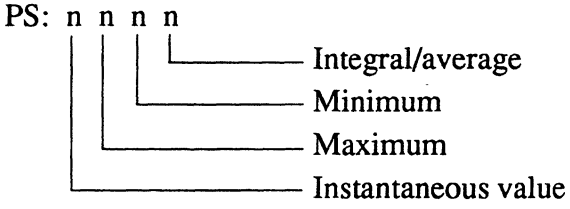
*Item selected for integration input from among A1, A2, A3, *A, or Wos.

Example: The following programming code selects W, VA, PF, and FRQ as maximum value wide display parameters.

DS2:78AB

7-3-3 Printer

1) Selecting the print parameter



n	Function
1	Specified data is printed
2	Specified data is not printed

Example: The following programming code prints only the instantaneous value.
PS:1222

2) Interval print ON/OFF

Code	Function
PV 1	Interval print ON
PV 2	Interval print OFF

3) Interval time

PIhhhhmm

hhhh - hours (0000 ~ 1000)
mm - minutes (00 ~ 59)
Settings in excess of 1,000 hours are not possible.

Example: The following programming code sets the interval time to 30 minutes.
PI000030

7-3-4 Integration, summarization, and recording

1) Selecting the integration, summarization, or recording mode

Code	Function
IM 1	Integration mode
IM 2	Summarization mode
IM 3	Recording mode

2) Selecting the integration/'summarization/recording start mode

Code	Function
SM 1	Auto start
SM 2	Manual start

3) Start time

STyymmddhhxx

yy: Last two digits of the year (Gregorian calendar, 00-99)
mm: The month (01-12)
dd: The day (01-last day of the month)
hh: The hour (00-23)
xx: The minute (00-59)

Example: Programming code to set the start time to 9:30 am on May 3, 1990 is as follows.

ST9005030930

4) Timer time

IThhhhmm

hhhh: Hours (0000-1000)
mm: Minutes (00-59)
Settings in excess of 1,000 hours are not possible.

5) Selecting the integration/recording stop mode

Code	Function
RM 1	Timer stop
RM 2	Manual stop

6) Selecting the integration input parameter

II:n

n	Integration parameter
1	A1
2	A2
3	A3
4	*A
5	Wos

7) Setting the number of repetitions

RPnnn

nnn:Number of repetitions (001-100)

8) Selecting the summary graph parameter

GS:nn

n	Summary graph parameter
1	W
2	VA
3	var
4	PF
5	INTEG SEL *1
6	NOSEL *2

*1 Choose A1, A2, A3, *A, or Wos, depending on which has been selected as the integration input.

*2 Graph is not printed.

9) Selecting the recording parameters

RS:nn

n	Recording parameter
1	V1
2	V2
3	V3
4	*V
5	A1
6	A2
7	A3
8	*A
9	W
A	VA
B	var
C	PF
D	FRQ
E	NOSEL *

* Recording not printed.

Example: The programming code to select W and PF as the recording parameters is as follows.

RS:9c

10) Selecting the chart speed

Code	Chart speed (minutes/DIV)
SP 1	1/3
SP 2	1
SP 3	5
SP 4	10
SP 5	30
SP 6	60

7-3-5 Frequency measurement, scaling, and D/A output

1) Selecting the frequency range

Code	Frequency range
FR 1	100Hz
FR 2	1000Hz
FR 3	10kHz
FR 4	Auto range

2) Turning the frequency measurement filter ON/OFF

Code	Function
FL 1	Frequency measurement filter ON
FL 2	Frequency measurement filter OFF

3) Setting the PT ratio

PTnnnnnn

nnnnnn: 5 numerals and a decimal point. The decimal point must not be placed in any of the first three positions.
(0 0 0. 0 1 ≦ n n n n n n ≦ 1 0 0 0 0.)

Example: The programming code to set the PT ratio to 100 is as follows.
PT100.00
(PT0100.0 or PT00100. are also acceptable.)

4) Setting the CT ratio

CTnnnnnn

nnnnnn: 5 numerals and a decimal point. The decimal point must not be placed in any of the first three positions.
(0 0 0. 0 1 ≦ n n n n n n ≦ 1 0 0 0 0.)

