POWER MULTIMETER

2721 / 2722

Instruction Manual

NF Corporation

DA00027017-003

2721/2722

POWER MULTIMETER

INSTRUCTION MANUAL

2721/2722 POWER MULTIMETER

USER'S MANUAL

Note: "2722" has been discontinued, and therefore the descriptions in this document are for reference only.

date : 2010/6/14

The instruction manual with disorder pages or missing pages is to be replaced. Please get in touch with NF Corporation or one of our representatives.

NOTE

- Reproduction of the instruction manual, part or whole, is forbidden without prior written permission.
- The contents of the instruction manual are subject to change without notice.
- Information provided in the instruction manual is intended to be accurate and reliable. However, we assume no responsibility for any damage regarding the contents of the instruction manual.

Preface

Thank you very much for purchasing our **"2721/2722 POWER MULTIMETER"**.
To ensure safe and proper use of this electric equipment, please read first **"Safety Precautions"** on the following pages.

■ Caution Symbols Used in This Manual

The following caution symbols are used in this manual. Be sure to observe these caution symbols and their contents to ensure the safety of the user and avoid damage to the equipment.

⚠ WARNING

This symbol indicates information for the avoidance of a hazard such as electric shock that may endanger human life or cause injury during handling of the equipment.

⚠ CAUTION

This symbol indicates information for the avoidance of damage to the equipment during handling.

Note

This symbol indicates important information for the handling of this product.

■ This manual has the following chapter organization:

1. OVERVIEW
This chapter gives general description of the product, as well as the operating principle.

2. PREPARATIONS BEFORE USE
This chapter describes important preparation before installation and operation. Be sure to read this chapter.

3. BASIC OPERATION
This chapter describes the functions, operations, and connecting method of the panels, as well as basic operations. Read this chapter while operating the device.

4. COUNTER FUNCTION
This chapter describes the operations and settings of the counter.

5. INTEGRATING FUNCTION
This chapter describes the operations and settings of the integrating function.

6. SETTING OPERATION WITH SHIFT KEY
This chapter describes the setting operation using the SHIFT key, except basic operations.

7. REMOTE CONTROL FUNCTION
This chapter describes the GPIB and RS-232C.

8. TROUBLESHOOTING AND MAINTENANCE
This chapter describes how to deal with error messages and troubles, as well as operation check and performance test.

9. SPECIFICATIONS
This chapter describes the product's specifications (functions and performance).

Safety Precautions

To ensure safe use, be sure to observe the following warnings and cautions.
NF Corporation shall not be held liable for damages that arise from a failure to observe these warnings and cautions.

■ Be sure to observe the contents of instruction manual.

This instruction manual contains information for the safe operation and use of this product.
Be sure to read this information first before using this product.
All the warnings in the instruction manual must be heeded to prevent hazards that may cause major accidents.

■ Be sure to ground the product.

This product uses a line filter and you will get shocked unless the product is grounded.
To prevent electric shock, be sure to safely implement grounding in according to Japanese technical standard of electrical equipment D (Type 3, ground resistance is less than 100Ω) or better.
This product is grounded when its three-pole power supply plug is connected to the three-pole power outlet having a protective ground connector.
When using a three-pole to two-pole conversion adapter, be sure to connect the grounding wire (green color) of the adapter to the grounding terminal next to the outlet.

■ Check the power supply voltage

This product operates on the power supply voltage indicated in **"2.2 Grounding and Power Supply Connection"** in this instruction manual.
Before connecting the power supply, check that the voltage of power outlet matches the rated supply voltage set with the Voltage Selector switch.

■ Observe the fuse rating

Using an unspecified fuse could cause a fire. Use the rated fuse specified in **"2.2 Grounding and Power Supply Connection"** of the instruction manual.
Also, when replacing the fuse, the power cord must be disconnected from the power outlet.

■ In case of suspected anomaly

If this device emits smoke, an abnormal smell, or abnormal noise, immediately power it off and stop using it.
If such an abnormal occurs, prevent anyone from using this product until it has been repaired, and immediately report the problem to NF Corporation or one of our representatives.

■ Do not use the product when flammable gas is present.

An explosion or other such hazard may result.

■ **Do not remove the cover.**

This device contains high-voltage parts. Absolutely never remove its cover.
Unavoidable internal inspections are to be performed only by service technicians who know what is hazardous and have been adequately trained.

■ **Do not modify this product.**

Never modify the product or replace the part with a part not authorized by NF Corporation, which otherwise may cause new hazards and may disqualify this product from repair in case of a failure.

■ **Safety-related symbols**

The general definitions of the safety-related symbols used on this product and in the instruction manual are provided below.

⚠	**Instruction Manual Reference Symbol** This symbol is displayed to alert the user to potential danger and refer him/her to the instruction manual.
⚠ WARNING	**Warning Symbol** This symbol indicates information for the avoidance of a hazard such as electric shock that may endanger human life or cause injury during handling of the equipment.
⚠ CAUTION	**Caution Symbol** This symbol indicates information for the avoidance of damage to the equipment during handling.

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Table

1. OVERVIEW

The **“2712/2722 Power Multimeter”** is a digital power multimeter capable of measuring alternating current signals at high accuracy.
It supports the voltage 3 inputs and current 3 inputs. Also, it can support up to the voltage 4 inputs and current 4 inputs by adding an optional “**2725** Input Unit”.
The measurement items are the line voltage, interphase voltage, current, electric power, power factor, phase between voltage and current, interphase phase, frequency, integration, and counter. Particularly, the phase difference can be measured between independent 4 inputs for both voltage and current.
Two types are available; **2721** portable type with the input and output terminals arranged on the side panels, and **2722** rack mount type with the I/O terminals arranged on the rear panel.

* “**2722** Rack mount type” has been discontinued.

1.1 Features

- **High accuracy**
  The voltage and current can be measured at high accuracy of ±(0.05% of displayed value + 0.05% of range), the electric power at ±(0.1% of displayed value + 0.1% of range), and the phase at ±0.05°.
- **Wide measurable range**
  The voltage can be measured from minimum 200mVrms to maximum 640Vrms.
  The current can be measured directly from minimum 10mArms to maximum 25Arms. The current can be measured from 200μA by connecting the **"2726 Micro-current Probe"**.
- **Connector for external current probe**
  The connector to attach external current probe is furnished, so that optional Micro-current Probe can be connected.
- **Simultaneous display of 6 item measured data**
  The measured data of 6 items can be displayed simultaneously. Four different measurement display settings can be stored by the display change key.
- **Multi-phase (4 phases) inputs**
  This device supports the voltage 3 inputs and current 3 inputs. Also, it can support up to the voltage 4 inputs and current 4 inputs by adding an optional **"2725 Input Unit"**. The **"2725 Input Unit"** should be chosen when placing an order.
- **Multiple functions**
  In the connection for phase measurement, the line voltage can be measured without changing the connection. The phase difference between any inputs can be measured. Also, DC voltage and current can be measured in the DC measurement mode.
- **Calculating function**
  The 3-phase voltage, current, electric power, and power factor in the 3-phase 3-wire type or 3-phase 4-wire type wiring can be calculated by arithmetic expressions.
- **Integrating function**
  The integrated power, integrated reactive power, and integrated current can be measured,
- **Counter function**
  The counter for time measurement is provided. The measurement modes are "interval", "one shot", and "train". In the interval mode, the operation time and recovery time can be displayed at a time. The function that holds the measured data by means of a trip signal is built in.
- **Scaling function**
  The scaling common to all phases or individual to four phases can be set.
- **Remote control interface**
  The GPIB and RS-232C are equipped as standard.

1.2 Principle of Operation

■ Functional block diagram

The voltage inputs are adjusted to the optimum level by the preamplifiers of which gain is variable, and they are converted into digital values by the A/D converters, and transmitted by the photocouplers, and then stored in the memories.
For the current inputs, the currents are converted into the voltages by the shunt resistors and entered in the preamplifiers, and then same processing as that of voltage inputs is executed.
For the frequency, the SYNC signal set by **"SYNC"** on the panel is used as a trigger signal to read the period by the counter and it is converted into the frequency to display. Also, the voltage and current are read in synchronization with the SYNC signal.
The input waveform data that were read as mentioned above are calculated to obtain the voltage, current, electric power, power factor, phase, etc. and the results are displayed on the panel.

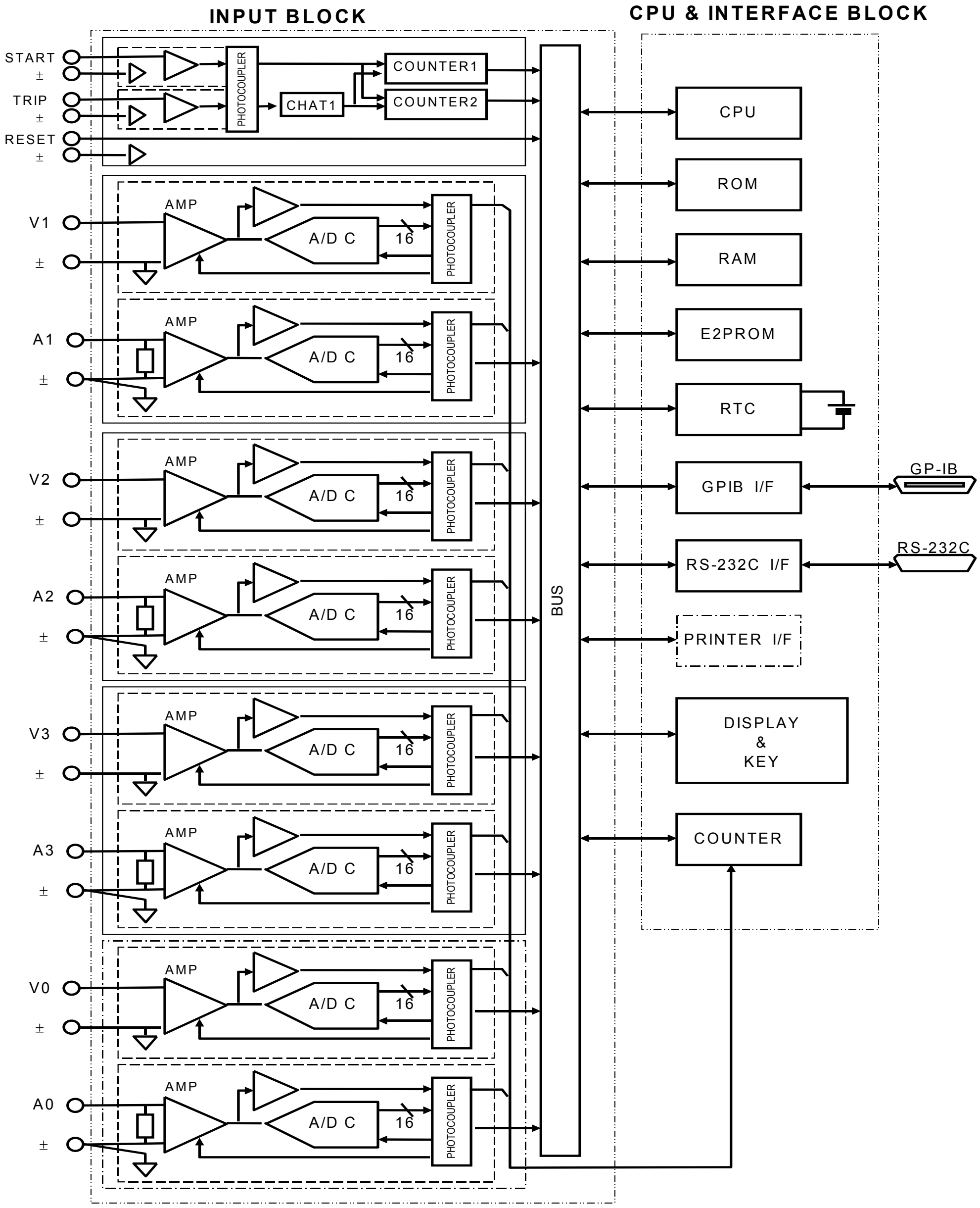


Figure 1-1 Block diagram

■ Arithmetic expressions of measurements

Arithmetic expressions of respective measurement items are shown below.

Here, Vn_i and An_i are the ith data when one period of the voltage input Vn and current input An is divided by 511.

- **AC voltage**

$$V_n(\mathrm{Vrms}) = \sqrt{\frac{1}{511}\sum_{i=0}^{510} Vn_i^{\,2}}$$

- **AC current**

$$A_n(\mathrm{Arms}) = \sqrt{\frac{1}{511}\sum_{i=0}^{510} An_i^{\,2}}$$

- **Active power**

$$W_n(\mathrm{W}) = \frac{1}{511}\sum_{i=0}^{510}\left(Vn_i \times An_i\right)$$

- **Phase difference (between A and B)**

$$\phi_{AB}(\mathrm{deg}) = \tan^{-1}\frac{\sum_{i=0}^{510}\left[A_i \times \cos\left(\frac{2\pi}{511}\times i\right)\right]}{\sum_{i=0}^{510}\left[A_i \times \sin\left(\frac{2\pi}{511}\times i\right)\right]} - \tan^{-1}\frac{\sum_{i=0}^{510}\left[B_i \times \cos\left(\frac{2\pi}{511}\times i\right)\right]}{\sum_{i=0}^{510}\left[B_i \times \sin\left(\frac{2\pi}{511}\times i\right)\right]}$$

- **Line voltage** mn

$$V_{mn}(\mathrm{Vrms}) = \sqrt{V_m^{\,2} + V_n^{\,2} - 2 \times V_m \times V_n \cos(\phi_{mn})}$$

- **Apparent power**

$$VA_n(\mathrm{VA}) = V_n \times A_n$$

- **Reactive power**

$$Var_n(\mathrm{var}) = \pm\sqrt{VA_n^{\,2} - W_n^{\,2}}$$

- **Power factor**

$$PF_n = \frac{W_n}{VA_n}$$

1.3 Description of Functions

- **Input function**

The voltage inputs and current inputs are isolated from the case. Respective inputs are also isolated from each other (test voltage AC 2kV).
A voltage range is 1V to 640V, and a current range is 0.04A to 24A.

- **Measuring function of micro-current (optional)**

Micro-current of 200μA (range: 1mA - 10mA) can be measured by connecting the **"2726 Micro-current Probe"**.

- **Display function**

The measurement and calculation results are displayed on six LED numeric displays (height 14.22mm, 5½ digits). Six data can be displayed at a time.
Also, since the function and element settings can be switched by the display change key, 24-different function and element settings can be stored, and six of them can be displayed at a time.

- **Calculating function**

From the measured voltage, current, and active power, the following items can be calculated. Wiring types are single-phase 2 wires, single-phase 3 wires, 3-phase 3 wires, or 3-phase 4 wires. Particularly, the line voltage and phase measurements can be done without changing the connection. Also, the scaling value can be set for full voltage and full current or for each input, and therefore the PT and CT can be used for any input. The scaling value is also effective for the following arithmetic expressions besides voltage and current. If the phase of current lags behind the voltage, the reactive power is displayed with plus (+), and the power factor is displayed with **LAG** in unit. If it leads from the voltage, the reactive power is displayed with minus (–), and the power factor is displayed with **LEAD**.

Table 1-1 Arithmetic expressions (1/2)

	Single-phase 2 wires	3-phase 3 wires	3-phase 4 wires
Voltage (Vrms)	V_1, V_2, V_3	$V_\Sigma = \frac{V_1 + V_3}{2}$ V_{12}, V_{23}, V_{31}	$V_\Sigma = \frac{V_1 + V_2 + V_3}{3}$ V_{12}, V_{23}, V_{31}
Current (Arms)	A_1, A_2, A_3	$A_\Sigma = \frac{A_1 + A_3}{2}$ A_1, A_2, A_3	$A_\Sigma = \frac{A_1 + A_2 + A_3}{3}$ A_1, A_2, A_3
Active power (W)	W_1, W_2, W_3	$W_\Sigma = W_1 + W_3$	$W_\Sigma = W_1 + W_2 + W_3$
Apparent power (VA)	$VA_1 = V_1 \times A_1$ $VA_2 = V_2 \times A_2$ $VA_3 = V_3 \times A_3$	$VA_\Sigma = \frac{\sqrt{3}}{2}(VA_1 + VA_3)$	$VA_\Sigma = VA_1 + VA_2 + VA_3$
Reactive power (var)	$Var_1 = \pm\sqrt{VA_1^2 - W_1^2}$ $Var_2 = \pm\sqrt{VA_2^2 - W_2^2}$ $Var_3 = \pm\sqrt{VA_3^2 - W_3^2}$	$Var_\Sigma = \pm(Var_1 + Var_3)$	$Var_\Sigma = \pm(Var_1 + Var_2 + Var_3)$

Table 1-2 Arithmetic expressions (1/2)

	Single-phase 2 wires	3-phase 3 wires	3-phase 4 wires
Power factor	$PF_1 = \pm\frac{W_1}{VA_1}$ $PF_2 = \pm\frac{W_2}{VA_2}$ $PF_3 = \pm\frac{W_3}{VA_3}$	$PF_1 = \pm\frac{W_1}{VA_1}$ $PF_2 = \pm\frac{W_2}{VA_2}$ $PF_3 = \pm\frac{W_3}{VA_3}$ $PF_\Sigma = \pm\frac{W_\Sigma}{VA_\Sigma}$	$PF_1 = \pm\frac{W_1}{VA_1}$ $PF_2 = \pm\frac{W_2}{VA_2}$ $PF_3 = \pm\frac{W_3}{VA_3}$ $PF_\Sigma = \pm\frac{W_\Sigma}{VA_\Sigma}$
Phase (deg)	$V_i - I_j$ $V_i - V_j$ $I_i - I_j$	$V_i - V_j, V_i - I_j$ $I_i - I_j$ $V_{12} - V_{23}, V_{23} - V_{31}$ $V_{31} - V_{12}$ $V_{12} - I_j, V_{23} - I_j$ $V_{31} - I_j$	$V_i - V_j, V_i - I_j$ $I_i - I_j$ $V_{12} - V_{23}, V_{23} - V_{31}$ $V_{31} - V_{12}$ $V_{12} - I_j, V_{23} - I_j$ $V_{31} - I_j$
Integration	Wh_1, Wh_2, Wh_3 Ah_1, Ah_2, Ah_3 $Varh_1, Varh_2, Varh_3$	Wh_1, Wh_2, Wh_3 Ah_1, Ah_2, Ah_3 $Varh_1, Varh_2, Varh_3$ $Wh_\Sigma, Ah_\Sigma, Varh_\Sigma$	Wh_1, Wh_2, Wh_3 Ah_1, Ah_2, Ah_3 $Varh_1, Varh_2, Varh_3$ $Wh_\Sigma, Ah_\Sigma, Varh_\Sigma$

■ Integrating function

Active power, current, and reactive power can be integrated. During the integration, the integrated value and the integration elapse time can be displayed simultaneously. For the integration measurement, three modes of manual integration, time integration, and actual time integration are available.

■ Counter function (msec)

The operation time from the start input to the trip input can be measured. By switching the counter mode, such high level time measuring function can be activated that the operation time and recovery time are displayed simultaneously.
By the trip input, the measurement can be held.
The start/trip input setting and input state can be operated/monitored on the front panel.

■ Remote control function

In addition to GPIB, the RS-232C is equipped as standard. 24 data can be sent at a time.

■ Other functions

A portable type and a rack-mount type having different appearances are available.
For the **(2721)** portable type, the input and output terminals are arranged on the side panels, enabling the input/output connections from the side. Also, the front panel cover is equipped as standard for easy transportation.
For the **(2722)** rack-mount type, the input and output terminals are arranged on the rear panel for easy connections in the rack, as well as safety use. The front cover is not equipped.
Electrical rating of both types is same.
* The **(2722)** rack-mount type has been discontinued.

2. PREPARATIONS BEFORE USE

This chapter describes the checking before using the **"2712/2722 Power Multimeter"**, general precautions on use, and installation method.
Before using the 2721/2722, be sure to read **"Safety Precautions"** located at the beginning of this instruction manual, and the items on and after page 2-2 to check for safety.
Particularly, pay attention to the installation, which will affect the life, reliability, and safety of the device.
Also, this device weighs about 16 kg. Be careful when carrying the device.

date 2010/6/14(#127)

2.1 Checking before Use

■ Unpacking and repacking

After unpacking, first check if the product is damaged due to an accident during the transportation. Though the product has been checked with care at the delivery, the customer is asked to check particularly if any accessory is missing.
If the product is repacked for transportation, put the product with the pads durable to the weight in a cardboard box having sufficient strength and margin, and make packing so that the product is protected adequately.

■ Standard configuration

The configuration of **"2721/2722 "**is as listed below:

Table 2-1 2721/2722 configuration table

Main unit (2721/2722)		1 unit
Instruction manual		1 copy
Accessories:	Front cover (2721 only)	1 piece
	Power cord (3 poles, 2m)	1 piece
	Power plug 3 poles – 2 poles adapter	1 piece
	Fuse* (T1.6A/125V, ø5.2×20mm)	1 piece

* Fuse is built in the fuse holder.

■ Input Unit configuration (for ELEMENT 0) [Choose this option when placing an order, if necessary]

The configuration of **"2725 Input Unit"** is as listed below:

Table 2-2 2725 Input unit configuration table

Main unit (2725)	1 unit

■ Micro-current probe configuration [Optional]

The configuration of **"2726 Micro-current Probe"** is as listed below:

Table 2-3 2726 Micro-current probe configuration table

Main unit (2726)	1 unit
Instruction manual	1 copy

2.2 Grounding and Power Supply

■ Grounding

⚠ WARNING

To prevent an electric shock accident, observe the following points:

Before making connection for measurement, be sure to connect the protective ground terminal to the ground. The protective ground terminal of this device is a ground pin of 3-pole power plug or a ground terminal ⏚ (2721 only).
Insert the power plug of the supplied power cord into the 3-pole power outlet having a protective ground contact or pin.
When only the 2-pole power outlet is available, use the supplied 3 poles to 2 poles adapter. At this time, first connect a ground wire (green) of the adapter to the ground terminal and then insert the power plug into the outlet.

■ Power supply

⚠ CAUTION

To protect the product from damage, beware of the following points:

- **Before connecting the power supply, confirm that the supply voltage setting of the device meets the voltage of the power outlet.**
- **The standard supply voltage setting made at the delivery of the device is AC100V. Adjust the Voltage Selector switch to the operating voltage.**

This product operates with commercial power supply.

- **Supply voltage range** : AC100/120/220/240V±10%, maximum AC250V
- **Supply frequency range** : 48 to 62Hz
- **Power consumption** : About 53VA for **2721/2722** alone, or about 62VA when **2725** is added

The rating of the supplied power cord is the power supply 125V and the withstand voltage 1250Vrms/1 minute. To use the device with the voltage exceeding AC125V, the power cord must be changed. Please contact us.

⚠ CAUTION

Do not change over the Voltage Selector switch with the power cord inserted into the outlet. The product may be damaged.

■ Line filter

This device uses a line filter of the circuit shown below.
The leakage current is maximum 0.5mArms at 250V 62Hz. Therefore you may get shocked if touching a metallic part of the device.
For the operator's safety, be sure to take grounding.

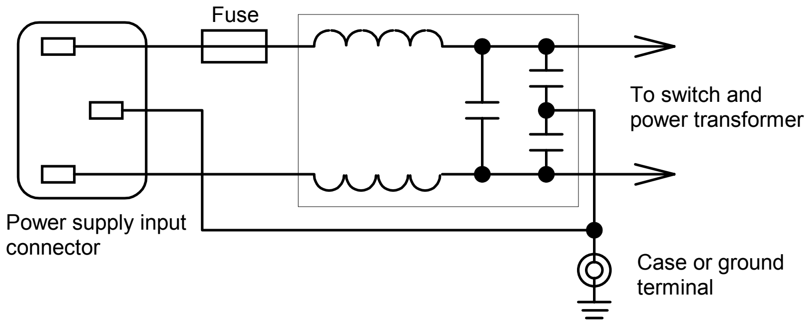


Figure 2-1   Line filter

■ Power fuse

⚠ WARNING

To prevent a fire, do not use a fuse other than the rated one.
Before replacing the fuse, be sure to disconnect the power cord.

The rated power fuse of this device is as follows:

- **Fuse capacity :** 1.6A at AC100/120V
  0.8A at AC220/240V
- **Fuse type :** Time-lag type, rated voltage 250V, ϕ5.2×20mm

Replace the fuse meeting the supply voltage. As standard, the device is delivered with 1.6A fuse. When 0.8A fuse is necessary, please contact NF Corporation.

2.3 Installation

■ Precautions

⚠ CAUTION

To protect the product from damage, beware of the following points:

- The device is forcibly cooled by air using a fan. When you find that the fan has stopped, turn off the power switch immediately and please contact NF Corporation or one of our representatives. Using the product with the fan stopped may increase the damage, thus making the repair impossible.
- The intake ports and exhaust ports are provided at the rear, side, and bottom of the device. Install the device, leaving a space between rear panel / side panels and wall.

■ Installation conditions

Install this device at a place that fulfills the following temperature and humidity conditions. Also, use the device free from condensation.

- **Operation guaranteed** : 0 to 40°C, 20 to 80%RH (Temperature range to guarantee accuracy: 23±5°C)
- **Storage** : −10 to 50°C, No condensation

Do not install the device in locations such as:

- location with direct sunlight or with a nearby source of heat
- location with significant amounts of dust, salt, metallic powders
- location with significant amounts of corrosive gases, vapor, soot
- Place where flammable gas or steam is present.
- location exposed to excessive vibration
- location close to a strong magnetic or electromagnetic field source
- location close to a pulsing noise source

■ Handling of the panel and case

When the case/panel surface needs cleaning, wipe with a soft cloth. To remove persistent contamination, wipe with a soft cloth soaked with neutral detergent and wrung out.
Do not use any organic solvents like thinner or benzene, or any chemical cleaning cloth, as they may cause the surface coating to deteriorate or come off.