5) Setting the SC value

SCnnnnnn

nnnnnn: 5 numerals and a decimal point. The decimal point must not be placed in any of the first three positions.

(0.0001≦nnnnnn≦10000.)

6) Selecting the D/A output parameter

DAn

n	D/A output parameter
1	VA
2	var
3	PF
4	*V
5	*A
6	Wos
7	FRQ

* After setting the output parameter, the D/A output does not change until the 3165 has been switched to the measurement mode with the X2 code.

7-3-6 Comparator

1) Selecting the comparator parameter

CS:n

n	Comparator parameter
1	V1
2	V2
3	V3
4	*V
5	A1
6	A2
7	A3
8	*A
9	W
A	VA
B	var
C	PF
D	FRQ

2) Setting the comparator level

CLnnnnu

nnnnn: 4 numerals and a decimal point. The decimal point must not be placed in the first position.

u: Designates the unit; specified as m, a space, k, or M. (The space may be omitted.)

(0.0001≦nnnnn≦9999.)

3) Turning the comparator warning buzzer ON/OFF

Code	Function
CB 1	Turns the comparator warning buzzer ON.
CB 2	Turns the comparator warning buzzer OFF.

* Comparator operation is done in the measurement mode. After making the buzzer setting, initiate comparator operation by switching to the measurement mode with the X2 code.

7-3-7 Real time meter

The code to set the real-time meter is as follows.

RTyymmddhhxxssw

yy: Last two digits of the year (Gregorian calendar, 00-99)
mm: The month (01-12)
dd: The day (01-last day of the month)
hh: The hour (00-23)
mm: The minute (00-59)
ss: The second (00-59)
w: The day of the week (1-7, where 1 is Sunday and 7 is Saturday)

7-3-8 Reset and miscellaneous other functions

1) Average display ON/OFF

Code	Function
AV 1	Average display ON
AV 2	Average display OFF

2) W offset display ON/OFF

Code	Function
WO 1	W offset display ON
WO 2	W offset display OFF

3) W offset level

WLpnnnnnu

p: Polarity, + or -.
nnnnn: 4 numerals and a decimal point. The decimal point must not be placed in the first position.
u: Designates the unit; specified as m, a space, k, or M. (The space may be omitted.)
(0.001≦nnnnn≦9999.)

4) Key input buzzer ON/OFF

Code	Function
KB 1	Key input buzzer ON
KB 2	Key input buzzer OFF

5) Input overflow warning buzzer ON/OFF

Code	Function
OB 1	Input overflow warning buzzer ON
OB 2	Input overflow warning buzzer OFF

6) Reset

RST

* Although RS-232C communication conditions are initialized by resetting from the keyboard in setup screen M7, they are not affected by a reset initiated by the RST code.

7-3-9 Data output specification

The data output specification codes described in this section make it possible to have the 3165 output data to the RS-232C interface. However, do not use these codes in combination with the programming codes described in other sections of this chapter. Also, always wait at least two seconds after setting the mode and range before sending these codes to allow time for acquisition of measurement data. Failure to observe this conditions will result in invalid data.

For details on the various output data formats, see 7-4, "Output data formats."

1) Measurement data output

Code	Function
Q 1	Instantaneous value data
Q 2	Maximum value data
Q 3	Minimum/maximum value data
Q 4	Integral/average value data
Q 5	Summary data

2) Status data output

E

Codes valid in each mode

Code \ Mode	Setup mode	Measurement mode	Integration/ summarization mode	Recording mode
MD		○		
VR		○	○	
AR		○	○	
AA		○	○	
VM		○		
AM		○		
F		○		
DH		○	○	○
KL	○	○	○	○
X	○	○		
WD		○	○	○
P		○	○	○
IS		○ ①		
IR			○ ①	○ ①
DR		○		
PM		○ ①	○ ①②	
PH	○ ①	○ ①	○ ①②	
PF	○ ①	○ ①	○ ①②	
PR	○	○	○	
DS	○			
PS	○			
PV	○			
PI	○			
IM	○			
SM	○			
ST	○			

Mode / Code	Setup mode	Measurement mode	Integration/ summarization mode	Recording mode
IT	○			
RM	○			
I I	○			
RP	○			
GS	○			
RS	○			
SP	○			
FR	○			
FL	○			
PT	○			
CT	○			
SC	○			
DA	○			
CS	○			
CL	○			
CB	○			
RT	○			
AV	○			
WO	○			
WL	○			
KB	○			
OB	○			
RST	○	○	○	○
Q		○	○	○
E	○	○	○	○

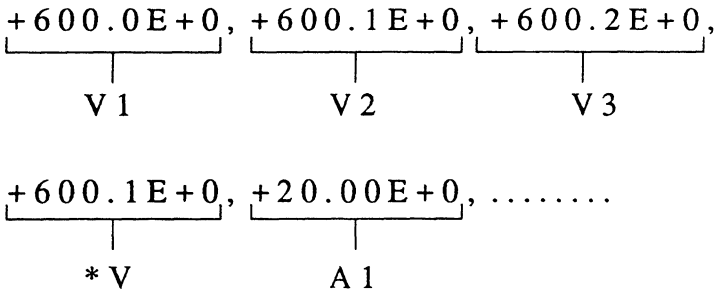
① Not valid during printing.
② Valid only when interval printing cancelled.

7-4 Output data formats

7-4-1 Measurement data output (output by code Q)

Data corresponding to that displayed in a normal display page can be output by specifying that page with the Q1 code.

Output example:



* Data that exceeds the display capacity or that is unmeasurable is output as follows.

Display	RS-232C
9.␣␣␣	99999E+9
8.␣␣␣	88888E+8
0.␣␣␣	00000E+0

The following paragraphs show the output data format for each page.

1) Data output by code Q1

The format for measurement data with instantaneous values is as follows.

±nnnnnE±m

nnnnn: 4 numerals and a decimal point. The decimal point must not be placed in the first position.

m: The numeral 0, 3, 6, 8, or 9.

Measurement data output in response to the Q1 code is delimited with commas and output in the following sequence.

Output sequence	Measured value	Data positions
1	Instantaneous voltage of channel 1	1 - 9
2	Instantaneous voltage of channel 2	11 - 19
3	Instantaneous voltage of channel 3	21 - 29
4	Average voltage of V1, V2, and V3	31 - 39
5	Instantaneous current of channel 1	41 - 49
6	Instantaneous current of channel 2	51 - 59
7	Instantaneous current of channel 3	61 - 69
8	Average current of A1, A2, A3	71 - 79
9	Instantaneous effective power	81 - 89
10	Instantaneous apparent power	91 - 99
11	Instantaneous reactive power	101 - 109
12	Instantaneous power factor	111 - 119
13	Instantaneous frequency	121 - 129

Number of bytes output: 129 (excluding delimiters)

2) Data output by code Q2 (maximum values)

The output data format for maximum measured values is the same as that for instantaneous values.
The sequence in which maximum measured values are output is as follows.

Output sequence	Measured value	Data positions
1	Maximum voltage of channel 1	1 - 9
2	Maximum voltage of channel 2	11 - 19
3	Maximum voltage of channel 3	21 - 29
4	Maximum current of channel 1	31 - 39
5	Maximum current of channel 2	41 - 49
6	Maximum current of channel 3	51 - 59
7	Maximum effective power	61 - 69
8	Maximum apparent power	71 - 79
9	Maximum reactive power	81 - 89
10	Maximum power factor	91 - 99
11	Maximum frequency	101 - 109

Number of bytes output: 109 (excluding delimiters)

* It is not possible to output the date and time of observation of maximum values.

3) Data output by code Q3 (minimum/maximum values)

The output data format for minimum measured values is the same as that for instantaneous values.

The sequence in which minimum measured values are output is as follows.

Output sequence	Measured value	Data positions
1	Minimum voltage of channel 1	1 - 9
2	Minimum voltage of channel 2	11 - 19
3	Minimum voltage of channel 3	21 - 29
4	Minimum power factor	31 - 39
5	Minimum frequency	41 - 49
6	Maximum voltage of channel 1	51 - 59
7	Maximum voltage of channel 2	61 - 69
8	Maximum voltage of channel 3	71 - 79
9	Maximum power factor	81 - 89
10	Maximum frequency	91 - 99

Number of bytes output: 99 (excluding delimiters)

* It is not possible to output the date and time of observation of minimum/maximum values.