MEMO

3. BASIC OPERATIONS

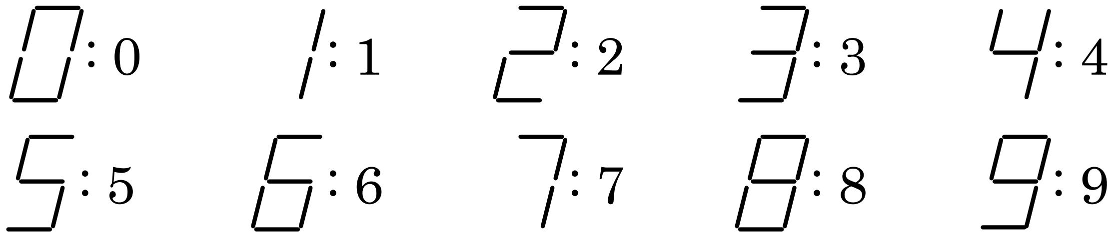
This chapter describes basic operating methods of the **"2721/2722 Power Multimeter"**.
Descriptions of basic operations include "names and operations of components on front panel and side/rear panel (side panel for **2721**, or rear panel for **2722**)", "measurement condition setting", "description and operation of Display **A, B, C, D, E, F**", "measurement of voltage, current, electric power, power factor, and phase difference", and "other measurements".
Detailed descriptions are given in the panel explanatory drawings on the following pages which should be referred to.
For an operating method of the counter function, see **"4. Counter Function"**, and for an operating method of the integrating function, see **"5. Integrating Function"**.
For the detailed settings of measurement, see **"6. Setting Operation with SHIFT Key"**.

date 2010/1/20(#6)

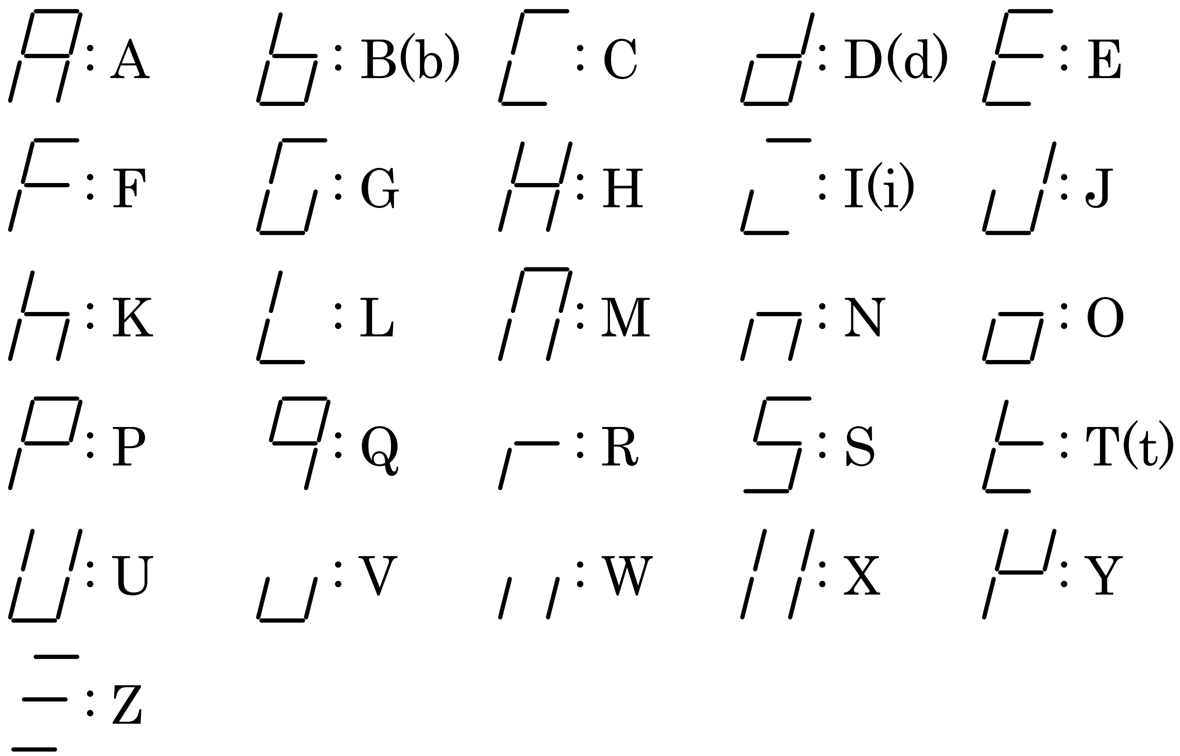
Description of displayed characters

Alphanumeric characters displayed in the Displays **A, B, C, D, E,** and **F** (7 segments) are as follows.
Alphanumeric characters are displayed as the settings of measurement conditions, counter mode, or present time, etc. Though they are displayed as straightforward as possible, some characters cannot be expressed. Accordingly, refer to the following list.

- **Numbers**



- **Alphabets**



- **Others**

■ Front panel

- Line voltage display

When FUNCTION [V] and ELEMENT [1], [2] light up, the line voltage calculated value of V12 is displayed.

- Phase display

When [deg], [V] and [1] light up, the phase difference between SYNC signal and V1 is displayed.

When [deg], [V], [A] and [1] light up, the phase difference between V1 and A1 is displayed.

Function selection and display
FUNCTION A, B, C, D (p.3-19)

V	Voltage measurement
A	Current measurement
W	Active power measurement
VA	Apparent power measurement
Var	Reactive power measurement
PF	Power factor measurement
deg	Phase measurement

Element selection and display
ELEMENT (p.3-19)

1	Element 1
2	Element 2
3	Element 3
0	Element 0
Σ	Calculation result

Function selection and display
FUNCTION E(p.3-19)

CNTR	Counter measurement
V/A	Impedance V/A
V/3A	Impedance V/√3A
Vsin	Impedance V/2Asinϕ
A-B	Phase difference between

Function selection and display
FUNCTION F(p.3-19)

Hz	Frequency measurement
Wh	Integrated active power
Ah	Integrated current
Varh	Integrated reactive power
C-D	Phase difference between

SYNC signal setting and display (p.3-15)
Sets the SYNC signal.
The lamp of selected phase lights up.

Input state display
PEAK OVER
Lights up when excess signal is input.

GPIB state display
SRQ
Lights up when serial request is output.
RMT
Lights up in the remote state.

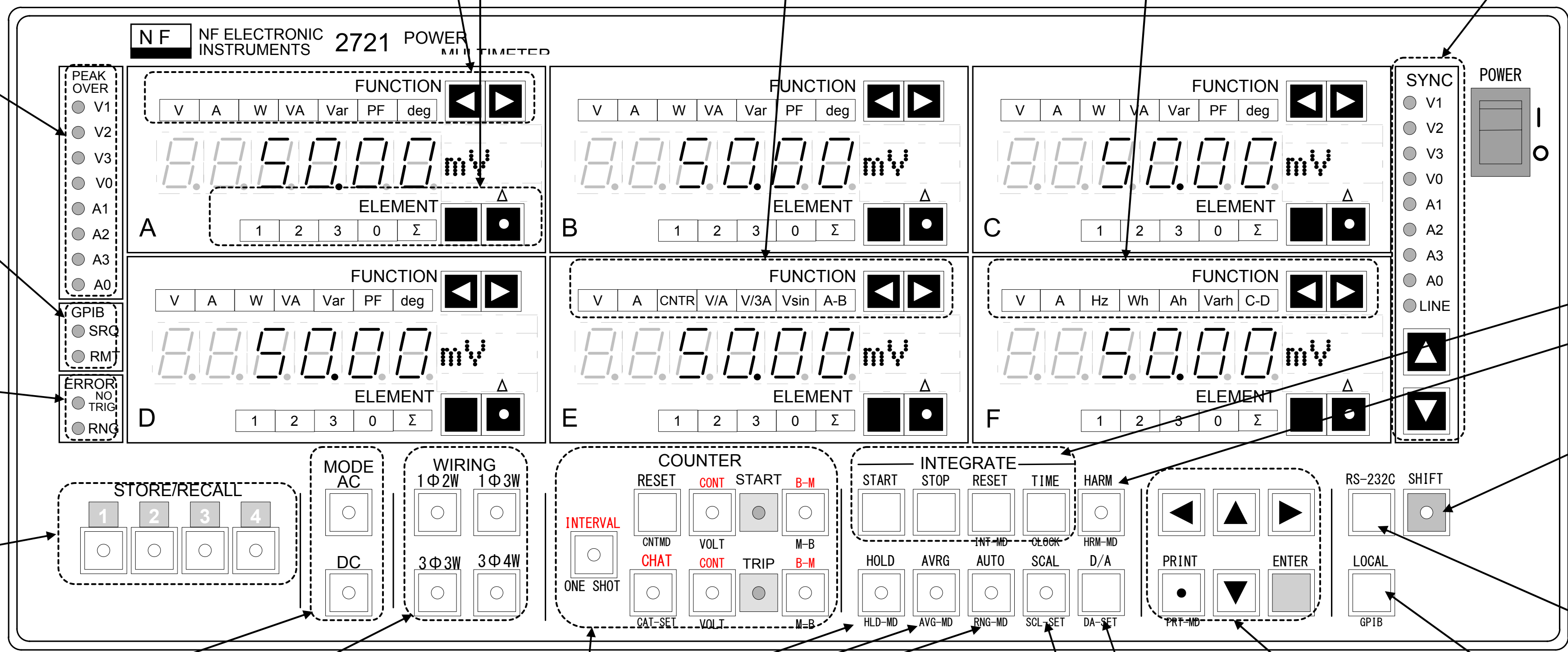
Error display
NO TRIG
Lights up when SYNC signal is not input.
RNG
Lights up when an input signal varies and a range is indefinite.

Display setting and recall keys (p.3-19)
STORE/RECALL [1],[2],[3],[4]
Four measurement item settings can be stored.

Measurement mode setting keys (p.3-15)
AC
Switches the measurement mode to AC mode.
The r.m.s. value is displayed.
DC
Switches the measurement mode to DC mode.

Wiring type setting keys (p.3-15)
1ϕ2W, 1ϕ3W, 3ϕ3W, 3ϕ4W
Sets the wiring conditions of calculating function.
If [Σ] is set for ELEMENT, the calculation result for the displayed and set wiring is displayed.

Note:
When a counter setting key is turned on (lamp ON), the function of red characters (upper side of key) is active, or when it is turned off (lamp OFF), the function of black characters (lower side of key) is active.



Integrating function keys (P.5-2)
Integrating function keys.
START
Start the integration.
STOP
Stops the integration.
RESET
Resets the integrated result.
TIME
Displays the integrated time.
SHIFT + INT-MD(p.5-4)
Activates the integration setting mode.
SHIFT + CLOCK(p.6-8)
Activates the date and time setting mode.

Harmonic measurement key
Inactive (To be set as an option)

SHIFT key
SHIFT
Press this key before pressing a setting mode key. The function indicated with blue characters on the lower side of key becomes active.

RS-232C setting key (p.7-3)
RS-232C
Activates the RS-232C setting mode.

GPIB / LOCAL key (p.7-2)
LOCAL
Switches the mode from remote to local.
SHIFT + GPIB
Activates the GPIB setting mode.

Cursor keys (p.6-3)
Use these keys in respective setting modes.
PRINT key
Inactive (To be set as an option)
SHIFT + ENTER(p.8-6)
Activates the calibration setting mode.

Auto range setting on/off key
AUTO(p.3-15)
Turns on/off the auto range function.
SHIFT + RNG-MD(p.6-6)
Activates the range display/setting mode.

Average function on/off key
AVRG(p.3-15)
Turns on/off the average function.
SHIFT + AVG-MD(p.6-5)
Activates the average setting mode.

Hold function on/off key
HOLD(p.3-15)
Holds the display.
Since this key only cancels the reading of waveform, if FUNCTION/ELEMENT is changed, the measured values of another parameters can be displayed even in the Hold state.
SHIFT + HLD-MD(p.6-4)
Activates the hold mode setting mode.

Analog output key
Inactive
(To be set as an option)

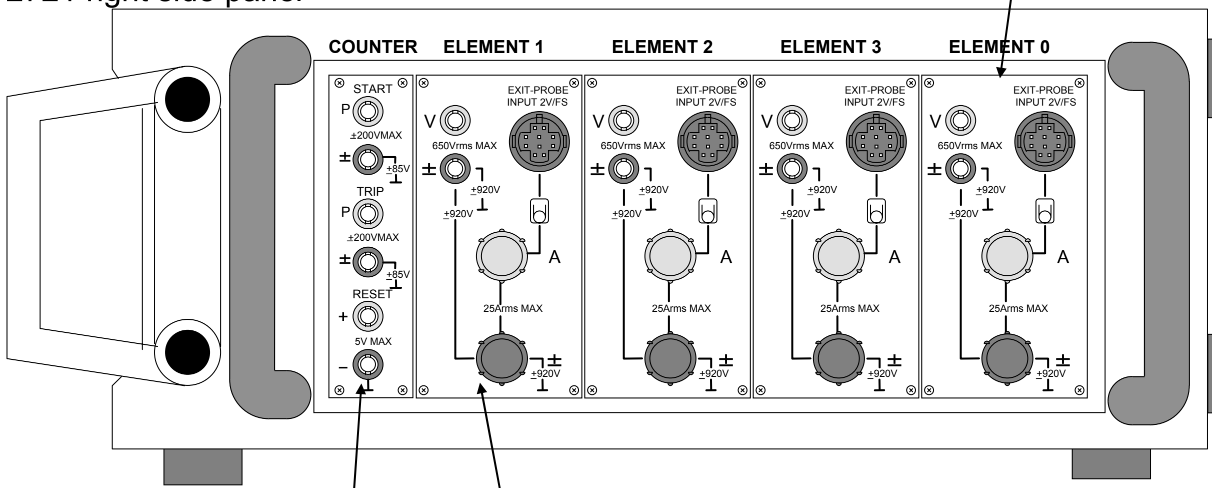
Scaling function on/off key
SCAL(p.3-15)
Turns on/off the scaling function.
SHIFT + SCL-SET(p.6-7)
Activates the scaling setting mode.

Counter measurement condition setting keys (p.4-5)
INTERVAL / ONE SHOT
Selects the interval mode or one shot mode.
When the lamp lights up, the interval mode is selected.
RESET
Reset key
CHAT
Turns on/off the chattering eliminating function.
CONT / VOLT
Switches the input format to contact or voltage. When the lamp lights up, the contact input is selected.
B-M / M-B
Switches the operation mode of input.
When the lamp lights up, the operation mode is Break (contact open/voltage present) → Make (contact closed/voltage 0V). When the lamp is off, the operation mode is Make → Break.
START / TRIP lamp
Indicates the input state.
They light up when the input is active (if B-M, contact closed/voltage 0V).

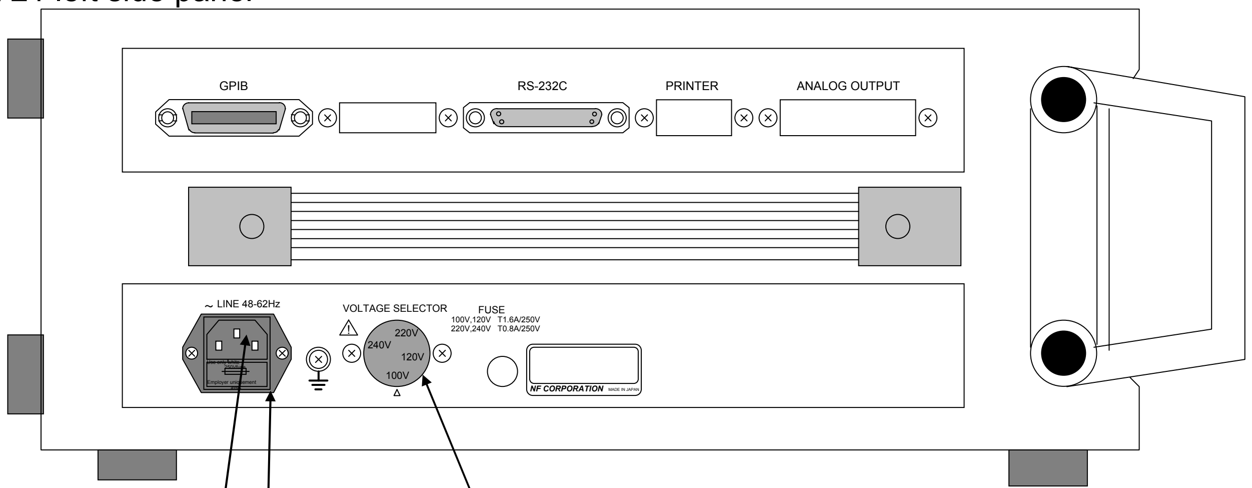
■ Side/Rear panel

2725 input unit
[Option when placing an order]

2721 right side panel



2721 left side panel



Counter input unit (p.4-4)

START
Input the counter start signal.

TRIP
Input the counter trip (stop) signal.

RESET
Input the counter data external reset signal.
For the input of start and trip signals, contact input or voltage input is selectable with the CONT/VOLT key on the front panel.
The operation mode of input is also selectable with the B-M/M-B key.
The reset signal input can be controlled on the TTL level where the counter display can be reset at 0V.

Voltage and current input unit (p.3-7)

V,±
Voltage input terminals

A,±
Current input terminals

EXT-PROBE
External current probe connector
"2726 Micro-current Probe", etc. can be connected.

Selector switch
Selects the current input. The lower position makes active the current input terminal, while the upper position makes active the external current probe connector.

Note: Do not connect to the current input terminals (A, ±) when the external current probe is used.

Power connector (p.2-3)

~ LINE 48-62Hz
3-pin connector with a protective ground terminal.
The ground terminal is separately provided on the side of power connector.

Supply voltage setting switch (p.2-3)

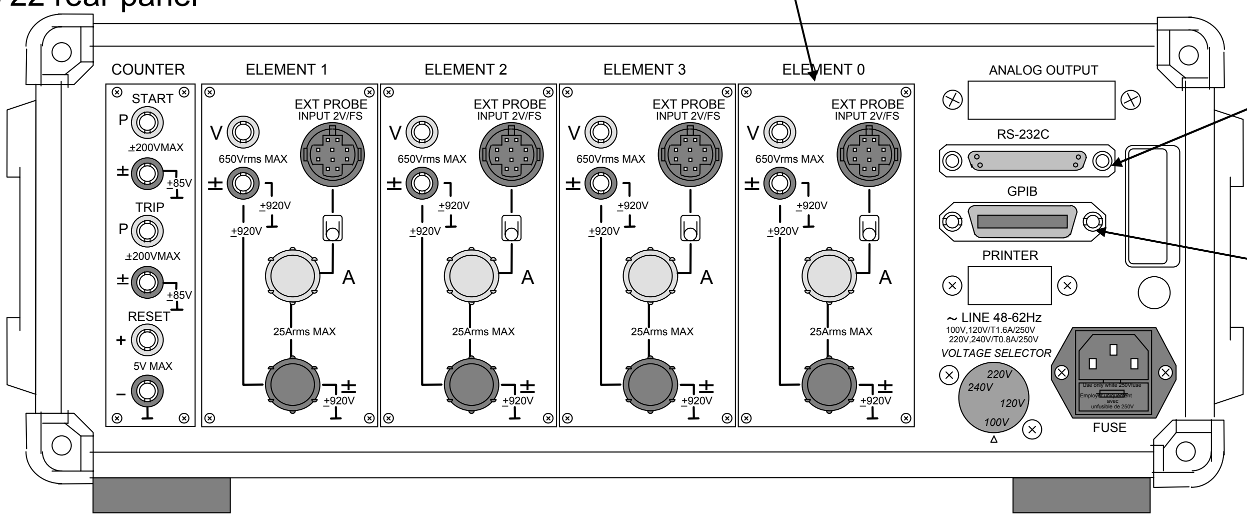
VOLTAGE SELECTOR
100V, 120V, 220V, 240V
Set the switch meeting the supply voltage used.

Power fuse holder (p.2-4)

100V/120V T1.6A/250V
220V/240V T0.8A/250V
Use the fuse meeting the supply voltage used. A spare fuse is contained in the holder.

2725 input unit
[Option when placing an order]

2722 rear panel



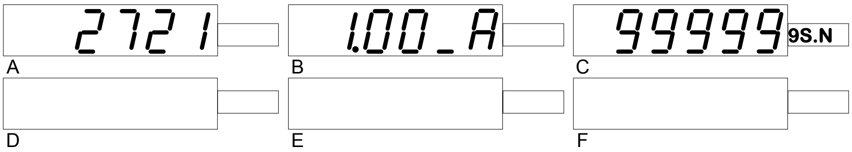
RS-232C connector (p.7-8)
Connect the RS-232C cable when making communication via RS-232C interface.

GPIB connector (p.7-4)
Connect the GPIB cable when making communication via GPIB interface.

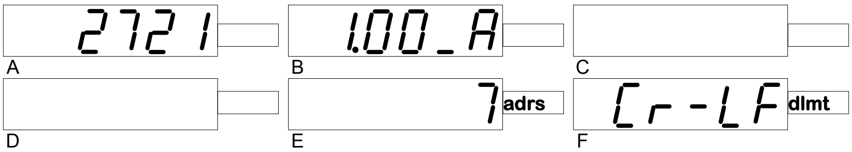
3.1 Operation at Power ON

■ Display when the power is turned on

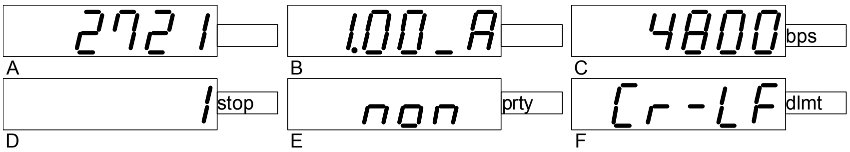
When the power switch is turned on, the test program starts to conduct a test. The contents of a test are RAM check, ROM check, etc.
At the power ON, the opening message as shown below is displayed.

(1)


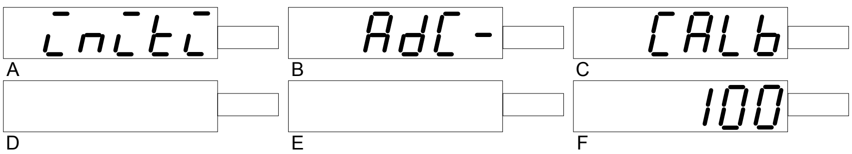
The Display **A** shows the model name **"2721"** or **"2722"**.
The Display **B** shows a program version. As the program version is subject to change, actual version shown on your Display may be different from this description.
The Display **C** shows the last 6 digits of a serial number of the product. The 6-digit number is composed of 7-segment 5 digits (99999) + 1-digit unit indication (9).

(2)


The Display **E** shows GPIB address setting, and Display **F** shows GPIB delimiter setting (factory setting: 7 adrs, CRLF).

(3)


The Display **C** shows RS-232C baud rate setting, Display **D** shows stop bit setting, Display **E** shows parity setting, and Display **F** shows delimiter setting (factory setting: 4800bps, 1 stop, NON, CR-LF).

(3)


The internal AD converter is calibrated. The Display **F** counts down from 100 to 0.

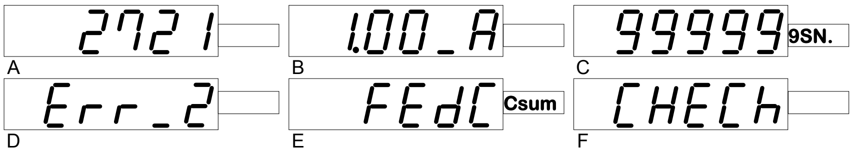
To measurement operation

Note

The warm-up time until all specifications are satisfied is about 30 minutes.

● Display in case of RAM/ROM error

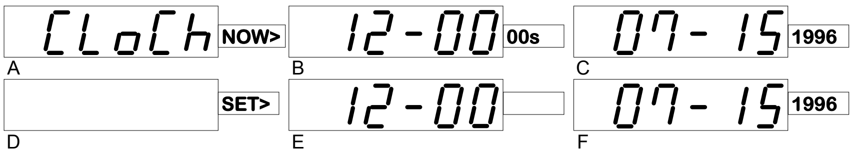
When RAM/ROM error occurred, the display of (1) on previous page is as shown below.



The Display **D** shows an error number (Error 2 in above case), Display **E** shows checksum data of ROM, and Display **F** shows a comment that requires a check. When an error is displayed, please contact NF Corporation one of our representatives.

■ Display/setting of date and time setting mode

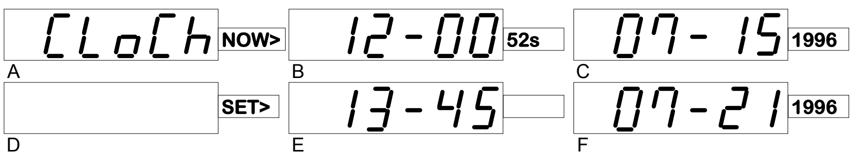
When the power switch is turned on, the "date and time setting mode" is activated unless the internal clock has been set.



- Display A: "CLoCk" — Indicates the date and time setting mode.
  - NOW> — Indicates that Displays **B** and **C** are internal time and internal date.
  - SET> — Indicates that Displays **E** and **F** are set time and set date.
- Display B: "12-00 00s" — Internal time (12H00M00S)
- Display C: "07-15 1996" — Internal date (July 15, 1996)
- Display D: "12-00 00s" — Set time (12H00M00S)
  Initial value is same as internal time on Display **C**.
- Display E: "07-15 1996" — Set date (July 15, 1996)
  Initial value is same as internal date on Display **C**.
  Year changes like "1996↔1997↔1998↔1999↔2000↔ ....".

A setting method is as follows:

- Cursor initial value ➔ Year "96" on Display **F**
- Setting method ➔ Year month day and hour minute are incremented or decremented by ▲ , ▼ keys.
- Setting canceling method ➔ TIME / CLOCK or SHIFT + TIME / CLOCK

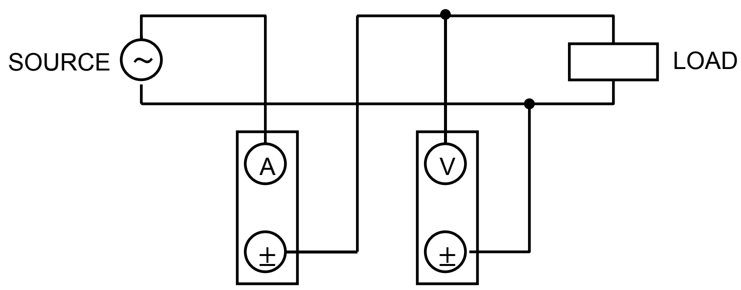


[Example] To change the day 15 to day 21, press ◀ key to move the cursor (blinking) to day "15" and press ▲ key 6 times.