4) Data output by code Q4 (integrals/averages)

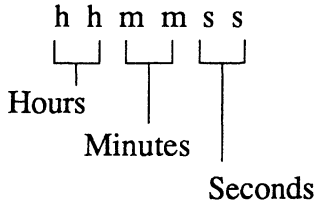
Integrals are output in the following format.

±nnnnnnn±m

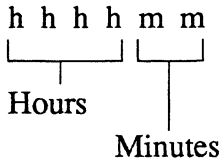
nnnnnnn: 6 numerals and a decimal point. The decimal point must not be placed in the first position.
m: The numeral 0, 3, 6, 8, or 9.

The output data format for averages is the same as that for instantaneous values.

Real-time data is represented in the following format.



Integration elapsed time data is represented in the following format.



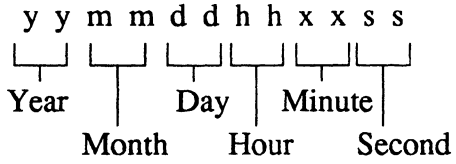
The sequence in which measured values are output is as follows.

Output sequence	Measured value	Data positions
1	Real time	1 - 6
2	Integration elapsed time	8 - 13
3	Effective power	15 - 25
4	Apparent power	27 - 37
5	Ampere hours	39 - 49
6	Average effective power during integration	51 - 59
7	Average apparent power during integration	61 - 69
8	Average reactive power during integration	71 - 79
9	Average power factor during integration	81 - 89
10	Average of arbitrary integration parameter during integration	91 - 99

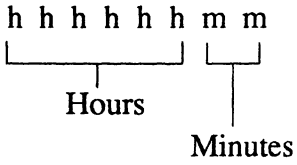
Number of bytes output: 99 (excluding delimiters)

5) Data output by code Q5 (summary values)

The starting and ending summarization times are output in the following format.



Total integration time are output in the following format.



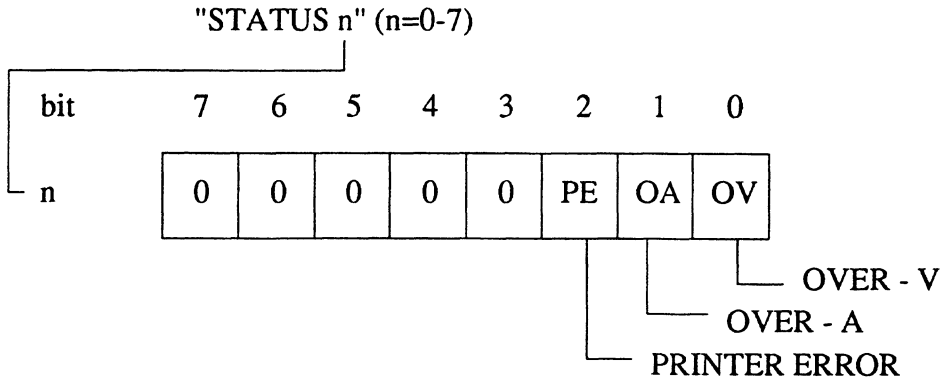
The sequence of items in the output data is as follows.

Output sequence	Measured value	Data positions
1	Summarization starting time	1 - 10
2	Summarization ending time	12 - 21
3	Total integration time	23 - 30
4	Average over total time (effective power)	32 - 40
5	Average over total time (apparent power)	42 - 50
6	Average over total time (reactive power)	52 - 60
7	Average over total time (power factor)	62 - 70
8	Average over total time (arbitrary integration parameter)	72 - 80
9	Average over maximum time (effective power)	82 - 90
10	Average over maximum time (apparent power)	92 - 100
11	Average over maximum time (reactive factor)	102 - 110
12	Average over maximum time (power factor)	112 - 120
13	Average over maximum time (arbitrary integration parameter)	122 - 130
14	Load factor	132 - 140
15	Total effective power	142 - 152
16	Total apparent power	154 - 164
17	Arbitrary total integration	166 - 176

Number of bytes output: 176 (excluding delimiters)

7-4-2 Status data output

Information concerning OVER-V and OVER-A conditions and printer errors can be output as status data by sending the E code. The format of data output is as follows.



bit / n	2 (PE)	1 (OA)	0 (OV)
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

This code also resets the OVER-V and OVER-A bits of the status data (bits 0 and 1).