3.2 Connecting Voltage and Current Cables

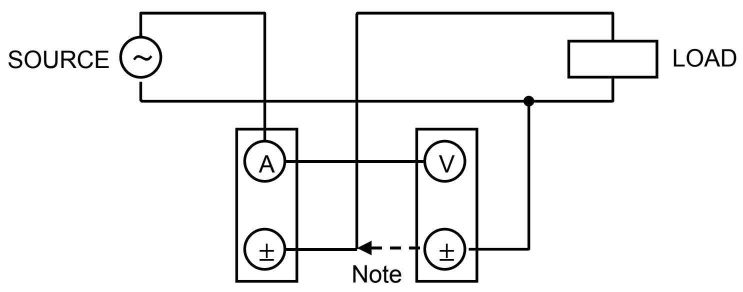
■ Precautions when connecting voltage and current cables

Connect the voltage and current to be measured to the voltage input terminals **"V, ±"** and current input terminals **"A, ±"** of each element panel.
For both voltage and current, the "±" terminal is the reference of the phase. Take care not to connect the cables reversely in the measurements of phase difference, active power, reactive power, and power factor that are affected by the phase.
The input impedance of voltage input terminal is about 1MΩ, and the impedance of current input terminal is about 5mΩ (contact resistance of the terminal is not included). To measure the electric power precisely, perform the wiring so that these influences are minimized.
Usually, in a case with small voltage and large current, perform the wiring as shown in **"Figure 3-1 Voltage and Current Cable Connection Diagram (1)"** to eliminate the influence of voltage drop due to the current sensing resistor. Also, in a case with large voltage and small current, perform the wiring as shown in **"Figure 3-2 Voltage and Current Cable Connection Diagram (2)"** to minimize the influence of voltage input impedance.



A: Large current V: Small voltage

Figure 3-1 Voltage and current cable connection diagram (1)



A: Small current V: Large voltage

Note: In the wiring in the left figure, the self power consumption of this product can be obtained by re-connecting the "±" terminal of voltage to the "±" terminal of current. True load power can be obtained by subtracting this value from the measured power.

Figure 3-2 Voltage and current cable connection diagram (2)

Note

The voltage and current measurement display does not become "0.0000" because of the residual noise or offset voltage even if the SYNC signal is set to LINE in the voltage input short-circuit and current input open states.
The device will be normal if the voltage is around several mV and the current around several 100μA after the warm-up.

■ Connection for voltage measurement

Connect the voltage to be measured to the voltage input terminals **"V, ±"** of the element panel. The "±" terminal is the reference of the phase. Take care not to connect the cables reversely in the measurement of phase difference.
The **FUNCTION** and **ELEMENT** settings and the contents of display are shown as a panel setting example. For the voltage measurement, the **WIRING** setting of a wiring type is not applicable.

● Voltage cable connection method in single-phase voltage measurement

FUNCTION	ELEMENT	Contents of display
V	1 / 2 / 3 /(0)	Voltage of ELEMENT 1/2/3/(0)

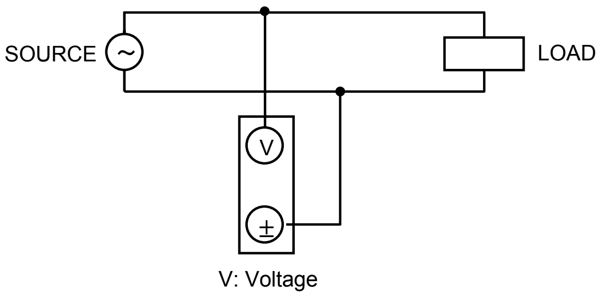


Figure 3-3 Single-phase voltage cable connection diagram

● Voltage cable connection method in 3-phase 3-wire type line voltage measurement

FUNCTION	ELEMENT	Contents of display
V	1	Voltage of ELEMENT 1 (RS line voltage)
	2	Voltage of ELEMENT 2 (ST line voltage)
	1 + 2 + △	Line voltage of ELEMENT 1-2 (RT line voltage)

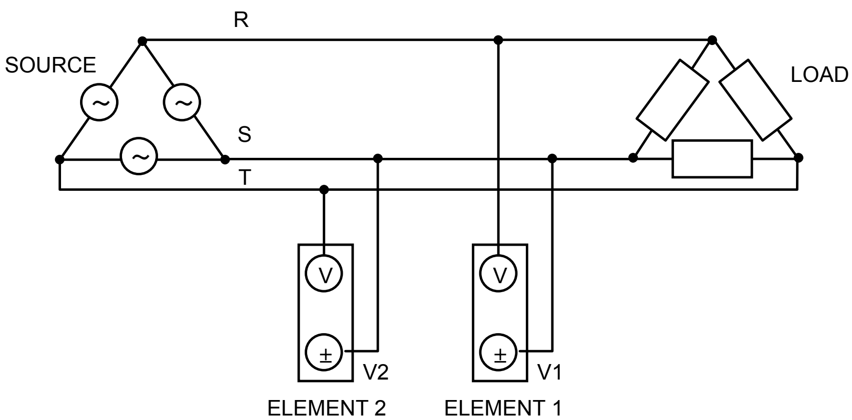
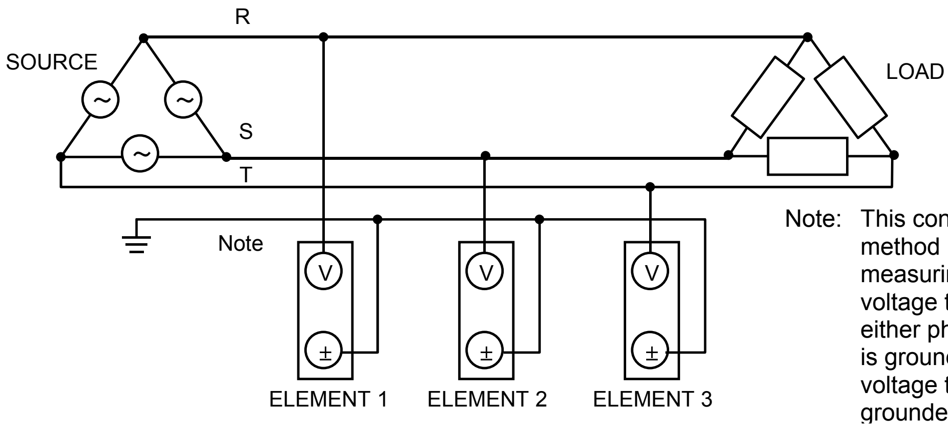


Figure 3-4 3-Phase 3-wire type voltage cable connection diagram (1)

- **Voltage cable connection method in 3-phase 3-wire type phase voltage measurement (to ground)**

FUNCTION	ELEMENT	Contents of display
V	1	Voltage of ELEMENT 1 (R phase voltage)
	2	Voltage of ELEMENT 2 (S phase voltage)
	3	Voltage of ELEMENT 3 (T phase voltage)
	1 + 2 + △	Line voltage of ELEMENT 1-2 (RS line voltage)
	2 + 3 + △	Line voltage of ELEMENT 2-3 (ST line voltage)
	3 + 1 + △	Line voltage of ELEMENT 3-1 (TR line voltage)



Note: This connection method is for measuring the voltage to ground. If either phase of RST is grounded, the voltage to the grounded phase is

Figure 3-5 3-Phase 3-wire type voltage cable connection diagram (2)

- **Voltage cable connection method in 3-phase 4-wire type wiring**

FUNCTION	ELEMENT	Contents of display
V	1	Voltage of ELEMENT 1 (R phase voltage)
	2	Voltage of ELEMENT 2 (S phase voltage)
	3	Voltage of ELEMENT 3 (T phase voltage)
V	1 + 2 + △	Line voltage of ELEMENT 1-2 (RS line voltage)
	2 + 3 + △	Line voltage of ELEMENT 2-3 (ST line voltage)
	3 + 1 + △	Line voltage of ELEMENT 3-1 (TR line voltage)

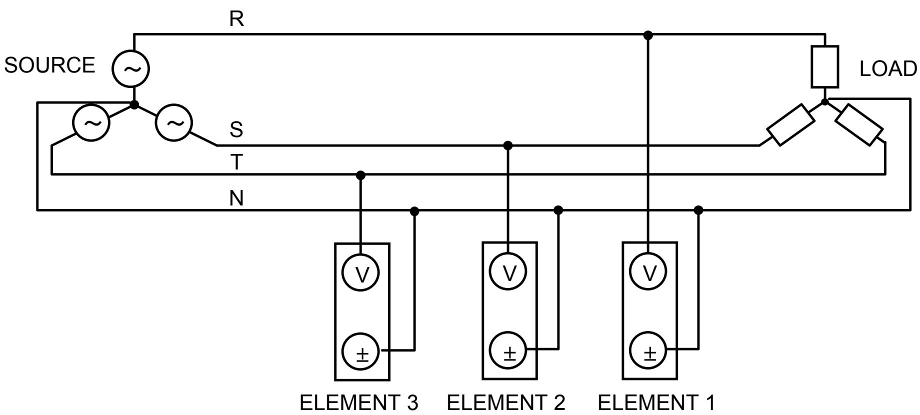


Figure 3-6 3-Phase 4-wire type voltage cable connection diagram

■ Connection for current measurement

Connect the current to be measured to the current input terminals **“A, ±”** of the element panel. The **“±”** terminal is the reference of the phase. Take care not to connect the cables reversely in the measurement of phase difference.
The **FUNCTION** and **ELEMENT** settings and the contents of display are shown as a panel setting example. For the current measurement, the **WIRING** setting of a wiring type is not applicable.

● Current cable connection method in single-phase

FUNCTION	ELEMENT	Contents of display
A	1 / 2 / 3 /(0)	Current of ELEMENT 1/2/3/(0)

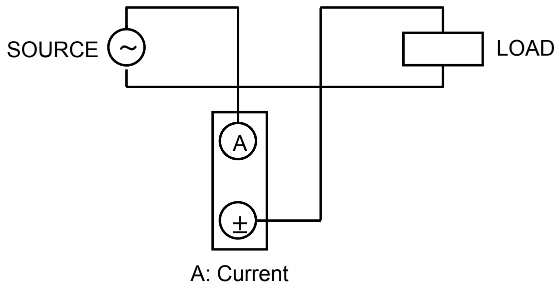


Figure 3-7 Single-phase current cable connection diagram

● Current cable connection method in 3-phase 3-wire type

FUNCTION	ELEMENT	Contents of display
A	1	Current of ELEMENT 1 (R phase current)
	2	Current of ELEMENT 2 (S phase current)
	3	Current of ELEMENT 3 (T phase current)

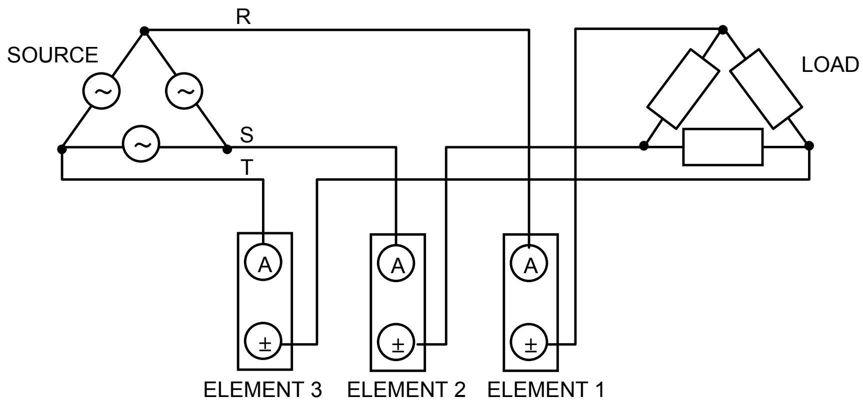
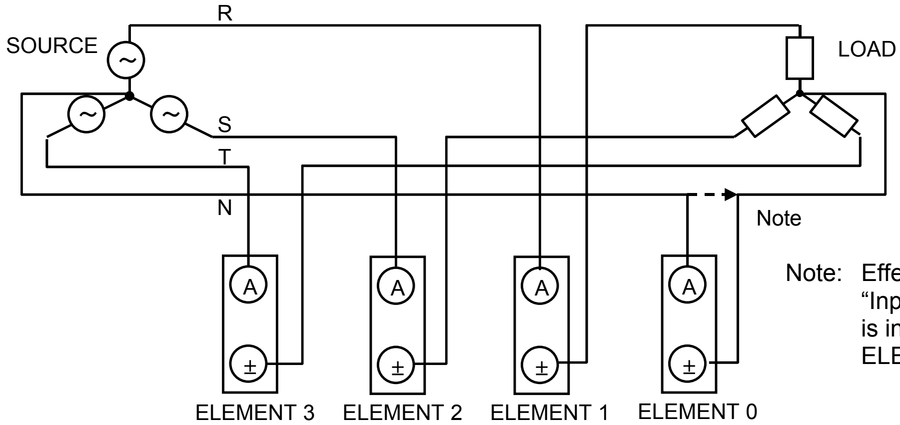


Figure 3-8 3-Phase 3-wire type current cable connection diagram

- **Current cable connection method in 3-phase 4-wire type**

FUNCTION	ELEMENT	Contents of display
A	1	Current of ELEMENT 1 (R phase current)
	2	Current of ELEMENT 2 (S phase current)
	3	Current of ELEMENT 3 (Tphase current)
	0 Note	Current of ELEMENT 0 (N phase current)



Note: Effective if the "Input Unit 2725" is installed in ELEMENT 0.

Figure 3-9 3-Phase 4-wire type current cable connection diagram

■ Connection for power measurement

● Power measurement in single-phase 2-wire type wiring

If both voltage and current are in the specification range, select one of three pairs of input voltage and current terminals, and perform the wiring as shown in **"Figure 3-10 Voltage and current cable connection diagram"**.
In this case, when **three** pairs are connected to the separate **SOURCES**, if the frequency is same, all inputs can be measured, but if the frequency is different, only the input selected with **SYNC** is measured normally.
The maximum measurement range is the voltage input 650Vrms, and the current input 25Arms. Accordingly when larger voltage or current is measured, connect an external potential transformer (PT) or external current transformer (CT) as shown in **"Figure 3-11 PT and CT connection diagram"**.
Instead of external current transformer, the clamp-on probe (20A, 200A) can be connected to the external current probe input.

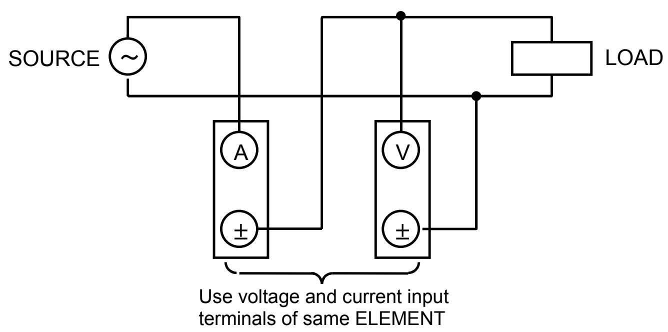


Figure 3-10 Voltage and current cable connection diagram

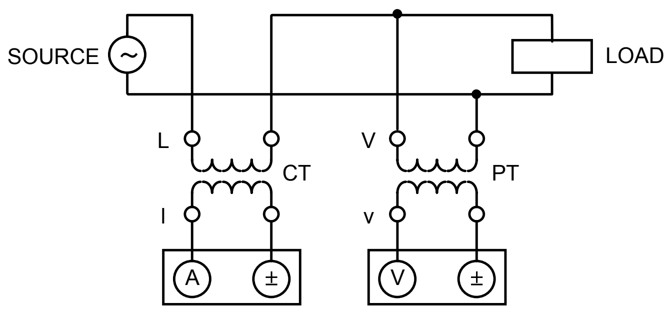


Figure 3-11 PT and CT connection diagram

● Power measurement in 3-phase 3-wire type wiring

To measure the electric power (balanced load) in the 3-phase 3-wire type wiring (symmetric 3-phase AC), perform the wiring of 2 pairs of voltage and current input terminals as shown in **"Figure 3-12 3-Phase 3-wire type voltage and current cable connection diagram"**.
In this case, connect to V1, A1 and V3, A3. In other connections, the electric power cannot be measured normally.
By setting the **WIRING** key to **"3ϕ3W"** type wiring and the **ELEMENT** to [Σ], the calculation result shown in **"Table 3-1 Arithmetic expression of 3-phase 3-wire type wiring"** is displayed.

WIRING	FUNCTION	ELEMENT	Contents of display	Arithmetic expression
3ϕ3W	[V]	[Σ]	3-phase voltage	$V_\Sigma=(V_1+V_3)/2$
	[A]		3-phase current	$A_\Sigma=(A_1+A_3)/2$
	[W]		3-phase active power	$W_\Sigma=W_1+W_3$
	[VA]		3-phase apparent power	$VA_\Sigma=\frac{\sqrt{3}}{2}\times(VA_1+VA_3)$
	[Var]		3-phase reactive power	$Var_\Sigma=Var_1+Var_3$
	[PF]		3-phase power factor	$PF_\Sigma=W_\Sigma/VA_\Sigma$

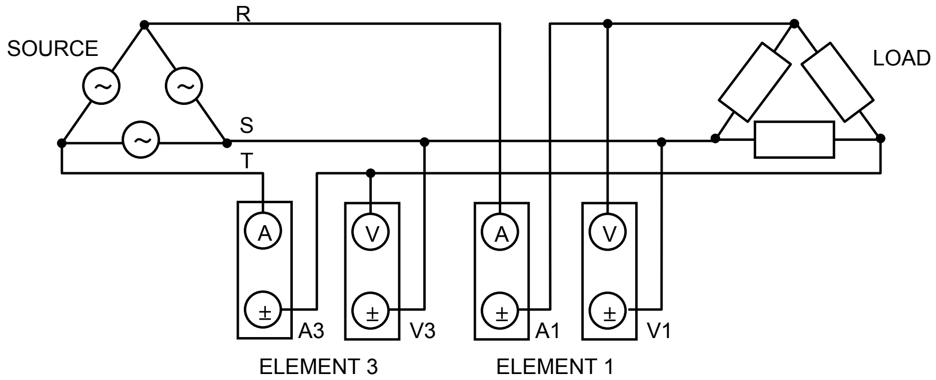


Figure 3-12 3-Phase 3-wire type voltage and current cable connection diagram

Table 3-1 Arithmetic expression of 3-phase 3-wire type wirring

FUNC,ELMT \ WIRING	Arithmetic expression of 3ϕ3W
[V],[Σ]	$V_\Sigma=\frac{V_1+V_3}{2}$
[A],[Σ]	$A_\Sigma=\frac{A_1+A_3}{2}$
[W],[Σ]	$W_\Sigma=W_1+W_3$
[VA]*,[Σ]	$VA_\Sigma=\frac{\sqrt{3}}{2}\times(VA_1+VA_3)$
[Var]*,[Σ]	$Var_\Sigma=Var_1+Var_3$
[PF]*,[Σ]	$PF_\Sigma=\frac{W_\Sigma}{VA_\Sigma}$

Note*: This arithmetic expression is established only when three phases are balanced sine waves.

● Power measurement in 3-phase 4-wire type wiring

To measure the electric power (balanced load) in the 3-phase 4-wire type wiring (symmetric 3-phase AC), perform the wiring of 3 pairs of voltage and current input terminals as shown in **"Figure 3-13 3-Phase 4-wire type voltage and current cable connection diagram"**.
By setting the **WIRING** key to **"3ϕ4W"** type wiring and the **ELEMENT** to $\boxed{\Sigma}$, the calculation result shown in **"Table 3-2 Arithmetic expression of 3-phase 4-wire type wiring"** is displayed.

WIRING	FUNCTION	ELEMENT	Contents of display	Arithmetic expression
3ϕ4W	V	Σ	3-phase voltage	$V_\Sigma=(V_1+V_2+V_3)/3$
	A		3-phase current	$A_\Sigma=(A_1+A_2+A_3)/3$
	W		3-phase active power	$W_\Sigma=W_1+W_2+W_3$
	VA		3-phase apparent power	$VA_\Sigma=VA_1+VA_2+VA_3$
	Var		3-phase reactive power	$Var_\Sigma=Var_1+Var_2+Var_3$
	PF		3-phase power factor	$PF_\Sigma=W_\Sigma/VA_\Sigma$

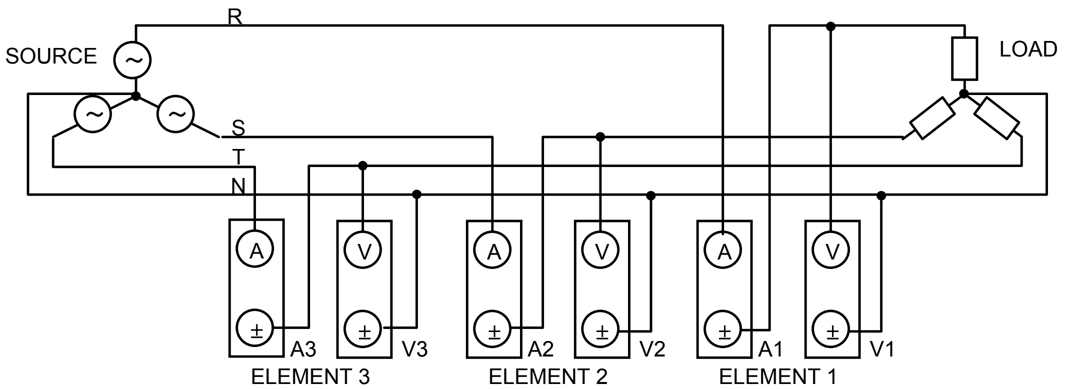


Figure 3-13 3-Phase 4-wire type voltage and current cable connection diagram

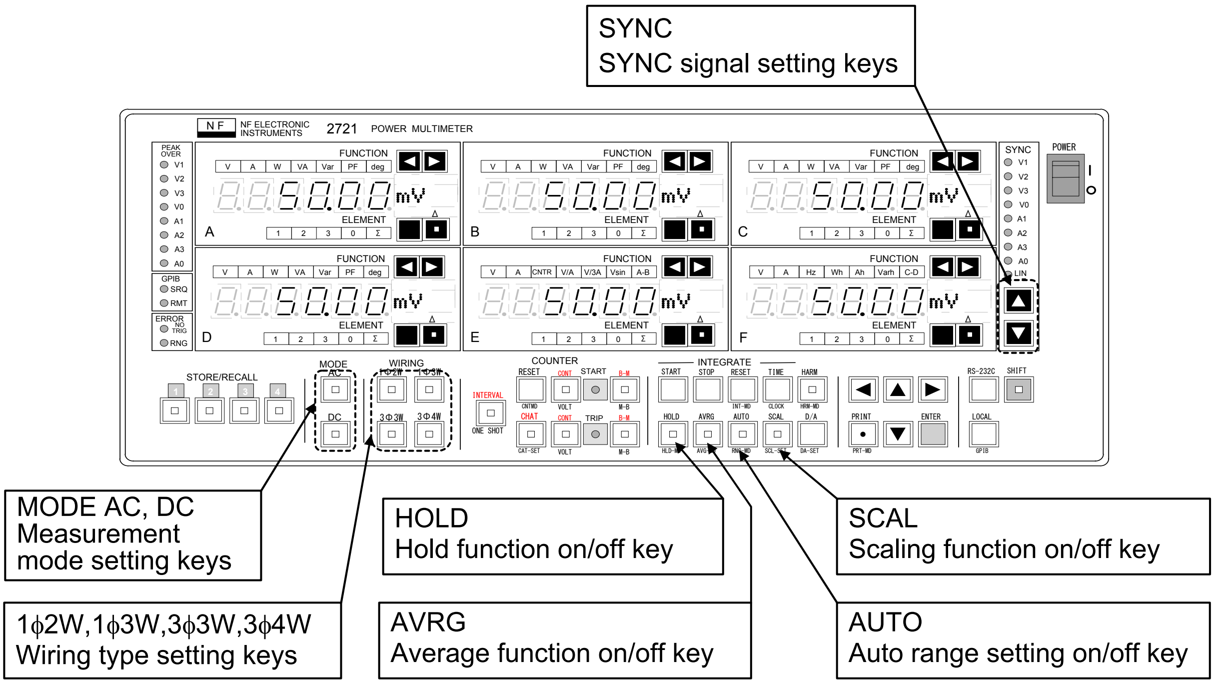
Table 3-2 Arithmetic expression of 3-phase 4-wire type wirring

WIRING / FUNC,ELMT	Arithmetic expression of 3ϕ4W
V, Σ	$V_\Sigma=\dfrac{V_1+V_2+V_3}{3}$
A, Σ	$A_\Sigma=\dfrac{A_1+A_2+A_3}{3}$
W, Σ	$W_\Sigma=W_1+W_2+W_3$
VA*, Σ	$VA_\Sigma=VA_1+VA_2+VA_3$
Var*, Σ	$Var_\Sigma=Var_1+Var_2+Var_3$
PF*, Σ	$PF_\Sigma=\dfrac{W_\Sigma}{VA_\Sigma}$

Note*: This arithmetic expression is established only when three phases are balanced sine waves.

3.3 Setting Measurement Conditions

This section describes the setting of measurement conditions.
As the measurement conditions, the SYNC signal, measurement mode, wiring type, hold function, average function, auto range setting, and scaling function can be set.
Since the setting of measurement conditions puts large influence on the measurement, if the factory settings are changed, the descriptions should be read carefully in advance.



■ Initializing the settings

To initialize respective set values to the factory settings, turn off the power switch once, and then turn on the power switch while pressing the **LOCAL** key. For the **LOCAL** key, press it continuously until all displays light up.

Table 3·3-1 Initializing the settings (1/2)

Panel setting	Key operation	Initial set values
Displayed items	STORE/RECALL 1	V1, A1, W1, Var1, A-B, Hz
	STORE/RECALL 2	W1, W2, W3, WΣ, V/A1, Hz
	STORE/RECALL 3	degV1,degV2,degV3,degV12,V/√3A1,Hz
	STORE/RECALL 4	degA1,degA2,degA3,degA12,V/sin1,Hz
SYNC signal	SYNC	LINE
Measurement mode	MODE	AC
Wiring type	WIRING	1ϕ2W
Counter	INTERVAL/ONE SHOT	INTERVAL(OFF)
	CHAT	OFF
	CONT/VOLT,B-M/M-B	VOLT(OFF), M-B(OFF)
Display hold	HOLD	OFF
Measurement average function	AVRG	ON
Scaling function	SCAL	OFF

Table 3·3-2 Initializing the settings (2/2)

Panel setting	Key operation	Initial set values
Counter mode	Interval mode	Single mode (SinGL)
	One Shot mode	One Shot mode (onESt)
	External reset function	OFF
	Trip input threshold	2.5V(trP2.5±)
Chattering	Time setting	100ms
Measurement condition setting	Phase display	0 to 360deg
	External hold function	OFF
Average setting	Moving average count	1 time
	Wavenumber average count	8 times
Scaling setting	Mode setting	All setting (ALL)
	Scaling value	1.0000
Integration setting	Integrate mode	Manual mode (norML)

■ Setting SYNC signal SYNC ▲,▼

Be sure to set the SYNC signal when the measurement mode is **AC**.
As the SYNC signal, set either one of **V1, V2, V3, V0, A1, A2, A3, A0,** and **LINE**. To select the SYNC signal, use ▲,▼ keys. The lamp of the selected signal in the **SYNC** display block lights up. The **V0** and **A0** do not light up if the **"2725 Input Unit (for ELEMENT 0)"** is not installed.

Note

The minimum level of SYNC input signal is <u>about 0.1V</u> for voltage and <u>about 4mA</u> for current.
When a signal smaller than the minimum level is measured, set the SYNC signal to the input signal larger than the minimum level of SYNC input signal which is synchronized with the signal to be measured.
ince the larger SYNC signal level enables the measurement at higher accuracy, set the input signal as large as possible.

Note

When measuring an input signal not synchronized with the power supply, exact measurement will not be performed if the SYNC signal is set to LINE.
Be sure to set the SYNC signal to the input signal which is synchronized with the signal to be measured.

■ Setting measurement mode MODE AC , DC

Select the mode to measure the voltage, current, or electric power. The **AC** or **DC** mode is selectable by pressing the **MODE AC** key or **DC** key on the front panel. The lamp on the selected key lights up.

- **AC**
  AC component and DC component of the input voltage and current are measured, and "true r.m.s. value" is displayed. All functions are operative.

- **DC**
  Select this mode when input voltage and current are direct current. The input voltage and current are simply averaged and displayed. Only the voltage, current, and electric power of the functions are operative. Apparent power, reactive power, power factor, and phase related functions are inoperative (– – – – – display).

■ Setting wiring type WIRING 1ϕ2W , 1ϕ3W , 3ϕ3W , 3ϕ4W

To measure electric power by using the calculating function, press either one of **WIRING** keys **1ϕ2W, 1ϕ3W, 3ϕ3W, 3ϕ4W** on the front panel according to the actual wiring type.
If the **ELEMENT** is set to Σ, the calculation is executed by arithmetic expression of the set wiring type and the result is displayed.
For the cable connection method and arithmetic expression of the 3-phase power measurement, see **"Connection for power measurement" (p.3-12)**.

■ Hold function HOLD HOLD-MD

To hold the measured value, press the **HOLD** key.
If the **HOLD** key is pressed, the lamp on the **HOLD** key lights up, indicating the hold state.
If the **HOLD** key is pressed again, the lamp on the **HOLD** key goes off and the measurement starts.

- **Operation in hold state**
  In the hold state, the reading of voltage and current inputs is stopped. However, the calculating operation is executed, and accordingly if the **FUNCTION** or **ELEMENT** is switched in the hold state, the waveform data read before the hold are calculated and the result is displayed.

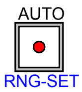
■ Measurement average function

To use the average function, press the **AVRG** key.
If the **AVRG** key is pressed, the lamp on the **AVRG** key lights up and the average function turns on.
If the **AVRG** key is pressed again, the lamp on the **AVRG** key goes off and the average function turns off.
For the average setting, see **"6.4 Average Setting Mode (AVG-MG)" (p.6-5)**.

Note

The average function of this product has "the moving average and the wavenumber average" which can be set separately.
For the moving average count, increase the count setting if the display is unstable at low frequencies. However, larger setting retards the response when the input level changes abruptly.
For the wavenumber average count, increase the count setting if the display is unstable at rapid cycles. However, larger setting retards the display updating cycle, and dampens the acceptance of operation keys.

■ Auto range setting



To switch the voltage and current measurement ranges, the auto range setting for switching the range automatically and the manual range setting for switching the range manually are available.

● Auto range setting

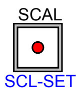
During the auto range setting, the lamp on the **AUTO** key is lighting. If the lamp on the **AUTO** key is in off state, press the **AUTO** key so that its lamp lights up.
Usually, use the auto range setting. In the auto range setting, the range that meets the input signal level is selected.

● Manual range setting

If the auto range setting is not used, press the **AUTO** key to turn off the lamp on the **AUTO** key. Use the manual range setting when pulse-shaped waveforms are input and the range cannot be kept constant.

To check the range in auto range setting mode or to change the range in manual range setting mode, see **"6.5 Range Display and Setting (RNG-SET)" (p.6-6)**.

■ Scaling function

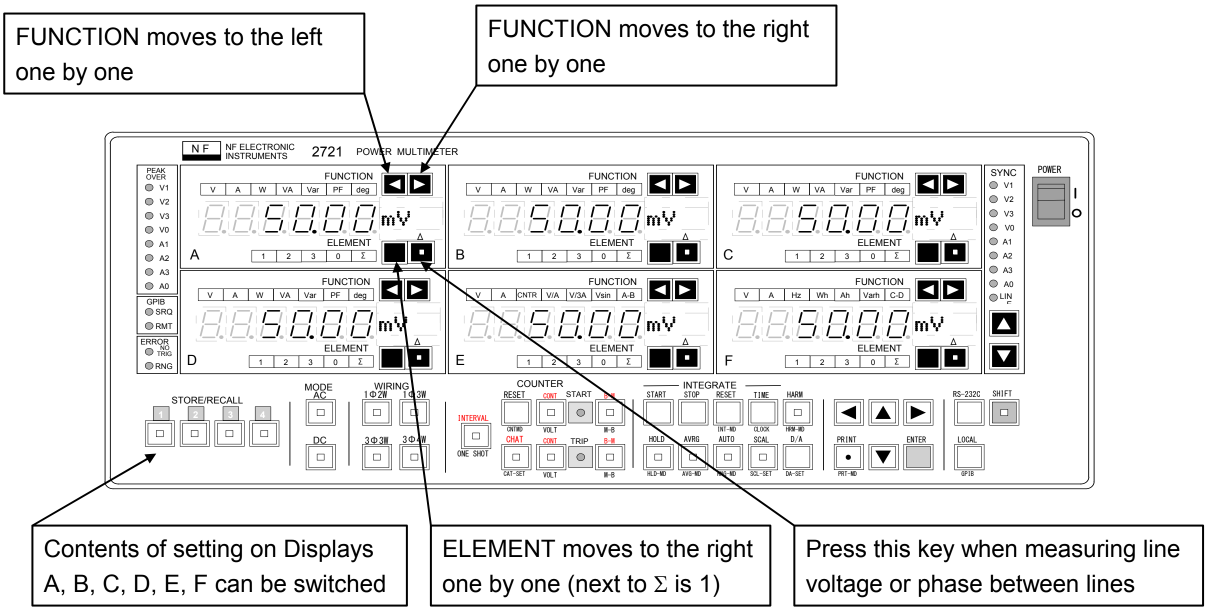


To use the scaling function, press the **SCAL** key to turn on the lamp on the **SCAL** key.
If the scaling function is not used, press the SCAL key again to turn off its lamp.
During use of the scaling function, the measured value multiplied by the scaling value is displayed.
For setting the scaling value, see **"6.6 Scaling Setting (SCL-SET)" (p.6-7)**.

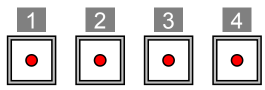
3.4 Setting Displays A, B, C, D, E, F

■ Selecting display item and input element

This product has six Displays **A, B, C, D, E,** and **F**. Set the items and input elements to be displayed on respective Displays. For this purpose, select the items to be displayed by using the **FUNCTION** keys and **ELEMENT** keys provided on respective Displays.



■ Operating STORE/RECALL (display switching) keys



By pressing the **STORE/RECALL** [1], [2], [3], [4] keys, <u>the contents of **FUNCTION** and **ELEMENT** settings on the Displays **A, B, C, D, E, and F**</u> can be switched.
The settings of measurement mode, wiring type, counter, etc. cannot be switched.
The contents of **STORE/RECALL** of the number being displayed (its lamp ON), i.e. the contents of the memory of that number are updated each time the **FUNCTION** key or **ELEMENT** key is pressed.
Accordingly, the contents of settings immediately before the power is turned off or the **STORE/RECALL** key is pressed are always stored in the memory, not requiring the **STORE** operation.

Though six displays are provided, the contents of display can be changed easily by pressing the **STORE/RECALL** [1], [2], [3], [4] keys, and therefore 24 displays can be set. Even in the display hold state, if the **STORE/RECALL** key is switched, the calculation is executed based on the waveform data, and thus multiple items can be measured synchronously.

■ Operating FUNCTION keys

If a **FUNCTION** key is pressed, the display item is switched. Though the item is different depending on the Display, The key operation and display changing way are same.

Shift with ▶ key / Shift with ◀ key

Displays A,B,C,D	FUNCTION	Contents of display
	V	Phase voltage
	A	Phase current
	W	Active power
	VA	Apparent power
	Var	Reactive power
	PF	Power factor
	V , A , deg	Phase difference between voltage and current of phase (reference on voltage)
	V , deg	Voltage phase difference (reference on SYNC signal)
	A , deg	Current phase difference (reference on SYNC signal)
	V , deg	Voltage phase between lines (between 1-2, 2-3, 3-1) △ lamp ON
	A , deg	Current phase between lines (between 1-2, 2-3, 3-1) △ lamp ON

Shift with ▶ key / Shift with ◀ key

Display E	FUNCTION	Contents of display
	V	Voltage
	A	Current
	CNTR	Counter data
	V/A	Impedance (V / A)
	V/3A	Impedance ($\mathrm{V} / (\sqrt{3} \times \mathrm{A})$)
	Vsin	Impedance ($\mathrm{V} / (2 \times \mathrm{A} \times \sin\phi)$)
	A-B	Phase difference between Displays A and B (reference on Display A)

Shift with ▶ key / Shift with ◀ key

Display F	FUNCTION	Contents of display
	V	Voltage
	A	Current
	Hz	Frequency of SYNC signal
	Wh	Integration active power
	Ah	Integration current
	Varh	Integration reactive power
	C-D	Phase difference between Displays C and D (reference on Display C)

■ Operating ELEMENT keys in phase measurement

If an **ELEMENT** key is pressed, the input to be measured is selected.
0 is not selected when optional **"2725 Input Unit (for ELEMENT 0)"** is not installed.

Displays **A**,**B**,**C**,**D**,**E**,**F**	ELEMENT	Contents of display
Shift with ELEMENT key	**1**	Measured value of ELEMENT 1
	2	Measured value of ELEMENT 2
	3	Measured value of ELEMENT 3
	0	Measured value of ELEMENT 0 (selectable only when 2725 is installed)
	Σ	Calculation result of arithmetic expression selected by the wiring type

■ Operating ELEMENT keys in line measurement

When the **FUNCTION** is set to **V** or **deg**, the line measurement mode is activated if the △● key is pressed.
If the △● key is pressed, its lamp lights up and two of ELEMENT **1**, **2**, **3** light up. For example, if **2** lights up with **1** lit at the same time, the line between phase 1 and phase 2 is selected.
If the key is pressed again with the lamp lit, the lamp goes off and the **ELEMENT** display changes to one.

Displays **A**,**B**,**C**,**D**,**E**,**F**	ELEMENT	Contents of display
Shift with ELEMENT key	**1**, **2**, △●	Measured values of V12 line voltage and phase
	2, **3**, △●	Measured values of V23 line voltage and phase
	3, **1**, △●	Measured values of V31 line voltage and phase

3.5 Measuring Voltage, Current, Power, Power Factor, and Phase Difference

■ Setting FUNCTION and ELEMENT

Set the item and input to be measured by pressing the **FUNCTION** key and **ELEMENT** key on the Displays **A, B, C, D, E,** and **F**. Set the **WIRING** if the **ELEMENT** is set to Σ.
However, the electric power and power factor cannot be measured with the Displays **E** and **F**.
Also, the phase measurement is partially different.

■ Setting measurement conditions

Set the measurement conditions by referring to **"3.3 Setting Measurement Conditions"**.
To measure **AC** signals, be sure to press the **AC** key of the measurement mode setting keys to turn on the **AC** key lamp.

■ Measuring voltage and current

● Measuring phase voltage and phase current

To measure the phase voltage, turn off the  key lamp of the **ELEMENT**.

● Measuring line voltage

In the 3-phase 3-wire or 3-phase 4-wire type wiring, the line voltage can be calculated from the phase voltage and the interphase phase.
Set the **FUNCTION** to **V**, and then press  key of the **ELEMENT**. Two of **ELEMENT** displays **1**, **2**, **3** light up, indicating the lines to be measured.

If V1=63.500V, V2=63.500, V1-V2=120.00deg, the line voltage between V1 and V2, V12=109.99V is displayed.

■ Measuring electric power

● Measuring active power

In the active power measurement, if a phase difference between voltage and current is 90 deg to 270 deg (90 to 180 deg, -90 to -180 deg), a minus value is displayed. If a phase difference between voltage and current is within ±90 deg and active power is displayed as a minus value, exchange the connection of voltage or current.

● Measuring reactive power

In the reactive power measurement, the polarity display is same as phase difference display, and therefore a plus sign is displayed if the current lags behind the voltage, or a minus sign is displayed if the current leads the voltage.

Note

For the plus and minus signs on the Display, "–" is displayed only for a minus value.

■ Measuring power factor

In the power factor measurement, if active power is a minus value, the power factor is also displayed with a minus sign. Also, for a phase difference between voltage and current, if the current lags behind voltage, [LEAD] is shown on the unit display, or if the current leads from voltage, [LAG] is shown.

■ Measuring phase difference

For the phase display, the lag from the reference is displayed with a plus sign.
The factory setting is 0 to 359.99 deg. If the phase display is set to ±180.00 deg, a phase difference is displayed with plus and minus signs.

● Measuring phase difference between voltage and current of same element

Press the **FUNCTION** keys to turn on [V],[A],[deg] of **FUNCTION**. Set the element to be measured with the **ELEMENT** keys.

A phase difference of current on the basis of voltage is displayed.

This measurement can be made with the Displays **A, B, C,** and **D**.

● Measuring phase difference from SYNC signal

Select the reference **SYNC** signal with the **SYNC** signal setting key.

Press the **FUNCTION** keys to turn on [V],[deg] or [A],[deg] of **FUNCTION**. Select the element to be measured with the **ELEMENT** keys.

A phase difference from the SYNC signal is displayed. This measurement can be made with the Displays **A, B, C,** and **D**. However, the measurement is disabled if the **SYNC** is set to **LINE**.

● Measuring interphase phase difference of voltage or current

Press the **FUNCTION** keys to turn on [V],[deg] or [A],[deg] of **FUNCTION**. Press △ key of **ELEMENT** keys to turn on its lamp. Two of **ELEMENT** [1],[2],[3] light up. Also, same display can be obtained by pressing the **FUNCTION** key continuously. For the operation of **FUNCTION** keys, see **"3.3.4 Setting Displays A, B, C, D, E, F"**.

A phase difference between phases of voltage or current indicated on ELEMENT is displayed. This measurement can be made with the Displays **A, B, C,** and **D**.

● Measuring phase difference of voltage or current between Displays

A phase difference of voltage or current between Displays **A** and **B**, or Displays **C** and **D** can be measured. A phase difference between Displays **A** and **B** can be shown on Display **E**, or that between Displays **C** and **D** can be shown on Display **F**.

Set the **FUNCTION** on Display **E** to [A-B], and display the voltage or current to be measured on the Displays **A** and **B**, so that a phase difference of Display **B** from the Display **A** is shown on the Display **E** with "a plus sign for lag or minus sign for lead". Similar display can be made on the Display **F**.

3.6 Other Measurements

■ Impedance measurement

Press the **FUNCTION** key on the Display **E** to select either **V / A** , **V/3A** , **Vsin** and press the **ELEMENT** key to set the input to be measured.
The result calculated with an arithmetic expression that corresponds to the selected **FUNCTION** is shown on the Display **E**.
Arithmetic expressions are as follows:

Display **E**	FUNCTION	Arithmetic expression
	V / A	V / A
	V/3A	$V / (\sqrt{3} \times A)$
	Vsin	$V / (2 \times A \times \sin\phi)$

The unit is **“ohm”** for all items.

■ Frequency measurement

Press the **FUNCTION** key on the Display **F** to select **Hz** . Set the input to be measured with the SYNC signal setting key.
The unit is **“Hz”**.

4. COUNTER FUNCTION

This chapter describes how to operate the counter function of the **“2721/2722 Power Multimeter”**.
For the description of counter function operating keys, see **“■ Names and operations of components on front panel and side/rear panel (side panel for 2721, or rear panel for 2722)”** in **“3. BASIC OPERATIONS”**.

The counter operation, signal type, and signal logic can be set on the front panel. Also, the signal input state is displayed on the front panel.
For the counter operation, the Interval mode (time difference measurement) and One Shot mode (pulse width measurement) are available.

date 2010/1/13(#7)

4. 1 COUNTER FUNCTION

■ Description of counter operation

This section describes the operation modes of the counter.

The counter operation modes can be switched with the INTERVAL/ONESHOT key. See **"4.4.3 Setting counter Measurement Conditions" (p.4-5)**.

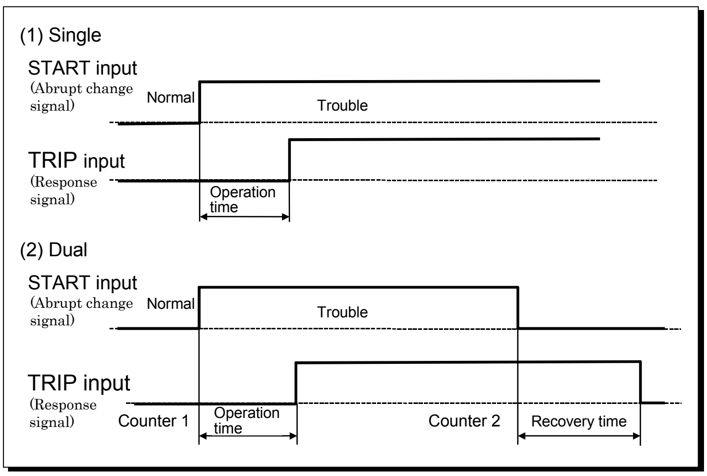
For the mode setting of respective operations, press SHIFT + RESET/CNTMD keys to activate the counter setting mode. For further information, see **"4.4.4 Counter Setting Mode" (p.4-8)**.

● INTERVAL mode (time difference measurement)

This mode is for measuring a time difference from the start signal to the trip signal.
The Interval mode provides the following three modes:

(1) Single : Either operation time or recovery time is measured.
(2) Dual : The operation time (counter 1) and recovery time (counter 2) are measured at the same time.
(3) Multi : The operation time and recovery time are measured at the same time, and respective maximum values and minimum values are stored.

In the single interval mode, the operation time or recovery time is shown on the Display **E**. In the dual interval mode, the operation time is shown on the Display **E**, and the recovery time is shown on the Display **F**. In the dual interval mode, the Displays **E** and **F** are used, and therefore the **FUNCTION** on Display **F** does not light up.
In the multi interval mode, the operation time is shown on the Display **B**, maximum value of operation time on Display **A**, minimum value on Display **C**, recovery time on Display **E**, maximum value of recovery time on Display **D**, and minimum value on Display **F** respectively. The multi interval mode uses all Displays and therefore the **FUNCTION** on Displays **A, B, C, D, E, F** do not light up. CNTR of **FUNCTION** on the Display **C** lights up.



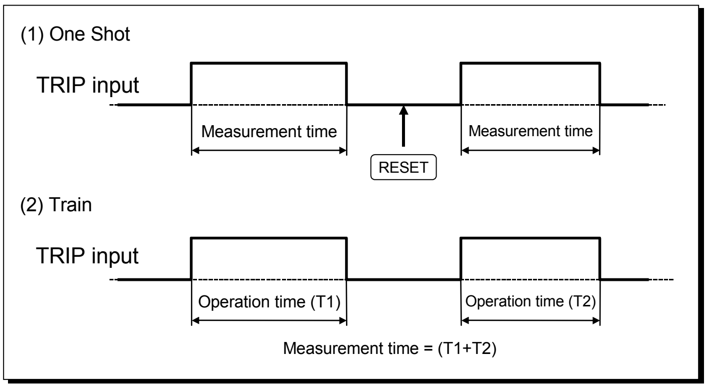
● ONE SHOT mode (pulse width measurement)

This mode is for measuring the trip signal width.
The One Shot mode provides the following two modes:

(1) One Shot : The operation time (1) shown in the following figure is measured, and then the operation time (2) is measured by the next trip input.

(2) Train : The operation time (1) is measured, and the operation time (2) is measured by the next trip input and added to (1).

In the one shot mode, the measurement result (operation time) is shown on the Display **E**.



4.2 Counter Input Terminals

The **START**, **TRIP** and **RESET** terminals have the circuits as shown below.
The START and TRIP inputs are isolated from the case. However, the RESET input has the case potential, requiring attention.
The "contact input" and "voltage input" of START and TRIP inputs are switched by the relays.
Also, the "threshold value" of TRIP input is switched by the resistors.

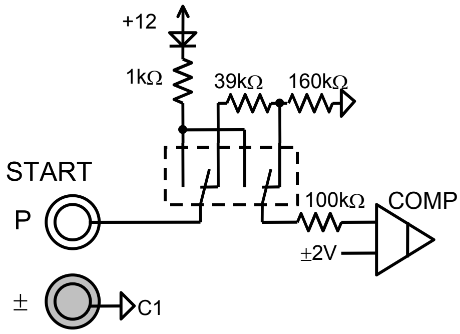
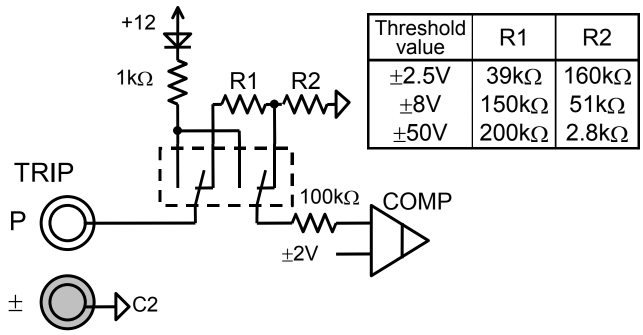


Figure 4-1 START Input Circuit



Threshold value	R1	R2
±2.5V	39kΩ	160kΩ
±8V	150kΩ	51kΩ
±50V	200kΩ	2.8kΩ

Figure 4-2 TRIP Input Circuit

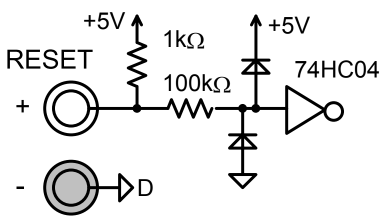
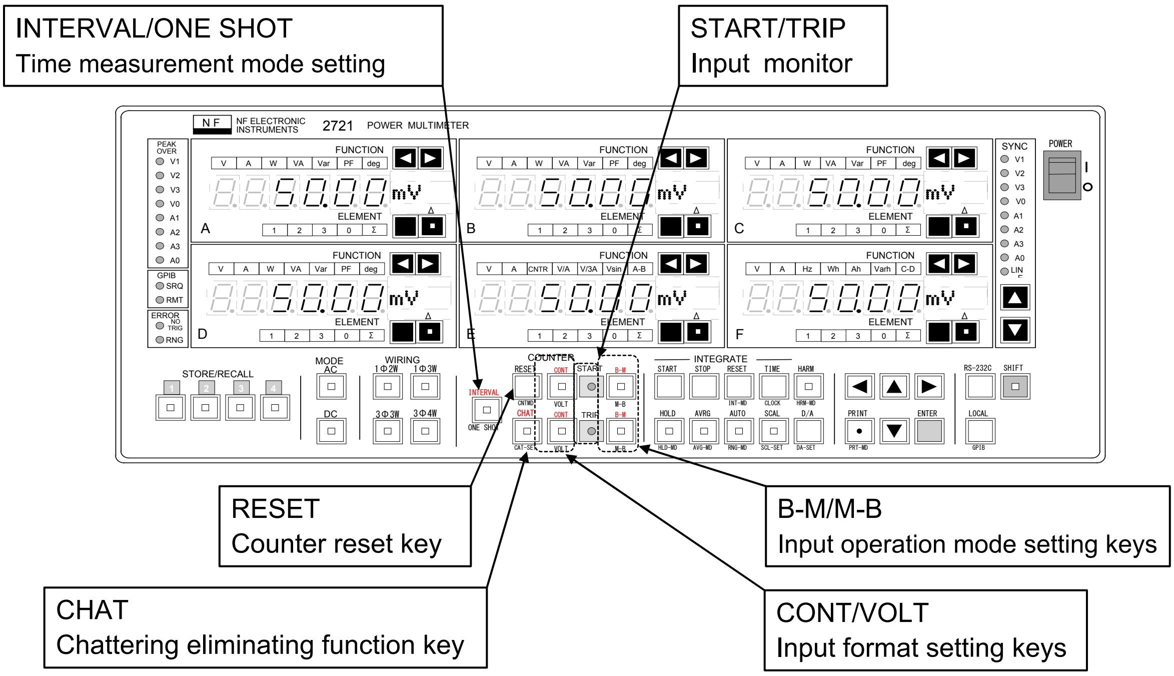


Figure 4-3 Reset Input Circuit

4.3 Setting Counter Measurement Conditions

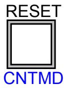
This section describes how to set the measurement conditions of the counter.



■ Setting time measurement mode (INTERVAL/ONE SHOT)

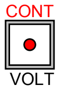
To measure a time difference from the start input to the trip input, press the **INTERVAL/ONE SHOT** key to turn on its lamp, so that the Interval mode is activated for the counter operation. To measure the pulse width time of the trip input, press the **INTERVAL/ONE SHOT** key to turn off its lamp, so that the One Shot mode is activated for the counter operation.
Even in the Interval mode, if the operation time and recovery time of the output of relays, etc. are to be measured individually, set the single interval mode, or if they are to be measured simultaneously, set the dual interval mode. Also, if the maximum value and minimum value of the operation and recovery time are to be obtained in the dual interval mode, set the multi interval mode.
In the One Shot mode, if the pulse width time is to be integrated, set the one shot train mode.