7-5 Sample Programs

The following sample programs illustrate use of the RS-232C interface in BASIC on two different computers, the NEC PC9801 and the HP9000 Series 300. The programs read instantaneous measurement data and display voltages, currents, and power. They also check for OVER-V and OVER-A conditions.

Communication conditions for both examples are as follows.

Transfer speed:	9600 baud
Data length:	8 bits
Stop bits:	1 bit
Parity check:	None

7-5-1 Program for the PC-9801

```
10  OPEN "COM:N81NN" AS #1
20  PRINT #1, "RST"
30  INPUT #1, A$
40  PRINT #1, "MD4, VR2, AR3"
50  INPUT #1, A$
60  '
70  FOR I=0 TO 4000: NEXT I
80  PRINT #1, "Q1"
90  LINE INPUT #1, A$
100 PRINT #1, "E"
110 INPUT #1, B$
120 '
130 PRINT "V=";MID$(A$,31,9)
140 PRINT "A=";MID$(A$,71,9)
150 PRINT "W=";MID$(A$,81,9)
160 B=VAL(MID$(B$,8,1))
170 IF B¥4>0 THEN B=B-4
180 IF B¥2>0 THEN B=B-2: PRINT "OVER-A"
190 IF B¥1>0 THEN PRINT "OVER-V"
200 PRINT
210 GOTO 70
220 END
```

*With this program, the 3165 send delimiter is CR, and the receive delimiter is CR/LF.

Program explanation

Line 10 Opens the RS-232C interface as a file
20 Initializes the 3165
30 Inputs a response message
40 Sets the measurement mode to 3-phase, 3-wire, 200V voltage range, 10A current range
50 Inputs a response message
60 Comment
70 2-second wait
80 Specifies instantaneous data output
90 Inputs instantaneous data
100 Specifies status data output
110 Inputs status data
120 Comment
130 Displays voltage data
140 Displays current data
150 Displays power data
160 Converts status data to numeric values
170 Clears bit 2
180 Displays "OVER-A" if bit 1 is 1
190 Displays "OVER-V" if bit 0 is 1
200 Displays a blank line
210 Branches to line 70
220 End of program

7-5-2 Program for the HP9000 Series 300

```
10   DIM A$[200]
20   CONTROL 9,0;1
30   CONTROL 9,3;9600
40   CONTROL 9,4;51
50   OUTPUT 9;"RST"
60   ENTER 9;A$
70   OUTPUT 9;"MD4,VR2,AR3"
80   ENTER 9;A$
90   !
100  WAIT 2
110  OUTPUT 9;"Q1"
120  ENTER 9;A$
130  OUTPUT 9;"E"
140  ENTER 9;B$
150  !
160  PRINT "V=";A$[31;9]
170  PRINT "A=";A$[71;9]
180  PRINT "W=";A$[81;9]
190  B=VAL(B$[8;1])
200  IF BIT(B,1) THEN PRINT "OVER-A"
210  IF BIT(B,0) THEN PRINT "OVER-V"
220  PRINT
230  GOTO 100
240  END
```

*With this program, the 3165 send delimiter is CR/LF, and the receive delimiter is CR/LF.

Program explanation

Line 10 Declares a character string
20 Resets the RS-232C interface
30 Sets the transfer speed to 9,600 baud
40 Sets the data length to 8 bits, the number of stop bits to 1, and the parity check to none
50 Initializes the 3165
60 Inputs a response message
70 Sets the measurement mode to 3-phase, 3-wire, 200V voltage range, 10A current range
80 Inputs a response message
90 Comment
100 2-second wait
110 Specifies instantaneous data output
120 Inputs instantaneous data
130 Specifies status data output
140 Inputs status data
150 Comment
160 Displays voltage data
170 Displays current data
180 Displays power data
190 Converts status data to numeric values
200 Displays "OVER-A" if bit 1 is 1
210 Displays "OVER-V" if bit 0 is 1
220 Displays a blank line
230 Branches to line 100
240 End of program

Result of sample program execution

```
V=+201.0E+0
A=+10.20E+0
W=+3.000E+3

V=+290.0E+0
A=+12.00E+0
W=+3.200E+3
OVER-V

V=+202.2.0E+0
A=+14.00E+0
W=+3.300E+3
OVER-A

V=+296.0E+0
A=+14.50E+0
W=+3.500E+3
OVER-A
OVER-V

V=+198.0E+0
A=+09.80E+0
W=+2.700E+3
```

Chapter 8

POWER FAILURES

On Power Failures and Power Restoration

❂ In case of power failure, the unit operates as follows:

All display indications go out.
Real time keeps running normally.
All setting are kept.
Maximum/minimum, integration, average and totalization data are kept.

- Help and Manual Printing
  Printing stops immediately (data are not kept).
- Integration and Totalization Printing
  Printing stops immediately (data are kept).
- Plotting
  Printing stops immediately (data are not kept).

❂ When power supply is restored, the unit operates as follows:

The display shows menu P1 «REAL VALUE».
Settings are the same as before the power failure.
The printer makes a paper feed.

- Help and Manual Printing
  Press the [HELP] or [MANUAL] key as required.
- Integration and Totalization Printing
  If power failed during standby, failure and restoration times are printed (Printing Sample 17). If printing was in progress, current data are printed from the beginning, followed by failure and restoration times (Printing Sample 18).

Printing Sample 17

```
POWER OFF   '90-04-04 16:38:35
POWER ON    '90-04-04 16:39:03
```

Printing Sample 18

```
INTEG RUN '90-04-04 WED 16:37:00
 U1:208.6   A1: 1.93   W  : 0.684k
 U2:206.2   A2: 2.16   VA : 0.795k
 U3:208.5   A3: 2.53   var: 0.405k
*U:207.8   *A: 2.20   PF : 0.860
          F/U: 60.1 Hz

 ELAPSED TIME     INTEG.VALUE
       00:00       Wh  :   2085.m

INTEG RUN '90-04-04 WED 16:37:00
 U1:208.6   A1: 1.93   W  : 0.684k
 U2:206.2   A2: 2.16   VA : 0.795k
 U3:208.5   A3: 2.53   var: 0.405k
*U:207.8   *A: 2.20   PF : 0.860
          F/U: 60.1 Hz

 ELAPSED TIME     INTEG.VALUE
       00:00       Wh  :   2085.m
                   VAh :   2397.m
                   *Ah :    6.95m
 AVERAGE VALUE
    W  : 682.2       PF : 0.870
    VA : 784.5       *A : 2.273
    var: 387.2

 POWER OFF   '90-04-04 16:37:18
 POWER ON    '90-04-04 16:37:27
```