■ Resetting the counter (RESET)



This key resets the counter display to 0.0000s.
Since the counter is automatically reset, the **RESET** key does not need to be pressed in the single interval mode, dual interval mode, and one shot mode. However, to reset the maximum value and minimum value in the multi interval mode, or to reset the integrated time in the train mode, press the **RESET** key.

■ Setting START or TRIP input type (CONT/VOLT)

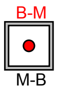


For the START or TRIP input format, the "contact input **(CONTact)**" and "voltage input **(VOLTage)**" are available.
When the input signal is a contact signal, turn on the **CONT/VOLT** key lamp. If it is a voltage signal, turn off the **CONT/VOLT** key lamp.

> **CAUTION**
>
> **Do not apply voltage from outside with the START or TRIP input set to the contact (CONT). Internal circuits may be damaged.**
> **Be sure to set the input type before connecting a signal.**

> Note
>
> **Set CONT or VOLT individually for the START and TRIP inputs. The upper CONT/VOLT key is for START input, and the lower key is for TRIP input.**

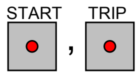
■ Operation modes of START and TRIP inputs (B-M/M-B)



For the operation modes of START and TRIP inputs, "Break (open) → Make (short)" and "Make (short) → Break (open)" are available.
Turn on the **B-M/M-B** key lamp if an input signal operates when the contact closed (shorted), or if it operates when a voltage signal moved from larger voltage than threshold value to smaller voltage. Or, in reverse case, turn off the key lamp.

> Note
>
> **Set B-M or M-B individually for the START and TRIP inputs. The upper B-M/M-B key is for START input, and the lower key is for TRIP input.**

■ Monitoring START and TRIP inputs



The START and TRIP input states can be monitored with the lamps on the front panel.
The lamp lights up when a signal with which the counter operates is input. For example, if the START input is set to **CONT** (lamp ON) and **B-M** (lamp ON), the lamp goes off when the START input opened, or the lamp lights up when shorted.

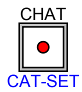
Table 4-1 START and TRIP Input Monitor Lamp Indication

CONT/VOLT	B-M/M-B	Input	Monitor lamp
CONT	B-M	Open	OFF
(Lamp ON)	(Lamp ON)	Short	ON
	M-B	Open	OFF
	(Lamp OFF)	Short	ON
VOLT	B-M	±10V	OFF
(Lamp OFF)	(Lamp ON)	0V	ON
Threshold value	M-B	±10V	OFF
=±2.5V	(Lamp OFF)	0V	ON

Note

In the Interval mode, the counter does not start even if the START signal is input unless the TRIP input monitor lamp is in OFF state.
Be sure to confirm that the START and TRIP monitor lamps are in OFF state.

■ Chattering eliminating function (CHAT)



To use the chattering eliminating function, press the **CHAT** key.
If the **CHAT** key is pressed, the **CHAT** key lamp lights up and the chattering eliminating function operates.
If the **CHAT** key is pressed again, the **CHAT** key lamp goes off and the chattering eliminating function stops.
The chattering eliminating function removes the chattering of the TRIP signal.
For setting the chattering eliminating time, see **"4.4 Counter Setting Mode" (p.4-8)**.

4.4 Counter Setting Mode

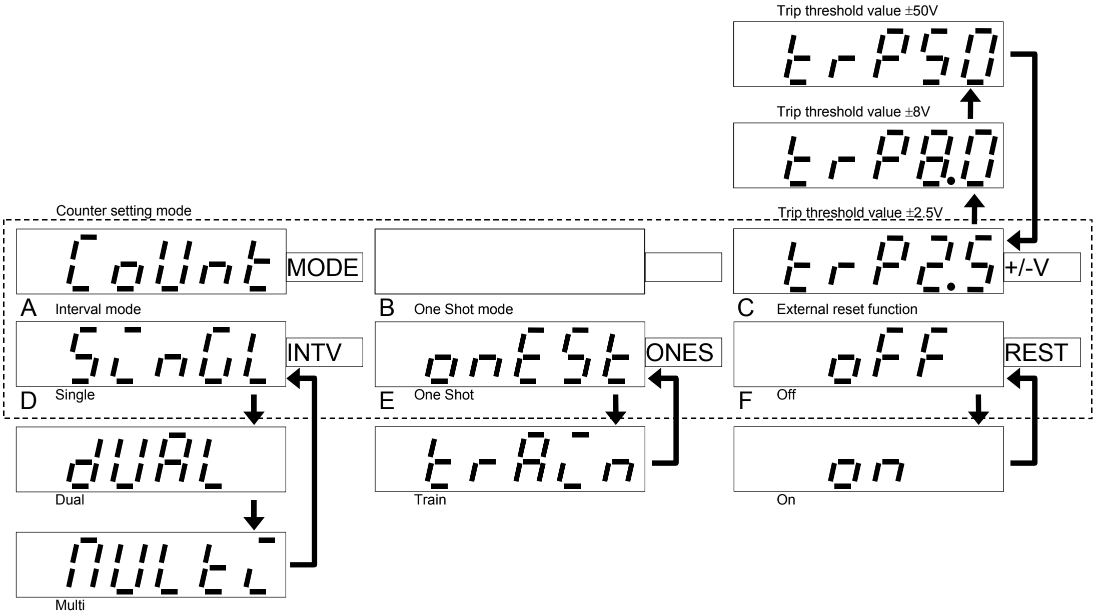
This section describes the “counter operation setting mode” and “chattering time setting”.

■ Counter setting mode (CNTMD)

Press the SHIFT + RESET (CNTMD) keys to activate the counter setting mode.

The counter setting mode enables the setting of Interval mode and One Shot mode, on/off of external counter reset function, and switching of voltage threshold value of trip input.

● Display of counter setting mode



- Display A : “CoUnt MODE” Indicates the counter setting mode
- Display C : “trP2.5+/-V” Trip input threshold value (±2.5V/±8V/±50V)
- Display D : “SinGL INTV” Interval mode setting (Single/Dual/Multi)
- Display E : “onESt” One Shot mode setting (One Shot /Train)
- Display F : “oFF” External reset function setting (ON/OFF)

● Counter setting

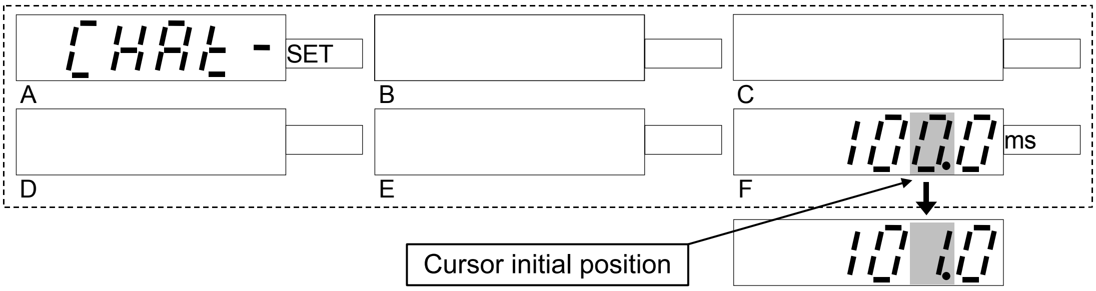
- Cursor initial position ➔ Display D (Interval setting mode)
- Setting item selection ➔ ▲, ▼ keys
- Setting canceling method ➔ RESET (CNTMD) or SHIFT + RESET (CNTMD)

■ Chattering time setting (CAT-SET)

Press the SHIFT + CHAT/CAT-SET keys to activate the chattering time setting mode.

Set the chattering time.

● Display of chattering time setting mode



- Display A : "CHAt- SET" Indicates the chattering time setting mode
- Display F : "100.0ms" Chattering time setting 1-125 ms (setting resolution 1ms)

● Chattering time setting

- Cursor initial position ➔ Digit of 1ms (cursor does not move to the digit of 0.1ms)
- Setting item selection ➔ ▲, ▼ keys
- Setting canceling method ➔ CHAT/CAT-SET or SHIFT + CHAT/CAT-SET

4.5 Time Measurement

■ Time measurement method

Set the **FUNCTION** on the Display E to **CNTR**.

Set the measurement conditions with the **INTERVAL/ONE SHOT** key, **CONT/VOLT** key, and **B-M/M-B** keys in the **COUNTER** operation block.

Note

The counter display is executed independently from the display and update of voltage and current.
However, the counter display is not updated during the reading of waveform data.
Accordingly, if the large wavenumber average count of average settings is set, the counter will not be displayed smoothly, but this is not a trouble.
When the counter is to be displayed smoothly, turn off the average function.

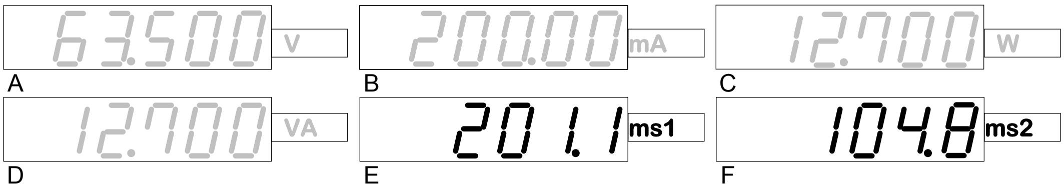
■ Displaying counter data

In the Interval mode, the counter display varies depending on which mode, single, dual, or multi, is selected.
With the Display **E** set to **CNTR** when the **INTERVAL/ONE SHOT** key lamp is turned on to set the Interval mode, if only the Display **E** shows the time, the single interval mode is activated, or if the Displays **E** and **F** show the time, the dual interval mode is activated, or if all Displays show the time, the multi interval mode is activated.
In the One Shot mode, only the Display **E** shows the time.

● Display in single interval mode, one shot mode, and train mode

The operation time is shown on the Display **E**. In the above case, the counter value is "200.5ms".

● Displaying dual interval mode



The Display **E** shows the counter 1 (operation time) and the Display **F** shows the counter 2 (recovery time).

● Displaying multi interval mode

The Display **B** shows the measured value [ms1] of counter 1 (operation time), the Display **A** shows the maximum value [ms1↑] of counter 1, and the Display **C** shows the minimum value [ms1↓] of counter 1.
The Display **E** shows the measured value [ms2] of counter 2 (operation time), the Display **D** shows the maximum value [ms2↑] of counter 2, and the Display **F** shows the minimum value [ms2↓] of counter 2

■ Time measurement range

The time measurable range and the time measurement range are as follows:

- Time measurable range: 0.1ms to 1677s
- Time measurement range (display resolution)

0.1ms	to	999.9ms(0.1ms)
1.0000s	to	9.9999s(0.0001s)
10.000s	to	99.999s(0.001s)
100.00s	to	999.99s(0.01s)
1000.0s	to	1677.0s(0.1s)

The time is displayed as “0.0000s” when reset.

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5. INTEGRATING FUNCTION

This chapter describes how to operate the integrating function of the **"2721/2722 Power Multimeter".**
For the description of integrating function operating keys, see **"■ Names and operations of components on front panel and side/rear panel (side panel for 2721, or rear panel for 2722)"** in **"3. BASIC OPERATIONS"**.

5.1 Measuring Integrated Active Power, Current, and Reactive Power

■ Integrate mode

For the integration measurement, set the **FUNCTION** on Display **F** to either $\boxed{\text{Wh}}$, $\boxed{\text{Ah}}$,,or $\boxed{\text{Varh}}$.

The integration result is shown on the Display **F**. Respective integrated values can be displayed. Also, the input element can be changed.

However, during the integrating operation, the following limitations are applied. To cancel the limitations, press the **STOP** key to stop the integration and press the **RESET** key to reset the integrated value.

- The average function is turned off.
- The **FUNCTION o**n Display **F** cannot be set, except $\boxed{\text{Wh}}$, $\boxed{\text{Ah}}$, and $\boxed{\text{Varh}}$.
- During the integrating operation, do not switch the display with the **STORE/RECALL** key. Normal integrating operation may not be performed.

Note

When the Display E is set to $\boxed{\text{CNTR}}$ and the Display F is used for counter display, the counter display has priority and therefore the integration measurement cannot be used.

The Integrate mode has the following three modes:

Integrate mode	Operation of INTEGRATE keys / Integrating operation
Manual integrate mode	Press START $\overset{\text{START}}{\square}$ key to start integration, STOP $\overset{\text{STOP}}{\square}$ key to stop integration, and RESET $\overset{\text{RESET}}{\underset{\text{INT-MD}}{\square}}$ key to rest the integrated value.
Time integrate mode	Press START $\overset{\text{START}}{\square}$ key to start integration, and after the time set to the timer elapsed, the integration stops. Press RESET $\overset{\text{RESET}}{\underset{\text{INT-MD}}{\square}}$ key to rest the integrated value. Restart is possible.
Real time integrate mode	After START $\overset{\text{START}}{\square}$ key is pressed, the integration starts at the reserved start time and stops at the stop time.

Note

Even after pressing the START key to start the real time integration, do not set the FUNCTION on Display F to any item other than $\boxed{\text{Wh}}$, $\boxed{\text{Ah}}$, and $\boxed{\text{Varh}}$ until the start time.

Normal integrating operation may not be performed, if the function is set to any item other than $\boxed{\text{Wh}}$, $\boxed{\text{Ah}}$, $\boxed{\text{Varh}}$ when the integration starts at the start time.

■ Integration display update cycle

The display update cycle of the integrated value is about one second.
During the integrating operation, the average function is automatically turned off.

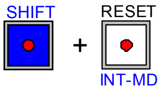
■ Display of integrated time

During the integrating operation, the integrated time can be monitored.

If the TIME CLOCK key is pressed during the integrating operation, the integrated time is shown on the Display **F**.

The Display **F** shows the integrated time, and it is “7 hours 14 minutes 37 seconds” in the above case. The integrated time display returns to the integrated value display in about 10 seconds.

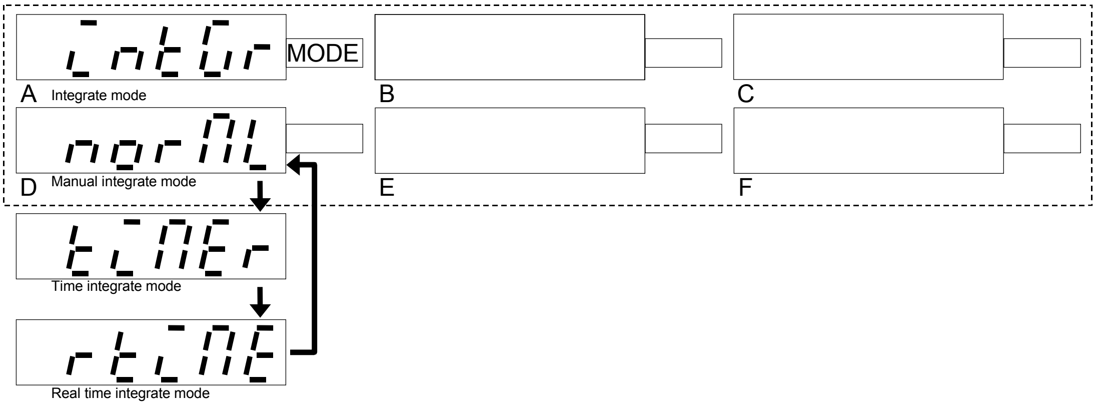
5.2 Integration setting mode (INT-MD)

Press the 

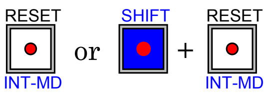
keys to activate the integrate setting mode.

In the integration setting mode, the integrate mode, integrated time, integration start time, and integration stop time can be set.

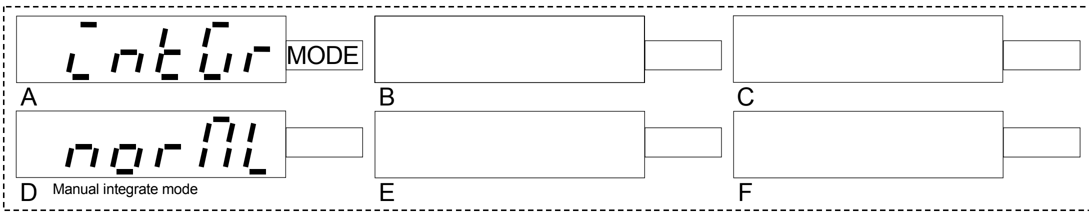
■ Display of integration setting mode



- Display A : "intGr" Indicates the integration setting mode
- Display D : "norML" Manual integrate mode
  "tiMEr" Time integrate mode
  "rtiME" Real time integrate mode

- Setting canceling method ➔ 

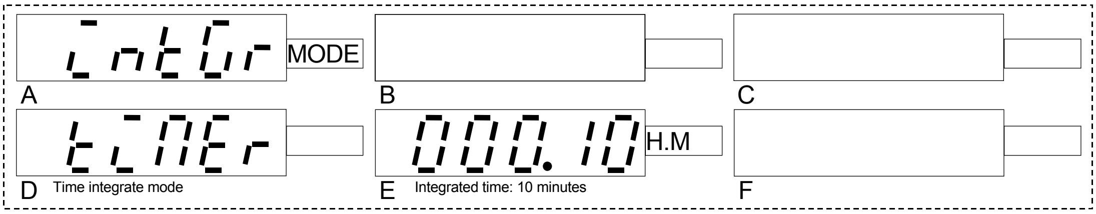
■ Display of manual integrate mode



- Display D : "norML" Manual integrate mode

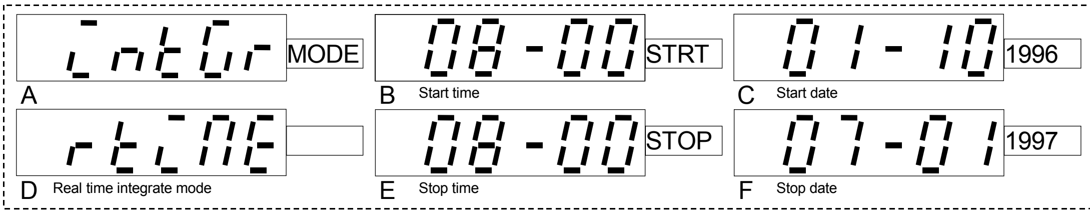
In the manual integrate mode, only the Display **D** is used for display, and Displays **B, C, E**, and **F** do not display anything at all.

■ Displaying and setting time integrate mode



- Display D : "tiMEr" — Time integrate mode
- Display E : "000.10 H.M" — Displays the setting of integrated time (in this case, integrated time setting is 10 min.)
  Higher-order digits than decimal point show hours, and decimal places show minutes.
- Setting method ➔ [▲], [▼] keys
  Hour is shown in ± **100**th digit, **10**th digit, unit digit, and minute is shown in ± every minute.
- Cursor moving method ➔ Cursor moving method → Cursor moves to "Display **D** ⇔ **100**th digit ⇔ **10**th digit ⇔ unit digit ⇔ minute digits ⇔ Display **D**".
  Minute digits blink together (resolution is 1 minute).

■ Displaying and setting real time integrate mode



- Display D : "rtiME" — Real time integrate mod
- Display B : "08-00 STRT" — Integration start time set value "8:00"
- Display C : "01-10 1996" — Integration start date set value "January 10, 1996"
- Display E : "08-00 STOP" — Integration start time set value "8:00"
- Display C : "07-01 1997" — Integration start date set value "July 1, 1997"
- Setting method ➔ [▲], [▼] keys
  Time is shown in ± every hour and every minute, and month in ± every month, day in ± every day, year in ± every year.
- Cursor moving method ➔ Display **D**"
  ⇔ Hour of start time ⇔ Minute of start time
  ⇔ Month of start date ⇔ Day of start date ⇔ Year of start date
  ⇔ Hour of stop time ⇔ Minute of stop time
  ⇔ Month of stop date ⇔Day of stop date ⇔Year of stop date
  ⇔ Cursor moves to "Display **D**

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6. SETTING OPERATION WITH SHIFT KEY

This chapter describes a setting operation that uses the SHIFT key of the **"2721/2722 Power Multimeter"**.

For a measuring method, see **"3. Basic Operations"**.

Also, as alphanumeric characters shown on digital displays **A, B, C, D, E, F** (7 segments) include some characters which may be difficult to read, refer to **"Description of displayed characters" (p.3-2)**.

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6.1 Setting Modes with SHIFT Key

When the **SHIFT** key is pressed and its lamp is lighting, the modes indicated with blue characters on the lower side of respective setting keys are active.
The settings using the **SHIFT** key are as follows:

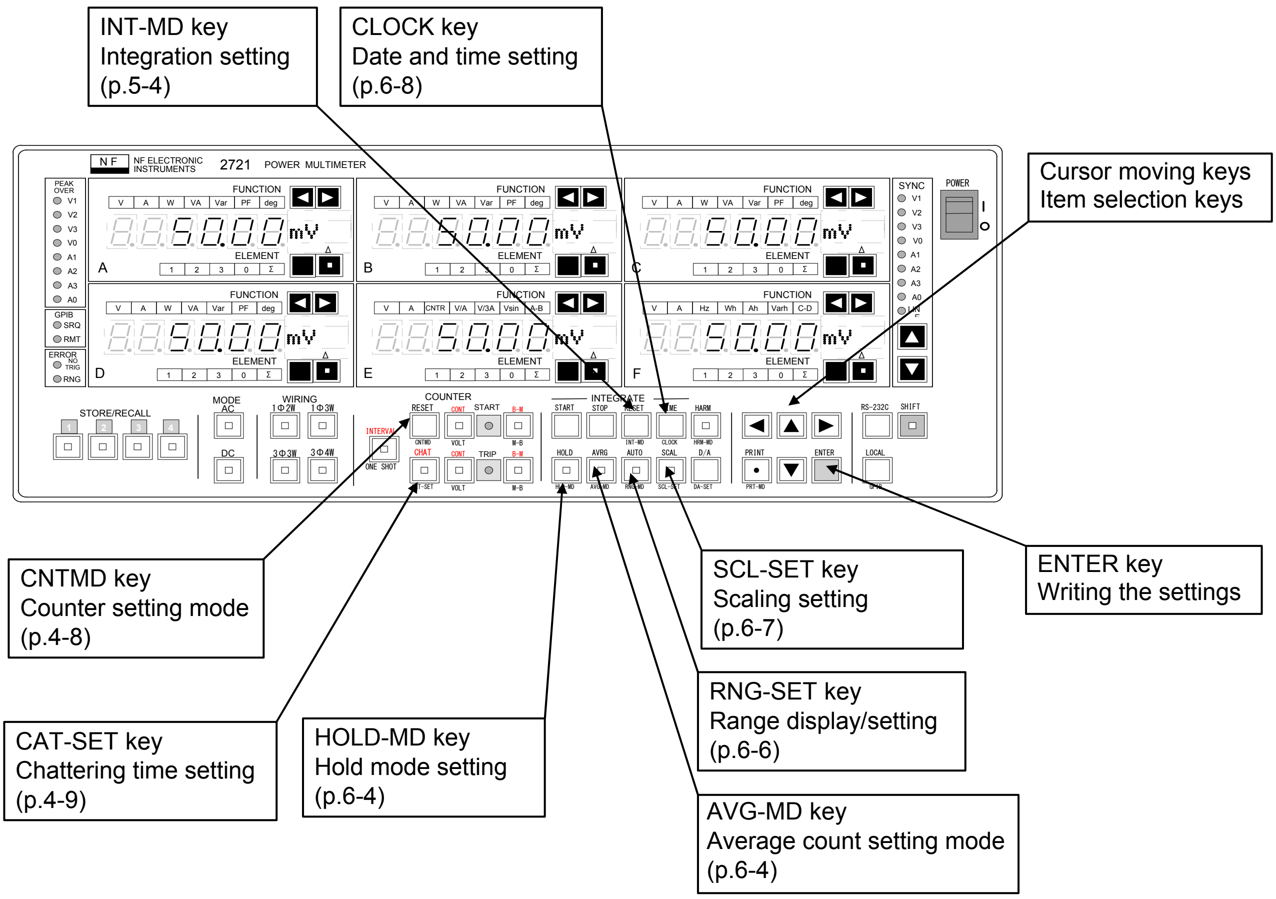
SHIFT+		Description
HOLD-MD	HOLD HOLD-MD	Sets the hold mode Set the phase display range (0 to 360deg/±180deg) Turns on/off the hold function by trip input
AVG-MD	AVRG AVG-MD	Sets the average count Set the moving average count (1, 2, 4, 8, 16, 32, 64) Set the wavenumber average count (1, 2, 4, 8, 16, 32)
RNG-SET	AUTO RNG-SET	Range display / setting At auto range setting ON: Displays the range At auto range setting OFF: Sets the manual range
SCL-SET	SCAL SCL-SET	Sets the scaling Set the scaling mode (all setting, individual setting) Set the scaling value
CLOCK	TIME CLOCK	Sets the date and time

The following setting modes are described in other chapters. See the given pages.

CNTMD	RESET CNTMD	Sets the counter Set the Interval mode (single, dual, multi) Set the One Shot mode (one shot, train) Turns on/off external reset function Set the voltage threshold value of trip input (±2.5V, ±8V, ±50V) (See p.4-8)
CAT-SET	CHAT CAT-SET	Sets the chattering time (1ms to 125ms) (See p.4-9)
INT-MD	RESET INT-MD	Sets the integration Set the Integrate mode (manual, time, and real time integrate modes) Set the integrated time, start time and stop time (See p.5-4)

6.2 Setting Mode Common Operations

This section describes the common operations in the setting modes such as “cursor movements, item selection, setting, and cancel of setting”.
To activate the setting mode, press the **SHIFT** key to turn on its lamp and press the key indicated with blue characters.
Even in the setting mode, the measurement continues, and therefore if large wavenumber average count is set with the average function, the operation of a key will not be accepted immediately. In such a case, turn off the average function.
In the setting mode, the name of setting mode (characters similar to blue characters of the key) is shown on the Display **A**. The contents of setting are shown on other Displays. When there is one setting item, it is shown on Display **F**, or they are shown on Displays **E** and **F** when two, or Displays **D, E** and **F** when three, or on Displays **D, E, F** and **C** when four.
However, the real time setting in the Integrate mode uses all Displays.
The cursor is located in the digit or Display that is blinking. The initial cursor position varies depending on the setting mode. To move the cursor, use ◀, ▶ keys.
To select each item of setting mode or to change a numeric value, use ▲, ▼ keys.
To set each item and numeric value in the setting mode, press the **ENTER** key at the end. The set values of respective items are written in the memory (nonvolatile).
To cancel the setting mode, press each setting mode key before pressing the **ENTER** key. Even if an item was changed on the front panel, the settings are not written in the memory but cancelled.