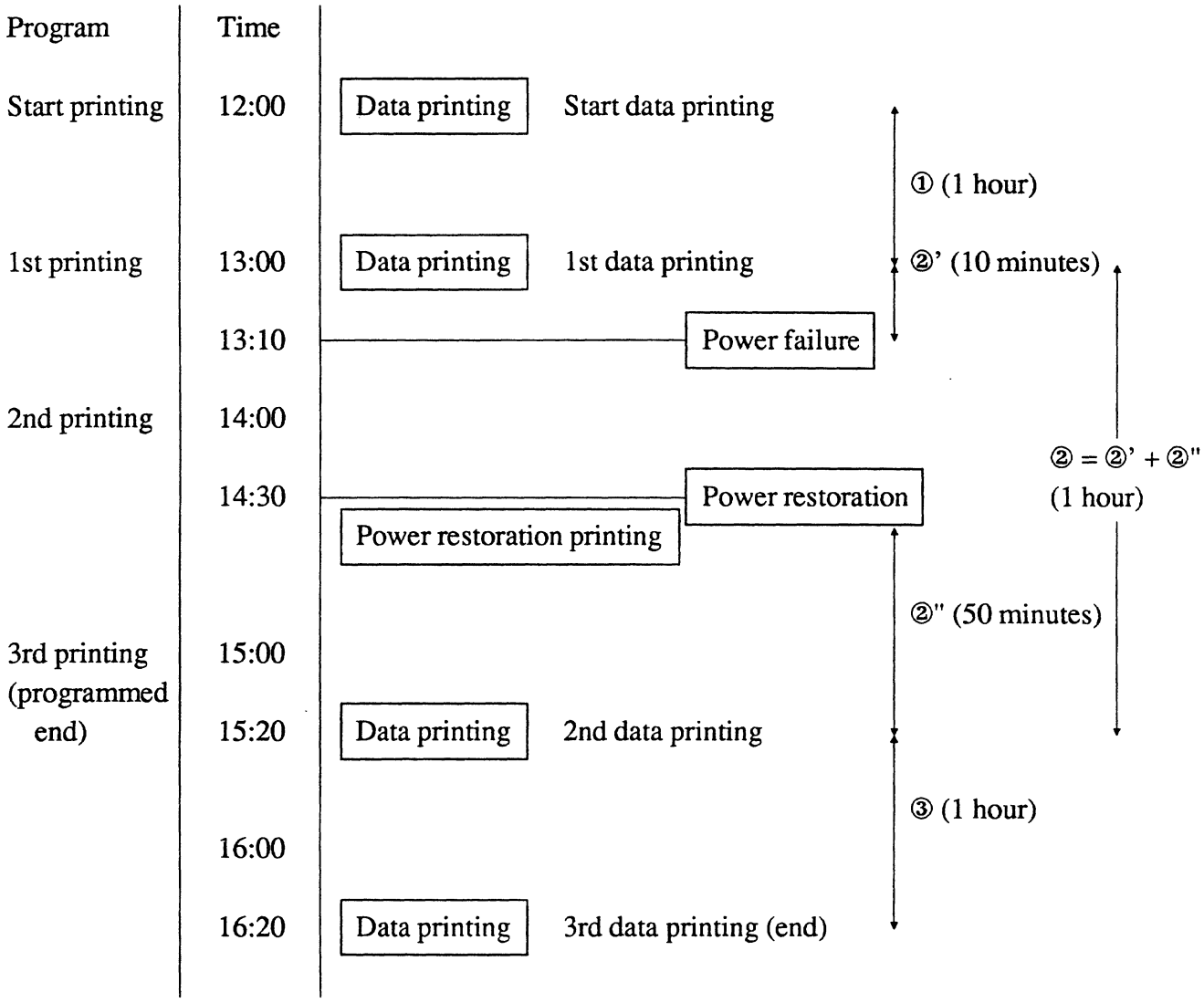
Except when integration or totalization has been completed (during printing of the last data), the unit stands by until the next printing time. While power supply is interrupted, integration elapsed time nd interval elapsed time are also paused. Therefore, times before and after the failure are added to form the interval until the next printing (Fig. 7-1).
In case the next printing time is reached before printing is completed after the restoration of power supply, remaining data are not printed.

- Plotting
  Failure and restoration times are printed regardless of the current mode (standby or printing). Then, paper is feed in and plotting starts.
  If power supply was interrupted during printing of the end message after the end of plotting time, failure and restoration times are not printed.

! CAUTION

Immediately after power supply is restored, the instantaneous maximum value can not be correctly displayed.

Integration start	12:00
Integration time	3:00 (3 hours)
Interval time	1:00 (1 hour)



① 1st interval
② 2nd interval
②' Portion of the 2nd interval before the power failure
②" Portion of the 2nd interval after power restoration
③ 3rd interval

Chapter 9

Appendix

Table of key operations

Key \ Operation mode	Setup	Measurement	Integration/ summarization	Recording	Key lock
MODE		○			
V		○	○		
RMS MEAN (V)		○			
A		○	○		
RMS MEAN (A)		○			
FREQ		○			
DATA HOLD		○	○	○	
START STOP		○①	○①	○①	
DATA RESET		○			
KEYLOCK	○	○	○	○	○
▲	○				
▼	○				
◀	○				
▶	○				
UP	○	○	○	○	
DOWN	○	○	○	○	
MEASURE MENU	○	○			
NORMAL WIDE		○	○	○	
STOP CONT	○	○	○		
MANUAL		○①	○①②		
HELP	○①	○①	○①②		
FEED	○①	○①	○①②		

① Not effective while printer is printing.

② Effective only when interval printing is cancelled.