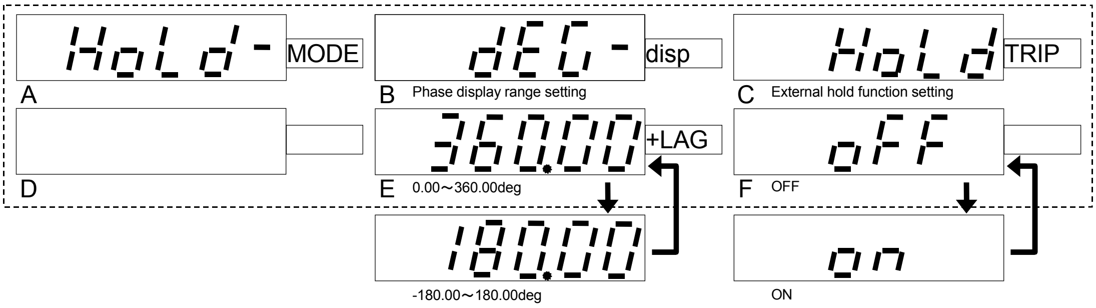


6.3 Hold mold setting (HOLD-MD)

Press the SHIFT + HOLD (HOLD-MD) keys to activate the hold mode setting.

In the hold mode setting, the on/off of hold function by the trip input and the phase display range can be set.

■ Display of hold mode setting mode



- Display A : “HoLd- MODE” Indicates the hold mode setting mode
- Display B : “deG-dsip” Indicates that the phase display range is shown on Display **E**
- Display C : “HoLd-TRIP” Indicates that the hold function setting by trip input is shown on Display **F**
- Display E : “360.00+LAG” Phase display range set value
- Display F : “ oFF” Setting of hold function by trip input

■ Hold mode setting

- Cursor initial position ➔ Display **E**, the cursor moves to Displays **E** and **F** only
- Setting method ➔ ▲, ▼ keys
- Phase display range setting ➔ 0.00 to 360.00deg / –180.00 to 180.00deg
- Hold function setting ➔ ON/OFF
- Setting canceling method ➔ HOLD (HOLD-MD) or SHIFT + HOLD (HOLD-MD)

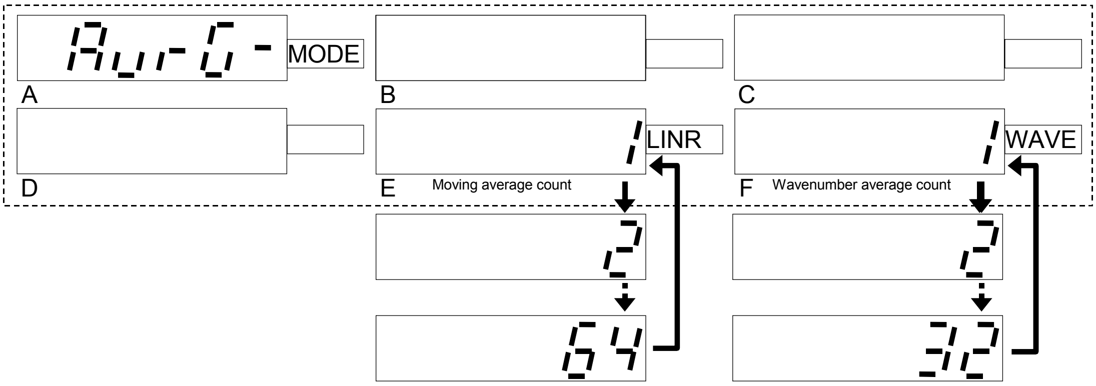
For an input method of trip, see **“4. Counter Function”**.

6.4 Average setting mode (AVG-MD)

Press the SHIFT + AVRG AVG-MD keys to activate the average setting mode.

In the average setting mode, the moving average count and wavenumber average count can be set.

■ Display of average setting mode



- Display A : "AvrG- MODE" — Indicates the average setting mode
- Display E : "1" — Set value of moving average count
- Display F : "1" — Set value of wavenumber average count

■ Average setting

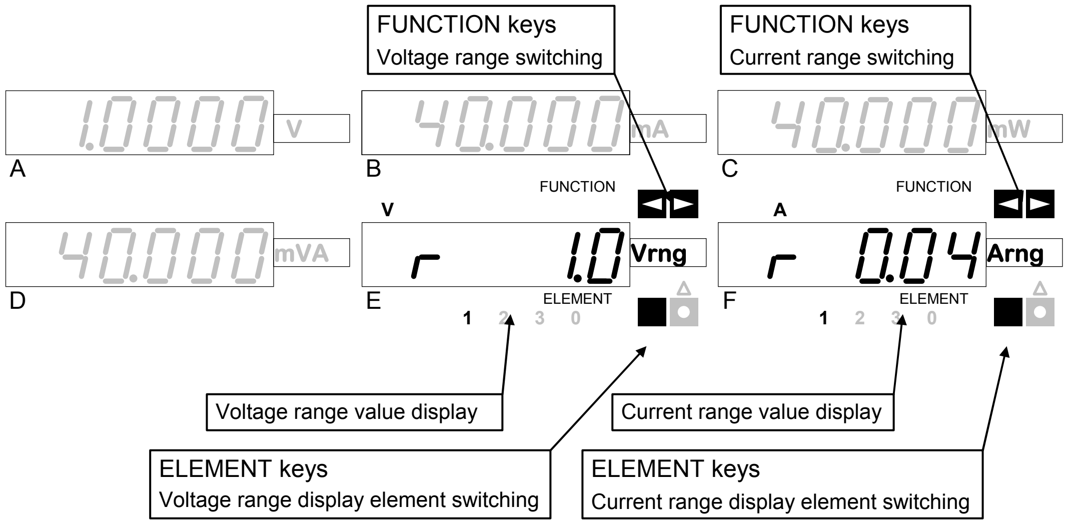
- Cursor initial position ➔ Display **E**, the cursor moves to Displays **E** and **F** only
- Setting method ➔ ▲, ▼ keys
- Moving average count ➔ Set either **1 / 2 / 4 / 8 / 16 / 32 / 64**
- Wavenumber average count ➔ Set either **1 / 2 / 4 / 8 / 16 / 32**
- Setting canceling method ➔ AVRG AVG-MD or SHIFT + AVRG AVG-MD

Increase the moving average count if the display is unstable at low cycles. However, larger setting retards the response when the input level changes.
Increase the wavenumber average count if the display is unstable at rapid cycles. However, larger setting retards the display updating cycle, and dampens the acceptance of operation keys.

6.5 Range display/setting (RNG-SET)

Press the SHIFT + AUTO RNG-SET keys to activate the range display/setting mode.

When AUTO RNG-SET key lamp lights up, the range display mode is activated. When AUTO RNG-SET key lamp goes off, the range setting mode is activated.



■ Range display mode

- Display E : “r 1.0” Displays the voltage range
- Display F : “r 0.04” Displays the current range
- Element switching ➔ For voltage range, use **ELEMENT** keys on Display **E**
  For current range, use **ELEMENT** keys on Display **F**
- Display cancel method ➔ AUTO RNG-SET or SHIFT + AUTO RNG-SET

■ Range setting mode

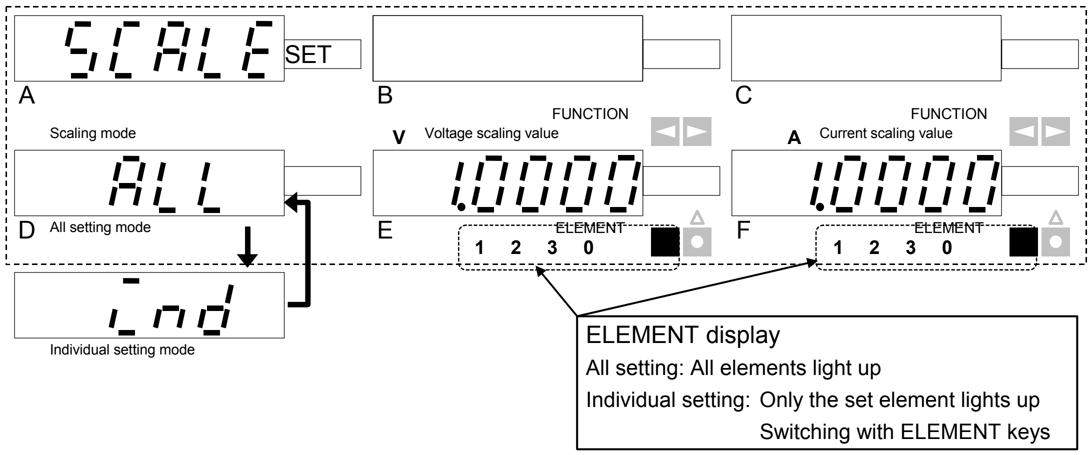
- Display E : “r 1.0” Displays the voltage range
- Display F : “r 0.04” Displays the current range
- Range change ➔ For voltage range, use **FUNCTION** keys on Display **E**
  For current range, use **FUNCTION** keys on Display **F**
  To reduce the range, press ◄ key, or to increase the range, press ► key
- Element switching ➔ For voltage range, use **ELEMENT** keys on Display **E**
  For current range, use **ELEMENT** keys on Display **F**
- Display cancel method ➔ AUTO RNG-SET or SHIFT + AUTO RNG-SET

6.6 Scaling setting (SCL-SET)

Press the SHIFT + SCAL/SCL-SET keys to activate the scaling setting mode.

In the scaling setting mode, whether the scaling values are set all together or individually can be selected and also the scaling values can be set.

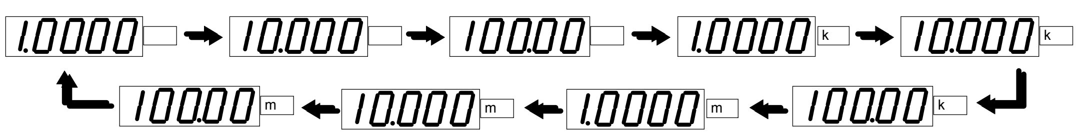
■ Display of scaling setting



- Display A : "SCALE SET" Indicates the scaling setting mode
- Display D : "ALL/ind" Indicates the scaling mode
  "ALL" indicates all setting, and **"ind"** indicates individual setting.
- Display E : "1.0000" Voltage scaling value
- Display F : "1.0000" Current scaling value

■ Scaling setting

- Cursor initial position ➔ Display D
- Setting method ➔ ▲, ▼, · keys
  With · key, the decimal point of scaling value moves and the unit changes.
  The decimal point and unit change in the following order:



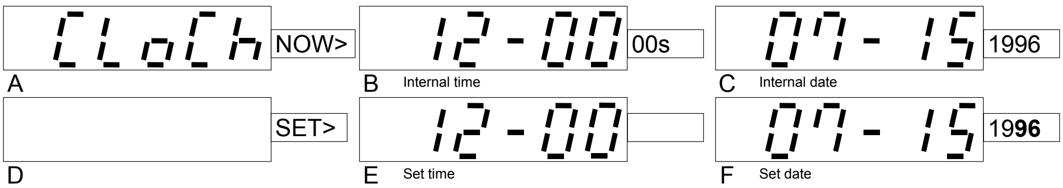
- ELEMENT switching ➔ For voltage scaling, use **ELEMENT** keys on Display **E**
  For current scaling, use **ELEMENT** keys on Display **F**
- Display cancel method ➔ SCAL/SCL-SET or SHIFT + SCAL/SCL-SET

6.7 Date and time setting(CLOCK)

Press the SHIFT + TIME/CLOCK keys to activate the date and time setting mode.

In the date and time (CLOCK) setting mode, the date and time of internal clock can be set.

■ Display of date and time setting

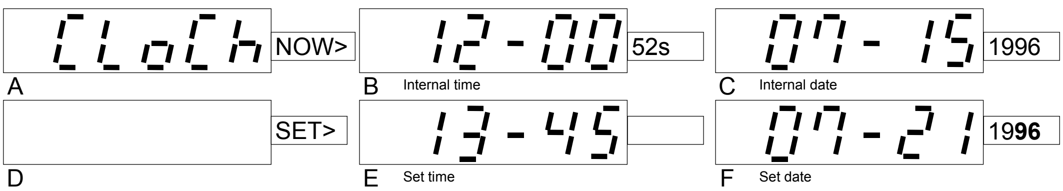


- Display A : “CLoCk” Indicates the date and time setting mode.
  - NOW> Indicates that Displays **B** and **C** are internal time and internal date.
  - SET> Indicates that Displays **E** and **F** are internal time and internal date.
- Display B : “12-00 00s” Internal time (12H00M00S)
- Display C : “07-15 1996” Internal date (July 15, 1996)
- Display D : “12-00 00s” Set time (12H00M00S)
  Initial value is same as internal time on Display **C**.
- Display E : ”07-15 1996” Set date (July 15, 1996)
  Initial value is same as internal date on Display **C**.

■ Date and time setting

- Cursor initial value ➔ Year “96” on Display **F**
- Setting method ➔ Year month day and hour minute are incremented or decremented by ▲, ▼ keys.
  Year changes like “1996↔1997↔1998↔1999↔2000↔2001↔ ....”.
- Setting cancel ➔ TIME/CLOCK or SHIFT + TIME/CLOCK

[Example] To change the day 15 to day 21, press ◀ key to move the cursor (blinking) to day “15” and press ▲ key 6 times.



7. REMOTE CONTROL FUNCTION

This chapter describes the GPIB interface and RS-232C interface of remote control function of the **“2721/2722 Power Multimeter”.**
Using the GPIB interface or RS-232C interface enables the remote control and the data reading.
Though the GPIB interface and RS-232C interface are equipped as standard, they cannot be used for communication at the same time.

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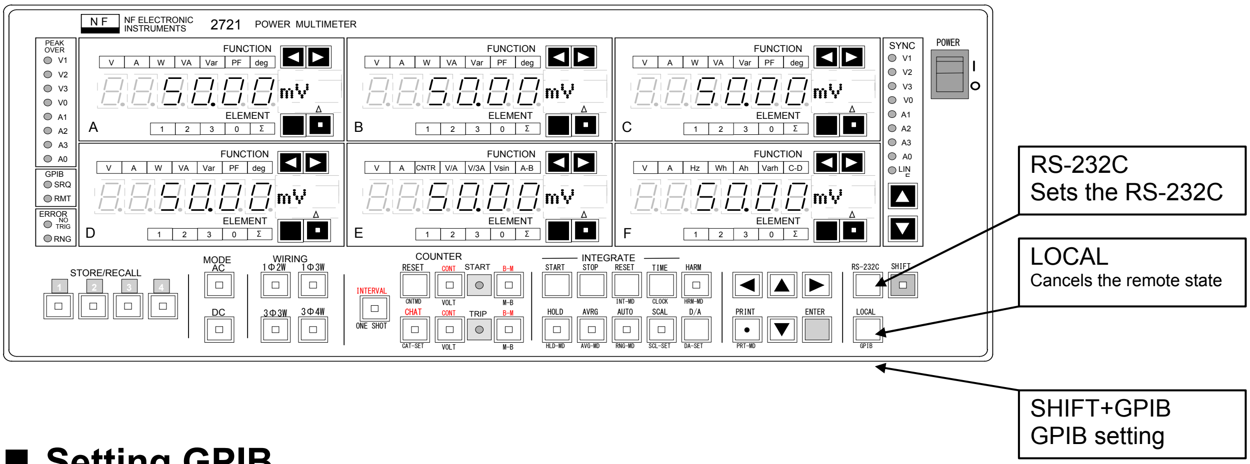
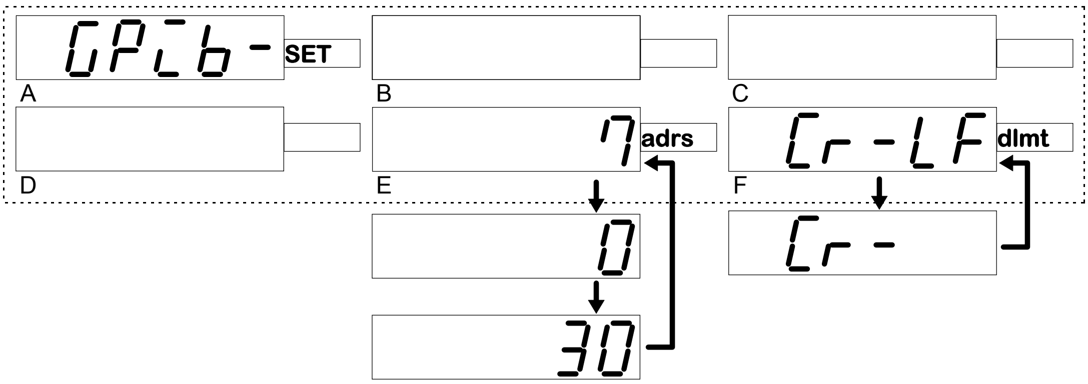
7.1 Setting GPIB / RS-232C

This section describes the GPIB setting (address and delimiter setting) and RS-232C setting (communication condition setting).



■ Setting GPIB

To activates the GPIB setting mode, press SHIFT + LOCAL (GPIB) keys.



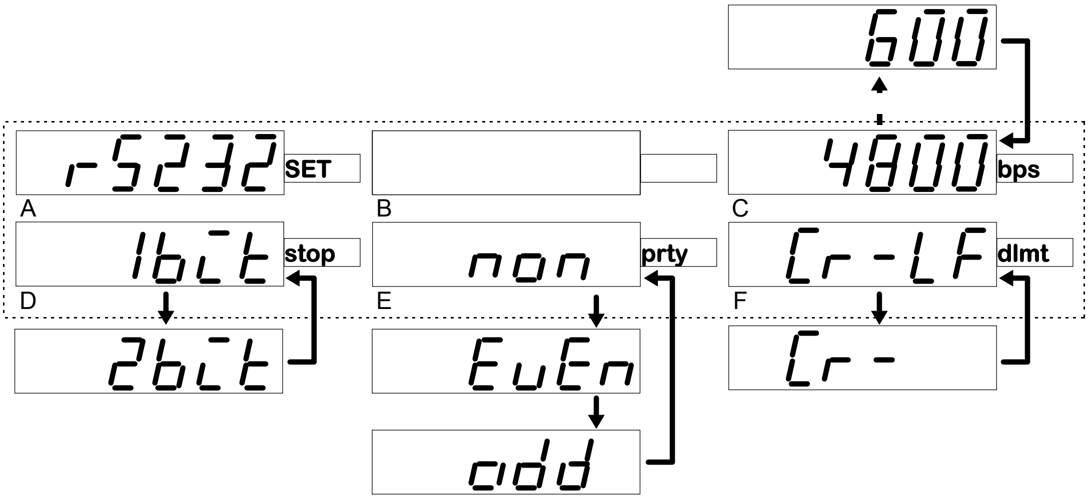
- Display A : "GPib SET" Indicates the GPIB setting mode
- Display E : "7 adrs" GPIB address set value (0 to 30)
- Display F : "Cr-LF dlmt" GPIB delimiter set value ("Cr-LF" / "Cr- ")

- Cursor initial position ➔ Display **E**, the cursor moves to Displays **E** and **F** only
- Setting method ➔ ▲, ▼ keys.
- Setting canceling method ➔ SHIFT + LOCAL (GPIB)

After selecting respective setting items, press the **ENTER** key. The set values are written in the memory (nonvolatile).

■ Setting RS-232C

To activates the RS-232C setting mode, press RS-232C keys.



- Display A : "rS232- SET" Indicates RS-232C setting mode
- Display C : "4800 bps" RS-232C data rate set value (600bps/1200bps/2400bps/4800bps)
- Display D : "1bit stop" RS-232C communication stop bit set value
  Select either **1bit** (1 stop bit) or **2bit** (2 stop bits)
- Display E : "non prty" RS-232C communication parity check set value
  Select either **"non"** (no parity), **"EvEn"** (even parity), or **"odd"** (odd parity)
- Display F : "Cr-LP dlmt" RS-232C communication delimiter set value
  Select either "Cr-LF" / "Cr-   "
- Setting canceling method ➡ RS-232C

After selecting respective setting items, press the **ENTER** key. The set values are written in the memory (nonvolatile).

■ Canceling remote state

In the GPIB remote state, the **"GPIB RMT"** lamp in the left center of front panel lights up.
At this time, if LOCAL GPIB key is pressed, the remote state is cancelled and the operation from the front panel is enabled. However, the LOCAL key is inactive in the local lockout state.
Also, in the RS-232C remote state, similarly press the LOCAL GPIB key to cancel the remote state.

7.2 GPIB interface

Through the GPIB interface of this product, almost all settable parameters can be set remotely.
Also, the settings and measured data can be sent to an external unit.
The codes used are the text format codes (ASCII codes) only.

The GPIB remote state is cancelled by pressing the LOCAL GPIB key on the front panel.

■ GPIB interface functions

The GPIB interface functions of this product are as listed in **"Table 7-1 GPIB interface functions"**.

Table 7-1 GPIB interface functions

Functions	Subset	Description
Source Handshak	SH1	All functions of transmission handshake provided
Acceptor Handshake	AH1	All functions of reception handshake provided
Talker	T6	Basic talker function, serial poll, talker cancel by MLA
Listener	L4	Basic listener function, listener cancel by MTA
Service Request	SR1	All functions of service request provided
Remote/Local	RL1	All functions of remote/local provided
Parallel Poll	PP0	Parallel poll function not provided
Device Clear	DC0	Device clear function not provided
Device Trigger	DT1	All functions of device trigger provided
Controller	C0	Controller function not provided

■ Device driver

The bus driver specifications of this product are as listed in **"Table 7-2 Device driver specifications"**.

Table 7-2 Device driver specifications

Signal line name	Specification
DIO1–8 NDAC NRFD SRQ	Open collector
DAV EOI	3 state

■ Outline of GPIB operations

The output of GPIB communication operations of this product is as described below.
Though the outline of the operations in the cases of listener and talker is listed below, see **"7.5 Command List"** for further information on commands.

● In the case of listener

Classification	Description
Measurement mode setting	The number of calculation items is set
Measurement item setting	The function and element to be displayed are set
Measured data query	For reading the measured data
Measurement condition setting	Sync signal, average-related items, measurement mode, etc. are set
Counter setting	The counter-related items are set and operated
Integration setting	The integration-related items are set and operated
Communication setting	The communication-related items are set and operated
System-related setting	The time and serial number are queried

● In the case of talker

Classification	Description
Transmission of measurement mode setting	The setting of the number of calculation items is transmitted
Transmission of measurement item setting	The settings of item and phase being displayed are transmitted
Transmission of measured data	Measured data is transmitted
Transmission of measurement condition setting	The settings of sync signal, average-related items, measurement mode, etc. are transmitted
Transmission of counter setting	The setting of counter-related items is transmitted
Transmission of integration setting	The setting of integration-related items is transmitted
Transmission of communication setting	The setting of communication-related items is transmitted
Transmission of system-related setting	The time and serial number are transmitted

■ Service Request (SRQ)

This product sends the SRQ command under the condition mentioned below. Among them, to send SRQ at the completion of count, further send the SRQ command to write the data to the service request enable register.

- After "GET" was received, when the measurement finished
  See the "Group Execute Trigger".
- When count completed
  At the completion of count, SRQ is sent, but in the train mode, SRQ is not sent.

The controller, when SRQ is received, should perform the serial poll to designate the interrupt generating source (this device) as a talker.
The status bytes that are output during the serial poll are as follows:

BIT	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
Contents	0	RQS	0	MEA	0	CNT	0	0

RQS: **1** when service request is made
MEA: **1** when service request is made at completion of measurement
CNT: **1** when service request is made at completion of count

■ Group Execute Trigger (GET)

When GPIB address command GET is received, this product sends SRQ to the controller when the next measurement completed.
If the GET command is used, be sure to read the measured data after the controller received the SRQ.

■ Go To Local (GTL)

When GPIB address command GTL is received, this product turns off the **GPIB RMT** lamp on the front panel to activate the local state.

■ Local Lock Out (LLO)

When GPIB universal command LLO is received, this product disables the LOCAL key on the front panel.

7.3 RS-232C interface

Through the RS-232C interface of this product, almost all settable parameters can be set remotely. Also, the settings and measured data can be sent to an external unit, and the codes used are the text format codes (ASCII codes).
Even with the RS-232C interface, the remote state can be set with the **RSM:RMT** command. In this case, the remote state is cancelled if the **LOCAL** key on the front panel is pressed.

■ RS-232C interface specifications

The RS-232C interface specifications of this device are as follows:

- Communication method : Half duplex
- Synchronizing method : Asynchronous
- Baud rate : 600, 1200, 2400, 4800
- Start bit : 1 bit fixed
- Data length : 8 bits fixed
- Parity : None, Even (EVEN), Odd (ODD)
- Stop bit : 1 bit, 2 bits
- Received buffer length : 256 bytes

■ Connection of RS-232C cables

When this product is connected to the host computer, connect as shown below:

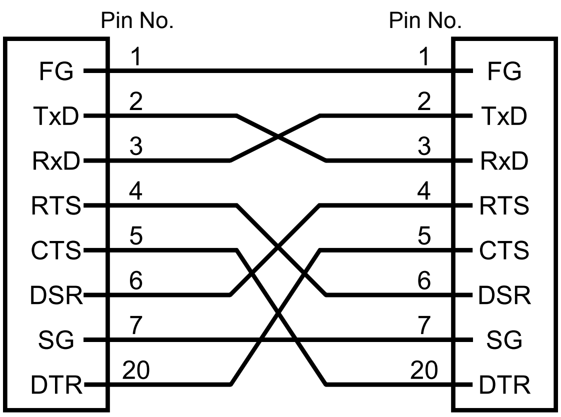


Figure 7-1 Connection of RS-232C cables

■ Connection of RS-232C interface

● Connector and signal names

#11, #13, and #14 are connected to GND. Other pins are not used.

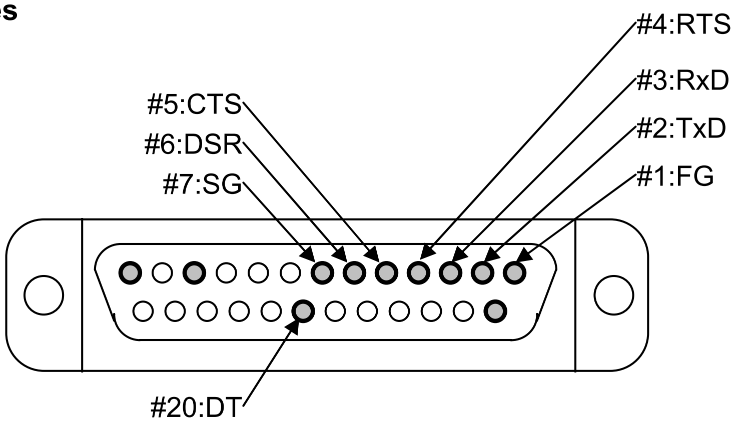


Figure 7-2 RS-232C Connector

(RS-232C connector: DBSP-JB25S or equivalents)

Table 7-3 RS-232C Connector pin assignment

Pin No.	Name	Symbol	Description	Direction
1	Frame Ground	FG	Connect to the case	
2	Transmitted Data	TxD	Data output	OUT
3	Received Data	RxD	Data input	IN
4	Request to Send	RTS	"H" at data output, and "L" at completion	OUT
5	Clear to Send	CTS	With "H", data output is ready	IN
6	Data Set Ready	DSR	At "H", data output is ready	IN
7	Signal Ground	SG	Connect to signal power supply	
20	Data Terminal Ready	DTR	"H" when data reception is ready, or "L" when data reception is not ready	OUT

■ Outline of RS-232C operations

The outline of data reception and data transmission is as mentioned in the following tables. For further information on the commands, see **"Table 7-4 Command list (1/2)"** and **"Table 7-5 Command list (2/2)"**.

● Data reception

Classification	Description
Measurement mode setting	The number of calculation items is set
Measurement item setting	The function and element to be displayed are set
Measured data query	For reading the measured data
Measurement condition setting	Sync signal, average-related items, measurement mode, etc. are set
Counter setting	The counter-related items are set and operated
Integration setting	The integration-related items are set and operated
Communication setting	The communication-related items are set and operated
System-related setting	The time and serial number are queried

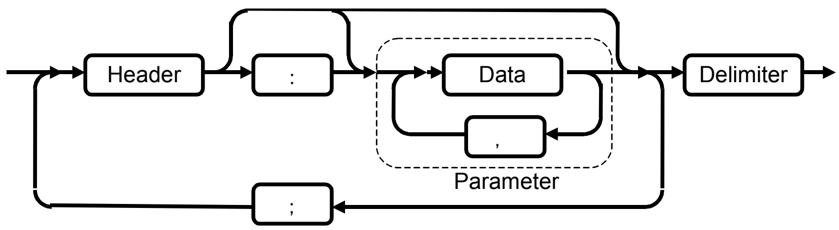
● Data transmission

Classification	Description
Transmission of measurement mode setting	The setting of the number of calculation items is transmitted
Transmission of measurement item setting	The settings of item and phase being displayed are transmitted
Transmission of measured data	Measured data is transmitted
Transmission of measurement condition setting	The settings of sync signal, average-related items, measurement mode, etc. are transmitted
Transmission of counter setting	The setting of counter-related items is transmitted
Transmission of integration setting	The setting of integration-related items is transmitted
Transmission of communication setting	The setting of communication-related items is transmitted
Transmission of system-related setting	The time and serial number are transmitted

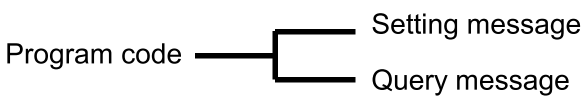
7.4 Program Codes

■ Program codes

The program codes are stored in the input buffer temporarily, and they are interpreted and executed in order of reception when a delimiter is received.
The input buffer capacity is 256 characters (256 bytes), and the null (00H) and a delimiter are not stored in the input buffer. When program codes exceeding 256 characters are received, up to 256 characters are executed, and the subsequent program codes are cleared and an error occurs. Also, if unspecified header or parameter exists in the program codes, it is treated as an error and the input buffer is cleared and the subsequent program codes are not executed.
When interpretation of program codes and execution of valid commands finished, the input buffer is cleared and the next input becomes ready.
A program code is composed of a header and a parameter. The syntax of a program code is shown below.



When multiple program codes are sent at a time, insert a semicolon (;) between program codes.
A program code is classified into a “setting message” that makes setting and a “query message” that queries the state and set value.



■ Setting message

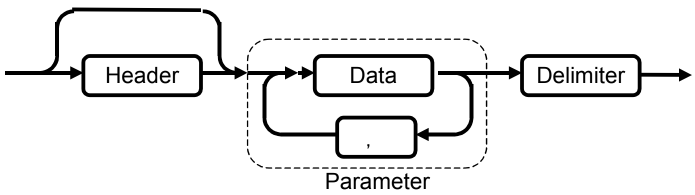
The setting message has the format as mentioned below. In this example, the **FUNCTION** and **ELEMENT** are set to “voltage **V1** on Display **A**, current **A1** on Display **B**, active power **W1** on Display **C**, reactive power on Display **D**, phase **A-B** on Display **E**, and frequency **Hz** on Display **F**”.

```
D1A : VL1 ; D1B : AM1 ; D1C : WT1 ; D1D : VR1 ; D1E : DA0 ; D1F : HZ0
 a  b  c  d  a     c     a     c     a     c     a     c     a     c
```

a: Header. It is composed of three alphanumeric characters, and uppercase or lowercase characters can be used.
b: Character for visibility, and a space may be used.
c: Parameter. It is composed of alphanumeric characters, and the number of characters vary depending on the command.
d: Semicolon to delimit plural setting messages

■ Query message

The query message is a command attached with "?" at the beginning of a program code and it is a program code to query the measured data, state, or set value to this product.
After the query message is sent, the result is output if the device is designated as a talker.
When program codes that contain multiple queries are received at a time, the product responds to the last query. Also, when a new query message is received without being designated as a talker after the query, the response message to the previous query is cleared and a response message to new query is prepared.



The header of response message to the query can be turned on/off by the setting message "HDR:1" / "HDR:0". It is turned on (header is output) at the power on.

7.5 Command List

External communication commands are as listed below.
For details of individual commands, see **"7.6 Description of Individual Commands"**.

Table 7-4 Command list (1/2)

Classification	Command		Description	Page
Measured items	Dna	:VLe	Phase voltage measurement	p.7-16
	?Dna	:AMe	Current measurement	
		:VVe	Line voltage measurement (1:V12, 2:V23,	
		:WTe	Active power measurement	
		:VAe	Apparent power measurement	
		:VRe	Reactive power measurement	
		:PFe	Power factor measurement	
		:DFe	Measurement of phase difference between V and A	
		:DSe	Measurement of phase difference of element based on reference phase	
		:DWe	Measurement of phase difference between voltage lines (1:V12, 2:V23, 3: V31)	
		:CN0	Counter display	
		:I1e	Impedance (V/A) measurement	
		:I3e	Impedance (V/(√3×A)) measurement	
		:ISe	Impedance (V/(2×A×sinϕ)) measurement	
		:HZ0	Frequency measurement	
		:WHe	Integration active power measurement	
		:AHe	Integration voltage measurement	
		:VHe	Integration reactive power measurement	
		:DA0	Measurement of phase difference between Displays A and B	
		:DC0	Measurement of phase difference between Displays C and D	
Measurement condition setting	SYC ?SYC	:e	SYNC signal setting/query	p.7-19
	DSP ?DSP	:n	Display number setting/query	p.7-16
	MSR ?MSR	:n	Measurement mode setting/query	p.7-18
	WRG ?WRG	:n	Wiring type setting/query	p.7-19
	HLD ?HLD	:{n,(E,n)}	Hold on/off setting, hold function setting by trip input/query	p.7-17
	AVG ?AVG	:{0,1,(S,m,w)}	Average on/off setting, count setting/query	p.7-14
	RNG ?RNG	:{0,1,(el,n)}	Range mode setting, range switching/query	p.7-18
	SCL ?SCL	:{0,1,(el,data)}	Scaling on/off setting, scaling factor setting/query	p.7-18

Table 7-5 Command list (2/2)

Classification	Command	Description	Page
Measured data reading	?INP :n	Measured data /query	p.7-17
	?STS	Input state query	p.7-19
Measurement mode	CLC :m ?CLC	Calculation mode setting/query	p.7-15
Counter setting	CNM :m,{n,nnn} ?CNM	Counter setting, chattering time setting/ query	p.7-15
	CRS :0	Counter reset	p.7-15
	CCT :n ?CCT	Counter chattering eliminating setting/ query	p.7-14
	CST :cb ?CST	Counter start signal setting/ query	p.7-15
	CTP :cb ?CTP	Counter trip signal setting/ query	p.7-16
	?CDT	Counter data query	p.7-15
Integrate setting	IDO :{SR,SP,RS} ?IDO	Integrate operation setting/query	p.7-17
	IMD :m,time ?IMD	Integrate mode setting, time setting/query	p.7-17
Communication setting	HDR n ?HDR	Header setting/query	p.7-16
	SRQ nnn ?SRQ	GPIB SRQ status setting/query	p.7-19
	RSM aaa ?RSM	RS-232C remote/local switching/query	p.7-18
System setting	CLK :data,time ?CLK	Internal clock setting/query	p.7-15
	*CBG el,±nn.nnn ?CBG	Gain calibration/query	p.7-14
	*CBO el ?CBO	Offset calibration/query	p.7-14
	*MDL nnnn ?MDL	Model name number setting/query	p.7-18
	*SRL :mm,ssssss ?SRL	Serial number setting/query	p.7-19

*Note: Do not execute the CBG, CBO, and MDL commands. The device may not operate normally.

7.6 Description of Individual Commands

This section describes in detail the commands. The commands are listed in alphabetical order. Also, the symbol used in the description has a meaning as mentioned below.

{ / }: Either one of the braced options is selected

■ AVG/?AVG

Description : Sets/queries the average function and average count.

Parameter : Specify the average function ON/OFF and specify the average count. (0/1/S,mm,ww)

0 : Average function OFF

1 : Average function ON

S,mm,ww : Specify the average count

mm : Moving average count {01,02,04,08,16,32,64}

ww : Wavenumber average count {01,02,04,08,16,32}

Response : Average function ON/OFF state and average count “mm,ww” is output.

AVG:{OFF/ON_},AV:mm,ww

■ CBG/?CBG

Description : Sets/queries the gain correction data. For the gain correction, only the range at the time when the data is sent is corrected.

Parameter : Specify the set input and set the gain correction data (%).(el,±nn.nnn)

el : Specify the input {V1,V2,V3,V0,A1,A2,A3,A0}

±nn.nnn : Gain correction data {-15.000% to +15.000%}

Specify the range when the content of gain correction data is queried (0 to 9)

0 : 1V,0.04A / 1 : 2.5V,0.1A / 2 : 5V,0.2A / 3 : 10V,0.4A / 4 : 20V,0.8A

/ 5 : 40V,1.6A / 6 : 80V,3.2A / 7 : 160V,6.4A / 8 : 320V,12A / 9 :640V,24A

Response : The date and time when correction is made and the gain correction data in the specified range are output.

CBG:yy/MM/dd,hh:mm,V1:±nn.nnn,V2:....,V3:....,V0:....,A1:....,A2:....,A3:....,A0:....

■ CBO/?CBO

Description : Sets/queries the offset correction. For the offset, the measurement result at the time when the command is sent becomes the correction data, and only the range at that time is corrected.

Parameter : Specify the set input (el)

el : Specify the input{V1,V2,V3,V0,A1,A2,A3,A0}

Specify the range when the content of offset correction data is queried (0 to 9)

0 : 1V,0.04A / 1 : 2.5V,0.1A / 2 : 5V,0.2A / 3 : 10V,0.4A / 4 : 20V,0.8A

/ 5 : 40V,1.6A / 6 : 80V,3.2A / 7 : 160V,6.4A / 8 : 320V,12A / 9 : 640V,24A

Response : The date and time when correction is made and the offset correction data in the specified range are output.

CBO:yy/MM/dd,hh:mm,V1:±nnnnn,V2:....,V3:....,V0:....,A1:....,A2:....,A3:....,A0:....

■ CCT/?CCT

Description : Sets/queries the chattering eliminating function of the counter.

Parameter : Specify the counter chattering eliminating function ON/OFF (0/1)

0 : OFF

1 : ON

Response : The counter chattering eliminating function on/off state is output.

CCT:{OFF/ON_}

■ ?CDT

Description : Queries the measured data of the counter.
Parameter : None
Response : The measured data of the counter is output. The type of data varies depending on the counter mode.
"CN1" denotes counter 1, "CN2" denotes counter 2, "C1X", "C2X" denote maximum value of counters 1 and 2, and "C1N", "C2N" denote minimum value of counters 1 and 2.
Counter in non-operating state : CDT:NOTCNT
Counter in single mode : CN1:±n.nnnnE±nn
Counter in dual mode : CN1:±n.nnnnE±nn,CN2:±n.nnnnE±nn
Counter in multi mode : CN1:±n.nnnnE±nn,C1X:±n.nnnnE±nn,C1N:±n.nnnnE±nn
,CN2:±n.nnnnE±nn,C2X:±n.nnnnE±nn,C2N:±n.nnnnE±nn

■ CLC/?CLC

Description : Sets/queries the calculation mode.
This command is settable from remote control only. "A" is always set at the power on.
Parameter : Set the calculation mode (A/B)
A : Only the functions being displayed are calculated. Only the data of displayed items (6 items) are sent.
B : The functions of all items are calculated. The data of 24 items are sent.
Response : The calculation mode state is output.
CLC:{A/B}

■ CLK/?CLK

Description : Sets/queries the date and time of internal clock.
Parameter : Specify date and time (yy/MM/dd,hh:mm)
yy/MM/dd,hh:mm : Year month day, hour minute
Response : The date and time of internal clock are output.
CLK:yy/MM/dd,hh:mm:ss

■ CNM/?CNM

Description : Sets/queries the counter mode.
Parameter : Specify the Interval mode, One Shot mode, external reset ON/OFF, threshold value of trip input, chattering time, and switch the counter operation.
(I,{0,1,2} / O,{0,1} / R,{0,1} / T,{0,1,2} / C,nnn / M, {0,1})
I,{0,1,2} : Interval mode setting 0= Single (SNGL), 1= Dual (DUAL), 2= Multi (MULT)
O,{0,1} : One shot mode setting 0= One shot (ONESH), 1= Train (TRAIN)
R,{0,1} : Set the external reset function 0=OFF, 1=ON
T,{0,1,2} : Set the trip input voltage threshold value 0=2.5V, 1=8V, 2=50V
C,nnn : Set the chattering time nnn: 001 to 125(ms)
M,{0,1} : Switch the counter operation 0= One shot (ONESH), 1= Interval (INTVL)
Response : The counter mode state and the setting content of each mode are output.
CNM:I/{SNGL/DUAL/MULT},O/{ONESH/TRAIN},R/{OFF/ON_},T/{2.5V/8.0V/50.V},C/nnn,M/{ONESH/INTVL}

■ CRS

Description : Resets the counter.
Parameter : None

■ CST/?CST

Description : Sets/queries the counter start input format and operation mode.
Parameter : Specify the start input format and operation mode. ({C,V}{B,M})
C : Specify contact input / V : Specify voltage input
B : B-M / M : M-B
("B" : Contact open or voltage High, "M" : Contact closed or voltage Low)
Response : The counter start input format and operation mode setting state are output.
CST:{C/V},{B/M}

■ CTP/?CTP

Description : Sets/queries the counter trip input forma and operation mode.
Parameter : Specify the trip input format and operation mode. ({C,V}{B,M})
C : Specify contact input / V : Specify voltage input
B : B-M / M : M-B
("B" : Contact open or voltage High, "M" : Contact closed or voltage Low)
Response : The counter trip input format and operation mode setting state are output.
CTP:{C/V},{B/M}

■ Dna/?Dna

Description : Sets/queries the FUNCTION and ELEMENT.
Exchange the character "n" in the command with STORE/RECALL number (1,2,3,4).
Exchange the character "a" in the command with the display location (A,B,C,D,E,F).
Parameter : Set the FUNCTION and ELEMENT. However, the display location of FUNCTION except voltage and current is limited. "e" specifies the element, and unless otherwise specified, 0-3 specifies the input phase, and 4 specifies "Σ".

VLe	: Phase voltage
AMe	: Current
VVe	: Line voltage / 1 : V12, 2 : V23, 3 : V31
WTe	: Active power [A,B,C,D only]
VAe	: Apparent power [A,B,C,D only]
VRe	: Reactive power [A,B,C,D only]
PFe	: Power factor [A,B,C,D only]
DFe	: Between current and voltage phase difference [A,B,C,D only]
DSe	: Phase difference of element based on reference phase. Reference input is SYNC input. [A,B,C,D only] 0 : V0, 1 : V1, 2 : V2, 3 : V3, 4 : A0, 5 : V1, 6 : V2, 7 : V3
DWe	: Phase difference between voltage lines／1 : V12, 2 : V23, 3 : V31 [A,B,C,D only]
CN0	: Counter display [E only]
I1e	: Impedance (V / A) [E only]
I3e	: Impedance ($V / (\sqrt{3}A)$) [E only]
ISe	: Impedance ($V / (2A \sin\phi)$) [E only]
HZ0	: Frequency [F only]
WHe	: Integration active power [F only]
AHe	: Integration current [F only]
VHe	: Integration reactive power [F only]
DA0	: Phase difference between Displays A and B [E only]
DC0	: Phase difference between Displays C and D [F only]

Response : The FUNCTION/ELEMENT state of measurement displayed is output.
Dna:{VLe/AMe/VVe/WTe/VAe/VRe/DFe/DSe/DWe/CN0/I1e/I3e/ISe/HZ0/WHe/AHe/VHe/DA0/DC0}

■ DSP/?DSP

Description : Sets/queries the STORE/RECALL number.
Parameter : Specify the STORE/RECALL number. (1 to 4)
In the calculation mode A, the measurement, display, and response data are switched.
In the calculation mode B, the display data is switched.
Response : The STORE/RECALL number state is output.
DSP:{1/2/3/4}

■ HDR/?HDR

Description : Sets/queries the header ON/OFF of response to the query.
Parameter : Header ON/OFF (0 / 1)
0 : OFF
1 : ON
Response : Response header ON/OFF setting state is output.
HDR:{OFF/ON_}

■ HLD/?HLD

Description : Sets/queries the display hold and the hold function by trip input.
Parameter : Specify the hold ON/OFF and set the hold function by trip input. (0 / 1 / E,{0,1})
0 : Cancel the hold (OFF)
1 : Set the hold (ON)
E,{0,1} : Hold function by trip input 0 = Invalid (OFF), 1 = Valid (ON)
Response : The hold state and the setting of hold function by trip input are output.
HLD:{OFF/ON_},EXT:{OFF/ON_}

■ IDO/?IDO

Description : Sets/queries the integration operation.
Parameter : Specify the integrating operation. (SR / SP / RS)
SR : Start the integrating operation
SP : Stop the integrating operation
RS : Integrating data reset
Response : The integrating operation state and integrated time state (hhh: hour, mm: minute) are output.
IDO:{SR/SP/RS},hhh.mm

■ IMD/?IMD

Description : Sets/queries the integrate mode.
Parameter : Specify the Integrate mode, integrated time, and integration start and stop time.
(M / T,timer / R,starttime,endtime)
M : Manual operation
T : Timer operation
timer : timer operation (hhh: mm: Specify hour, mm: minute)
R : Real time integrating operation
starttime : Specify the start time (yy/MM/dd,hh:mm : Specify year month day, hour minute)
endtime : Specify the end time (yy/MM/dd,hh:mm : Specify year month day, hour minute, same as startime)
Response : The Integrate mode setting state and the setting content of each mode are output.
IMD:M
IMD:T,timer
IMD:R,starttime,endtime

■ ?INP

Description : Queries the measured data.
Parameter : Specify the transmitted data (Parameter varies depending on the calculation mode A or B)
In the calculation mode A (only the displayed function is calculated)
Parameter none, Measurement result being displayed is sent
In the calculation mode B (all items are calculated)
0 : Send the measurement result being displayed
1,2,3,4 : Send only the measurement result of the specified STORE/RECALL number
A : Send the measurement result of all 24 items
Response : Measured data specified by the parameter are output.
dna:±n.nnnnE±nn,dnb:±n.nnnnE±nn,dnc:±n.nnnnE±nn,dnd:±n.nnnnE±nn,dne:±n.nnnnE±nn,dnf:±n.nnnnE±nn
[/d2a:±n.nnnnE±nn,d2b:±n.nnnnE±nn,d2c:±n.nnnnE±nn,d2d:±n.nnnnE±nn,d2e:±n.nnnnE±nn,d2f:±n.nnnnE±nn
/d3a:±n.nnnnE±nn,d3b:±n.nnnnE±nn,d3c:±n.nnnnE±nn,d3d:±n.nnnnE±nn,d3e:±n.nnnnE±nn,d3f:±n.nnnnE±nn
/d4a:±n.nnnnE±nn,d4b:±n.nnnnE±nn,d4c:±n.nnnnE±nn,d4d:±n.nnnnE±nn,d4e:±n.nnnnE±nn,d4f:±n.nnnnE±nn]
"dna,dnb,dnc,dnd,dne,dnf" specify the FUNCTION/ELEMENT of the measurement. Refer to the "Dna" parameter. If the data of all 24 items are output, the data in [ ] continue.
The header "INP" is not attached to the above data even if the header ON is specified.

■ MDL/?MDL

Description : Sets/queries the model name number (specify).
Parameter : Specify the model name number. (2721 / 2722)
[Note] Never change the model number.
Response : The model number, program version, and with/without 2725 input unit are output.
MDL:{2721/2722},n.nn_a,ELMT{123_/1230}
n.nn_a : Program version number
123_ : Without 2725 input unit
1230 : With 2725 input unit

■ MSR/?MSR

Description : Sets/queries the measurement mode.
Parameter : Specify the measurement mode. (0 / 1)
0 : AC mode
1 : DC mode
Response : The measurement mode state is output.
MSR:{AC/DC}

■ RNG/?RNG

Description : Sets/queries the range.
Parameter : Select either manual range or auto range, and specify the range. (0 / 1 / el,n) However, the range is ineffective in the auto range even if it is specified.
0 : Manual range
1 : Auto range
el : Specify the input {V1,V2,V3,V0,A1,A2,A3,A0}
n : Specify the range {0 to 9}
0 : 1V,0.04A / 1 : 2.5V,0.1A / 2 : 5.00V,0.20A / 3 : 10.0V,0.40A / 4:20V,0.8A
/ 5 : 40V,1.6A / 6 : 80V,3.2A / 7 : 160V,6.4A / 8 : 320V,12A / 9 : 640V,24A
Response : The range setting state and range state are output.
mgV is a voltage range (1V to 640V), and mgA is a current range (0.04A to 24V / 0.001A to 0.01V / 2A to 20V / 20A to 200V).
RNG:{OFF/ON_},V1:rngV,V2:rngV,V3:rngV,V0:rngV,A1:rngA,A2:rngA,A3:rngA,A0:rngA

■ RSM/?RSM

Description : Sets/queries the remote / local for RS-232C interface.
Parameter : Select remote / local for RS-232C interface.
RMT : Select remote state
LCL : Change from remote state to local state
Response : The remote / local state for RS-232C interface is output.
RSM:{RMT,LCL}

■ SCL/?SCL

Description : Sets/queries the scaling function and scaling factor.
Parameter : Specify the scaling function ON/OFF, scaling mode setting, and scaling factor.
(0 / 1 / el,+n.nnnnE±nn)
0 : Scaling function OFF
1 : Scaling function ON
el : When same factor is set for all items, specify voltage or current: {VA,AA} / +n.nnnnE±nn : factor
When individual factors are set, specify the input {V1,V2,V3,V0,A1,A2,A3,A0} / +n.nnnnE±nn: factor
Response : The scaling function on/off state and the setting content of scaling are output.
When same factor is set :
SCL:{OFF/ON_},V:±n.nnnnE±nn,A:±n.nnnnE±nn
When individual factors are set:
SCL:{OFF/ON_},V1:±n.nnnnE±nn,V2:±n.nnnnE±nn,V3:±n.nnnnE±nn,V0:±n.nnnnE±nn,
A1:±n.nnnnE±nn,A2:±n.nnnnE±nn,A3:±n.nnnnE±nn,A0:±n.nnnnE±nn

■ SRL/?SRL

Description : Sets/queries the last 6 digits of a serial number. Do not change the setting.
Parameter : Specify a serial number. (MF,mmmmmm / el,nnnnnne)
[Note] Never change the setting.
MF : Specify the serial number of the main frame.
mmmmmm : Serial number (100000 to 999999) last 6 digits
el : Specify the input {V1,V2,V3,V0,A1,A2,A3,A0}
nnnnnne : Serial number (1000000 to 9999993) 7digits
[Note] The serial number of standard input unit for 2721 or 2722 is "last 6 digits of serial number of the main frame + element number". The serial number assigned to the 2725 input unit (optional) is not applicable here.
Response : All serial numbers contents are output.
SRL:mmmmmm,V1:nnnnnn1,V2:....,A1:nnnnnn1,....