Table of messages

Message	Error No.	Meaning
SYSTEM ERR	0	Backup error relating to the mode, voltage/current range, rectification method, or frequency setting
	1	Setup menu 1 (wide display) backup error
	2	Setup menu 2 (printer) backup error
	3	Setup menu 3 (integration/summarization/recording) backup error
	4	Setup menu 4 (frequency, scaling, D/A output) backup error
	5	Setup menu 5 (comparator) backup error
	6	Setup menu 6 (real time) backup error
	7	Setup menu 7 (other) backup error
	8	Setup menu 8 (RS-232C) backup error
	10	MAX/MIN, integral, average over interval, summary data backup error
CLAMP RANGE ERR		The connected clamp sensor does not match the rated range.
PRINT SELECT OVER		More than three printer items were set when the interval time was set to 1.
9.␣␣␣ (Display/printer) 99999E+9 (RS-232C)		Indicates that the measurement data exceeded 1.5 x the range (V, A) or 1.25 x the range (W, VA, var).
8.␣␣␣ (Display/printer) 88888E+8 (RS-232C)		• Indicates that the results of calculation are not definite. (VA was 0 for power factor calculation.) • Indicates that the display range was exceeded due to scaling (that a value exceeded 9999M).
0.␣␣␣ (Display/printer) 00000E+0 (RS-232C)		Indicates that no measurement is being taken.
CLAMP RANGE	CHχ (χ=1~3)	Indicates the clamp sensor range for channel 1~3. N.C indicates not connected.
RESET MEASUREMENT DATA		Indicates that measurement data is being reset.

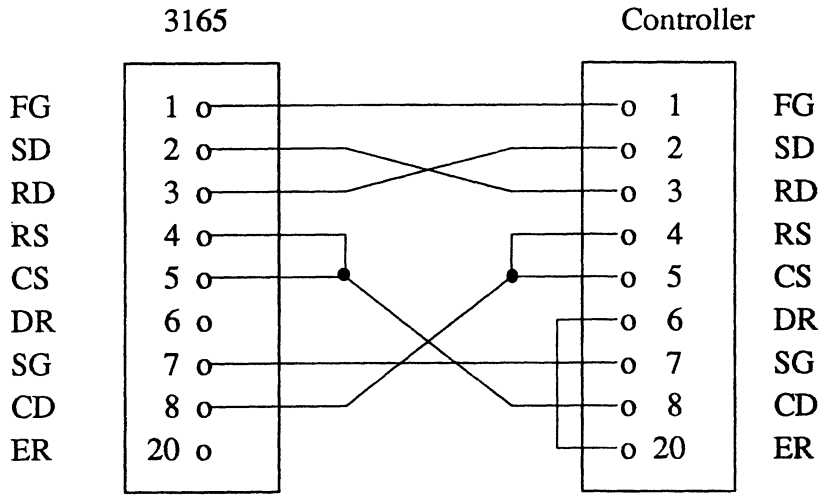
Table of RS-232C programming codes

Mode / Code	Setup mode	Measurement mode	Integration/ summarization mode	Recording mode
MD		○		
VR		○	○	
AR		○	○	
AA		○	○	
VM		○		
AM		○		
F		○		
DH		○	○	○
KL	○	○	○	○
X	○	○		
WD		○	○	○
P		○	○	○
IS		○ ①		
IR			○ ①	○ ①
DR		○		
PM		○ ①	○ ①②	
PH	○ ①	○ ①	○ ①②	
PF	○ ①	○ ①	○ ①②	
PR	○	○	○	
DS	○			
PS	○			
PV	○			
PI	○			
IM	○			
SM	○			
ST	○			

Mode / Code	Setup mode	Measurement mode	Integration/ summarization mode	Recording mode
IT	O			
RM	O			
I I	O			
RP	O			
GS	O			
RS	O			
SP	O			
FR	O			
FL	O			
PT	O			
CT	O			
SC	O			
DA	O			
CS	O			
CL	O			
CB	O			
RT	O			
AV	O			
WO	O			
WL	O			
KB	O			
OB	O			
RST	O	O	O	O
Q		O	O	O
E	O	O	O	O

① Not effective while printer is printing.
② Effective only when interval printing is cancelled.

Example of RS-232C connection



* When connecting the 3165 to an NEC PC9801, connection can be made using NEC's PC9896 RS-232C cable (cross-connected cable).

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Instruction Manual

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