■ SRQ/?SRQ

Description : Sets/queries the service request enable register. The service request is made even if it is not set with the command, when the measurement finished after the Group Execute Trigger was received.
Parameter : Set the service request enable register.
0 : Service request is not made at the completion of count
4 : Service request is made at the completion of count
Response : The setting of service request enable register is output.
SRQ:nnn

■ ?STS

Description : Queries the input state.
As the input states, there are "range data state of each input", "synchronous or asynchronous state of sync input" and "error number".
Parameter : None
Response : The input state is output.
STS:RNG:vvvv_aaaa,TRG,ERR:nn
vvvv_aaaa : The range state of each input is indicated.
vvvv indicates the voltage V1,V2,V3,V0, and aaaa indicates the current A1,A2,A3,A0 in this order.
0 to 9 is a range number.
0 : 1V,0.04A / 1 : 2.5V,0.1A / 2 : 5.00V,0.20A / 3 : 10.0V,0.40A/4:20V,0.8A
/ 5 : 40V,1.6A / 6:80V,3.2A / 7 : 160V,6.4A / 8 : 320V,12A / 9 : 640V,24A
For under range, "U" is given instead of range number, or for over range, "D" is given.
TRG : Synchronous state is indicated. "TRG" indicates synchronous state, and "NTG" indicates asynchronous state.
ERR:nn : A communication error number is indicated. The error numbers are as follows.
[30] Header error / [31] Parameter error / [32] Buffer over error
[40] Parity error / [41] Overrun error / [42] Flaming error
[43] Break detection error

■ SYC/?SYC

Description : Sets/queries the synchronous signal.
Parameter : Specify the synchronous signal. (0 to 8)
0 : V0 / 1 : V1 / 2 : V2 / 3 : V3 / 4 : A0 / 5 : A1 / 6: A2 / 7 : A3 / 8 : LINE
Response : The synchronous signal state is output.
SYC:{V1/V2/V3/V0/A1/A2/A3/A0/LINE}

■ WRG/?WRG

Description : Sets/queries the wiring method.
Parameter : Specify the wiring method. (1 to 4)
1 :1 ϕ2W(1f2W) / 2 : 1ϕ3W(1f3W) / 3 : 3ϕ3W(3f3W) / 4 : 3ϕ4W(3f4W)
Response : The wiring method setting state is output.
WRG:{1f2W/1f3W/3f3W/3f4W}

7.7 Sample Programs

The GPIB and RS-232C sample programs are shown below.
This is a case that uses PC-9801 (made by NEC) as a controller.

■ GPIB sample program

With the SYNC signal V1, "voltage V1, current A1, active power W1, apparent power VA1, voltage to current phase difference degAB, sync input frequency Hz" are set for the element 1 input, and the measured data are read.

```
1010 '**********************************************************
1020 '*    FOR 2721/2722 POWER MULTIMETER                      *
1030 '*    GPIB SAMPLE PROGRAM                                 *
1040 '**********************************************************
1050 'SAVE "2721IBCK.BAS",A
1060 ADR=7                      'GPIB address      :7
1070 CMD DELIM=0                'Delimiter setting :CR+LF
1080 ISET IFC,100               'Clear the interface
1090 ISET REN                   'Set the interface to remote
1100 FOR I=0 TO 100:NEXT I      'Waite
1110 ' Set measurement conditions
1120 PRINT@ ADR;"MSR:0"         'Measurement mode  :AC
1130 PRINT@ ADR;"DSP:1"         'Display number    :[1]
1140 PRINT@ ADR;"SYC:1"         'Synchronous signal setting:V1
1150 PRINT@ ADR;"AVG:1"         'Average           :ON
1160 PRINT@ ADR;"RNG:1"         'Range setting     :AUTO ON
1170 PRINT@ ADR;"SCL:0"         'Scaling           :OFF
1180                            'FUNCTION setting  :V1,A1,W1,VA1,degAB,Hz
1190 PRINT@ ADR;"D1A:VL1;D1B:AM1:D1C:WT1;D1D:VA1;D1E:DA0;D1F:HZ0"
1200 ' Time waiting
1210 FOR I=0 TO 50000!:NEXT I
1220 ' End after 5-time measurements
1230 FOR K=1 TO 5
1240 ' Query the measured data
1250   PRINT@ ADR;"?INP"
1260 ' Read the data
1270   INPUT@ ADR;DA$,DB$,DC$,DD$,DE$,DF$
1280   PRINT "K=";K
1290   PRINT  DA$,DB$,DC$,DD$,DE$,DF$ ' Display the read data
1300 ' Time waiting
1310   FOR I=0 TO 50000!:NEXT I
1320 NEXT K
1330 ' LOCAL
1340 IRESET REN                  ' Cancel the remote
1350 END
```

■ RS-232C sample program

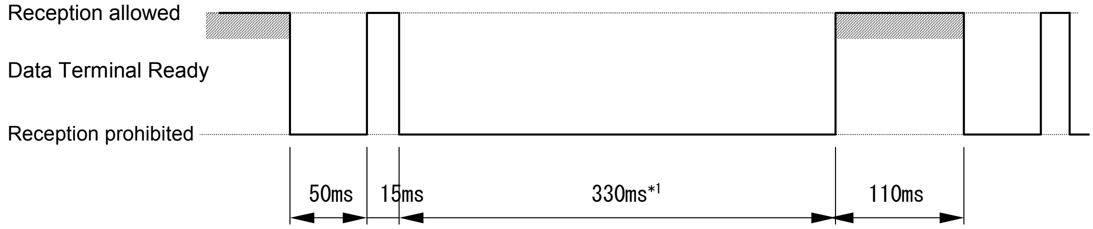
With the SYNC signal V1, “voltage V1, current A1, active power W1, apparent power VA1, voltage to current phase difference degAB, sync input frequency Hz” are set for the element 1 input, and the measured data are read.

```
1010 '**********************************************************
1020 '*    FOR 2721/2722 POWER MULTIMETER                      *
1030 '*    RS-232C SAMPLE PROGRAM                              *
1040 '**********************************************************
1050 'SAVE "2721RS_1.BAS",A
1060 OPEN "COM1:N81NN" AS #1   'Communication port open 8BIT,1BIT,NON
1070 FOR T=0 TO 1000:NEXT T    'Processing time waiting
1080 ' Set measurement conditions
1090 PRINT #1,"HLD:1"          '
1100 FOR T=0 TO 1000:NEXT T    'Processing time waiting
1110 PRINT #1,"?HLD"           '
1120 LINE INPUT #1,RCV$:PRINT RCV$
1130 PRINT #1,"MSR:0"          'Measurement mode  :AC
1140 PRINT #1,"?MSR"           'Measurement mode  :AC
1150 LINE INPUT #1,RCV$:PRINT RCV$
1160 PRINT #1,"DSP:1"          'Display number    :[1]
1170 PRINT #1,";?DSP"
1180 LINE INPUT #1,RCV$:PRINT RCV$
1190 PRINT #1,"SYC:1"          'Synchronous signal setting:V1
1200 PRINT #1,"?SYC"
1210 LINE INPUT #1,RCV$:PRINT RCV$
1220 PRINT #1,"RNG:1"          'Range setting  :AUTO ON
1230 PRINT #1,"?RNG"
1240 LINE INPUT #1,RCV$:PRINT RCV$
1250 PRINT #1,"SCL:0"          'Scaling:OFF
1260 PRINT #1,"?SCL"
1270 LINE INPUT #1,RCV$:PRINT RCV$
1280 'FUNCTION Setting:V1,A1,W1,VA1,degAB,Hz
1290 PRINT #1,"D1A:VL1;D1B:AM1:D1C:WT1;D1D:VA1;D1E:DA0;D1F:HZ0"
1300 PRINT #1,"HLD:0"          '
1310 FOR T=0 TO 1000:NEXT T    'Processing time waiting
1320 PRINT #1,"?HLD"           '
1330 LINE INPUT #1,RCV$:PRINT RCV$
1340 FOR T=0 TO 10000:NEXT T   'Processing time waiting
1350 ' Time waiting
1360 FOR I=0 TO 50000!:NEXT I  'Processing time waiting
1370 'End after 50000000-time measurements
1380 FOR K=1 TO 5E+06
1390 ' Query the measured data
1400 PRINT "K=";K
1410 *HOLD
1420 PRINT #1,"HLD:1"
1430 FOR T=0 TO 10000:NEXT T   'Processing time waiting
1440 PRINT #1,"?HLD"
1450 LINE INPUT #1,RCV$:PRINT RCV$
1460 IF MID$(RCV$,5,3)="ON_" THEN *HOLD
1470 PRINT #1,"?INP"
1480 ' Read the data
1490 INPUT #1,DA$,DB$,DC$,DD$,DE$,DF$
1500 PRINT  DA$,DB$,DC$,DD$,DE$,DF$ 'Display the read data
1510 PRINT #1,"HLD:0;?HLD"     '
1520 LINE INPUT #1,RCV$:PRINT RCV$
1530 ' Time waiting
1540 FOR I=0 TO 50000!:NEXT I
1550 NEXT K
1560 CLOSE 1                   'Communication port close
1570 END
```

■ RS-232C supplementary description

● Receivable section

The RS-232C interface of the 2721/2722 can receive data when "Data Terminal Ready (DTR)" is in "H" state.
The "Data Terminal Ready (DTR)" signal is as shown below.
The data should be sent from the host in a section of 110ms shown below.



The conditions are "waveform averaging count: 8 times, frequency: 50Hz".
In the reception prohibited section, the "voltage/current waveform is reading". The initial 50ms is for checking the range, and accordingly if the range is changed, the range check is repeated until the range is determined. The next 330ms is for reading the waveform data, and thus it varies if the "waveform averaging count" is changed. If the "waveform averaging count" is set to 1 or the average function is turned off, 330ms*1 varies to 50ms.
During the time that the reception processing is executed after a command was received, the "Data Terminal Ready" is placed in low state to prohibit the reception of next command.
During the prohibited period, do not send a command.
For the command transmission interval, provide "50ms or more" with the "reception allowed".

● Communication method

When the setting or measured data are queried, set the "hold state" for smooth communication.
The command that sets the "hold state" is "HLD:1". After setting, confirm that the hold state has been set.
In the hold state, the reception is ready at all times, but an interval of more than 50ms should be provided to transmit a command.

8. TROUBLESHOOTING AND MAINTENANCE

This chapter describes corrective actions, maintenance method, and calibration method when a problem occurred in the **"2721/2722 Power Multimeter"**.
The **"2721/2722 Power Multimeter"** can be calibrated using the keys on the front panel. However, the operation without reason may cause the internal correction data to be changed and thus the accuracy not to be guaranteed. Accordingly, enough care should be taken when performing the calibration.

date 2010/6/14(#93)

8.1 Troubleshooting

■ Error display

At the power ON, the self-diagnosis is conducted, and if an error is found, an error number is shown on the Display **D**.
The description and its cause of the error number, and necessary action are mentioned below.
For the display when the power switch is turned on, see **“3.1 Operation at Power ON” (p.3-5)**.

Table 8-1 Error display

Error display	Cause	Necessary action
D Err_1	Internal RAM read/write error	NF Corporation or one of our representatives
D Err_2	Internal ROM sum check error	NF Corporation or one of our representatives

■ When the device appears to be a problem

When the device appears to be a problem, take corrective action mentioned below. After that, if the device does not recover, please contact NF Corporation or one of our representatives.

Table 8-2 Troubleshooting (1/2)

Problem	Possible cause	Corrective action	Page
Power does not turn on	The power supply out of rated range is used.	Check the supply voltage and the setting of voltage selector switch	p.2-3
	Power fuse has blown	Replace the fuse. (Be sure to use the rated power fuse)	p.2-4
	Malfunction due to external noise	Install the device in a place under good environmental conditions	p.2-5
Front panel keys are not accepted	The device is in remote state	Press the LOCAL key to set the local state	p.7-3
	Keys are deteriorated	Please contact NF Corporation or one of our representatives	-
Response of panel operation is slow	The wavenumber average count has been set to large value (16 or 32)	Turn off the measurement average function, or reduce the average count.	p.3-15 p.6-5
Error in displayed data is large	When the measurement mode is AC, there is a DC component (offset) in the input signal	In the AC mode, the measurement is performed with “true r.m.s. value” and thus the DC component is included in the measured value. Try to measure the DC component in the DC mode.	p.3-17

Table 8-3 Troubleshooting (2/2)

Problem	Possible cause	Corrective action	Page
Displayed data is erroneous	Ambient temperature and humidity are not within the accuracy guarantee range	Use the device in the environment within the specified range	p.2-5
	The device is not warmed up enough	After the power on, warm up the device for more than 30 minutes	p.3-5
Displayed data is erroneous (Query result by GPIB or RS-232C is erroneous)	Cables are not connected correctly	Connect the cables correctly	p.3-7
	Measurement mode setting is wrong	If AC signal is measured, set the measurement mode to AC	p.3-15
	Display is held	Turn off the HOLD key lamp to cancel the hold state	p.3-15
	The level and range of input signal are not met	Turn on the AUTO key lamp to set the auto range	p.3-15
	The scaling value is set and the scaling function turns on	Turn off the SCAL key lamp to turn off the scaling function, or set correct scaling value	p.3-15 p.6-7
	The device is affected by noise	Input a signal not containing a noise, or install the device free from noise. Also, when making a query through GPIB or RS-232C, use a program such that a query is made again if data is erroneous.	-
	A signal that contains harmonics is used as SYNC signal	As SYNC signal, use the signal not containing harmonics	-
Displayed data is unstable	The SYNC signal level is small and stable synchronization is not attained	Change the SYNC signal to the signal having adequate level	p.3-15
	The input signal contains much noise or it is unstable	Set the average count to a larger value and turn on the measurement average function	p.3-15 p.6-5
Unmeasurable NO-TRIG occurs	The SYNC signal level is small and stable synchronization is not attained	Change the SYNC signal to the signal having adequate level	p.3-15
Setting by GPIB cannot be made	Address in a program does not meet the setting of this device	Set the address that meets the device setting	p.7-2
	Same address as that of other devices is set	Set the address different from other products	p.7-2
Setting by RS-232C cannot be made	Communication conditions of RS-232C do not meet the controller	Set the communication conditions of RS-232C, meeting the controller	p.7-3

8.2 Outline of Maintenance

■ Contents of maintenance work

To use the **“2721/2722 Power Multimeter”** under best conditions, appropriate maintenance is required.

- Operation inspection: Check if the device operates correctly.
- Performance testing: Check if the device respects the rated values.
- Adjustment, calibration: If the rated values are not satisfying, NF Corporation will make the necessary adjustment or calibration to restore performance.
- Damage repair: When the performance cannot be restored by the adjustment or calibration, NF Corporation will identify the cause and location of the damage and will execute repairs.

This instruction manual describes how to easily proceed with **“operation inspection and performance testing”**.
For more accurate “inspections, adjustments, calibration or repair”, contact NF Corporation or one of our representatives.

■ Backup battery for internal clock

The lithium battery used for internal clock is charged with small current while the power is supplied to the device.
With full charge, the backup period is about 60 days. However, it varies depending on the ambient temperature.
To charge the battery fully from empty state, the power must be supplied for about 60 hours. After that, the battery is kept in full charge state if the power is supplied usually for more than 20 hours. The battery is not over-charged even if the power is supplied continuously.。
The backup period is reduced when the lithium battery is deteriorated. In such a case, please ask for battery replacement to us. (Nonfree)
The battery life may be reduced without supplying the power for more than 6 months, and therefore it is recommended that the power be supplied sometimes.

8.3 Operation Inspection

■ Confirmation before operation inspection

Before the operation inspection, confirm the following items:

- Power voltage : Within rated voltage (AC100V, AC120V, AC220V, AC240V) ±10%
- Ambient temperature : 0 to 40°C
- Ambient humidity : 20 to 80%RH (no-condensing)

■ Function check

● Check at power ON

At the power ON, check that no error is displayed. When an error is displayed, see **"Table 8-1 Error display"**.

● Check of main functions

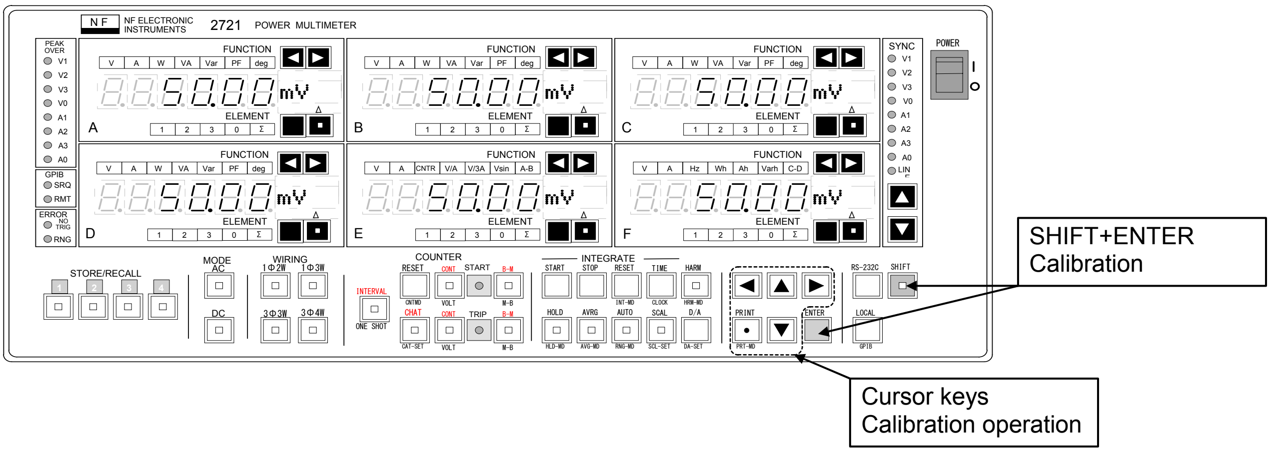
Initially, set the device to the factory settings.
To initialize the device to the factory settings, turn on the power switch while pressing the LOCAL key.
Then, enter the signal of same voltage and current values to respective voltage and current input terminals to check that the measured values of similar extent are displayed.
For the phase measured value, since the same signal is entered, ±0.05deg is displayed as a phase difference between voltages, and ±0.1deg as a phase difference between currents.
Operate a key on the front panel to check that the display changes.
For the counter function, set the start and trip inputs as follows.

Input format : Contact input CONT (lamp ON)
Operation mode : M-B (lamp OFF)

Then, check that the counter starts when the start input is short-circuited, and then the counter stops when the trip input is short-circuited.

8.4 Calibration Operation Method

This product can be calibrated (offset calibration, gain calibration) by the panel operation.



■ About calibration

This device stores the offset correction data and gain correction data in each range of each input in the nonvolatile memory, and recalls them at the power ON for correction during measurement.
Since the nonvolatile memory is not backed up by the battery, the correction data are not cleared even when the battery is discharged.
The correction data can be changed by the panel operation.
The offset calibration can be executed by pressing the keys on the front panel with the “voltage input short-circuited and current input opened”. The reference voltage “0V” can be set easily by short-circuiting the voltage input, and the reference current “0A” can be set by opening the current input easily, and therefore the offset calibration can be executed even if the standard instrument is not used.
For the gain calibration, the gain can be corrected within ±15% to the reference gain. However, the gain calibration cannot be executed unless the standard “voltage and current generator” is used.

■ Check before calibration

Before executing the calibration, check the following items.

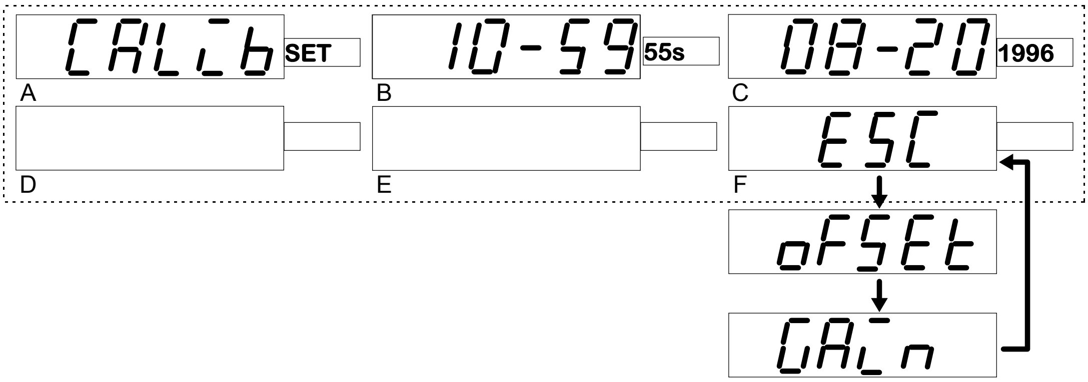
- Warm-up time : 2 hour or more
- Ambient temperature/ humidity : 23±5°C / 20 to 80%RH (no-condensing)
- Power voltage :100V±2V

■ Display of calibration mode

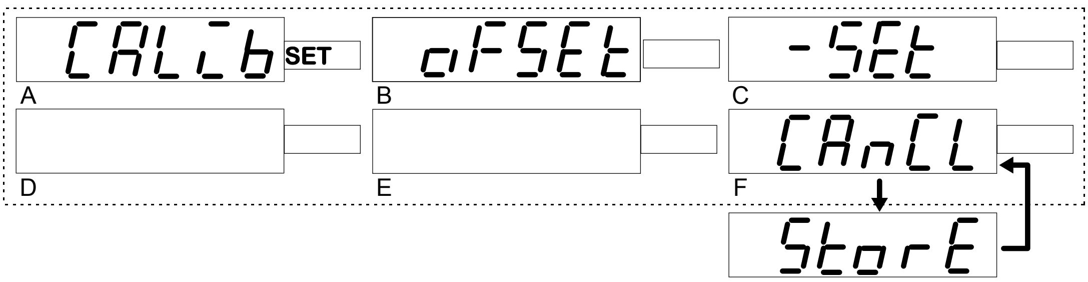
Press SHIFT + ENTER keys to activate the calibration mode.

The calibration mode display is as shown below. In this state, if any key is pressed, the calibration mode is deactivated and the measurement mode is restored.

Press [▲], [▼] keys to set **"oFSEt"** or **"GAin"** on the Display F, and press the **ENTER** key to set each calibration mode.



After the offset calibration or gain calibration, if the **ENTER** key is pressed, the display will be as shown below:

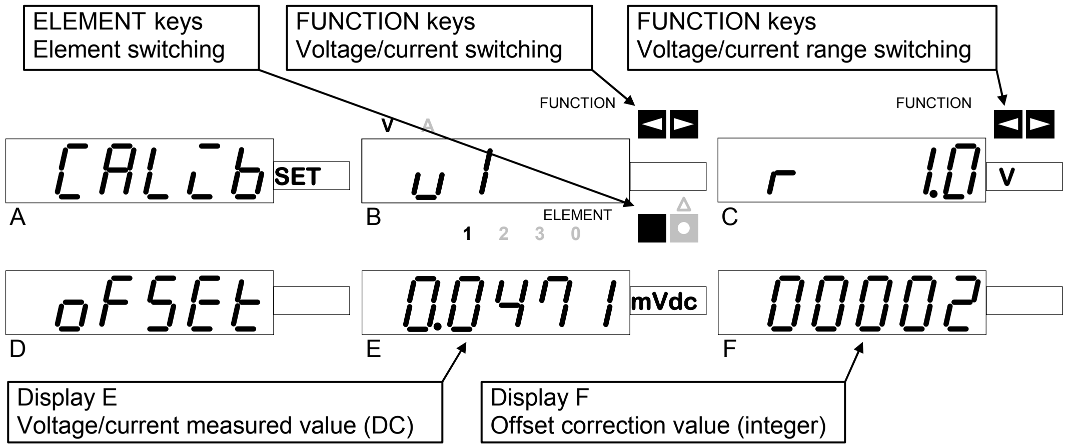


To set the correction data, press [▲], [▼] keys to set **"StorE"** on the Display **F** and press the **ENTER** key. The correction data is stored in the nonvolatile memory.

To cancel the calibration, set **"CAnCL"** on the Display **F** and press the **ENTER** key, and turn off the power switch once and then turn it on again.

Since the changed correction data is not stored in the nonvolatile memory, the correction data before change is recalled by turning off and on the power switch.

■ Display of offset calibration mode



• Display A : "CALib SET"	Indicates the calibration mode.
• Display B : "v1"	Indicates the input to be calibrated.
• Display C : "r 1.0"	Indicates a range of the input shown on Display **B**.
• Display D : "oFSEt"	Indicates the offset calibration mode.
• Display E : "0.0471mVdc"	Measured value of the input **(V1)** shown on Display **B** **DC** measurement is performed (simple average).
• Display F : "00002"	The averaged result is displayed with integer value (raw data of **AD** converter). Value "00000" on Display **F** indicates the minimum offset state.

■ Offset calibration setting method

To execute the offset calibration, follow the procedure mentioned below:

(1) Short-circuit the voltage input and open the current input.

(2) Select the input of which offset is to be calibrated. For this purpose, select the voltage input or current input with the **FUNCTION** keys on Display **B**, and the element with **ELEMENT** keys.

(3) Select a range with the **FUNCTION** keys on Display **C**. The initial value is present range setting. Usually, the auto range may be set. If nothing has been input, the minimum range is set.

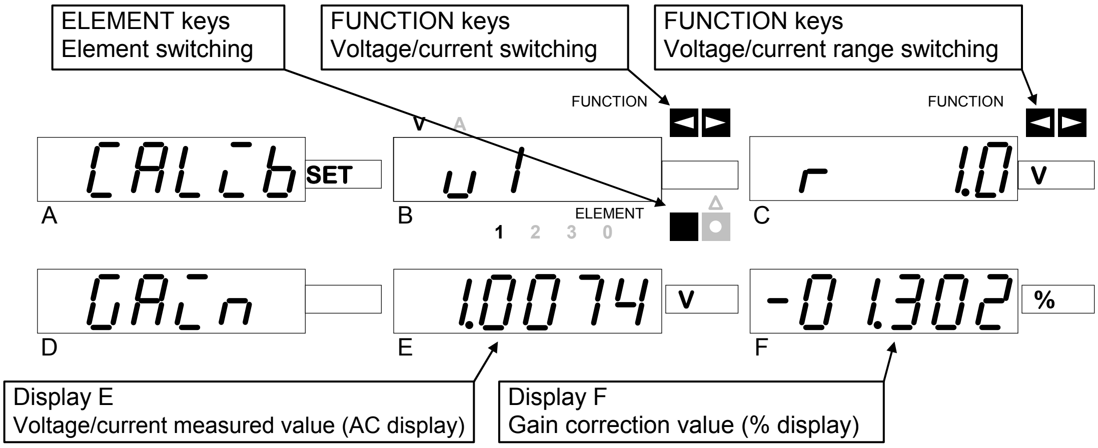
(4) Press [▲], [▼] keys to execute the offset calibration. Press [▲], [▼] keys repeatedly until the Display **F** shows **"00000"**. Pressing the [・] key resets the present correction data to zero. If cleared, the correction data becomes large.

(5) uccessively, to execute the calibration of all ranges, switch the range with the **FUNCTION** keys on Display **C** and perform the operation in step (4).

(6) When the calibration up to the maximum range (voltage 640V, current 24A) finished, switch the input with the **FUNCTION** keys and **ELEMENT** keys on the Display **B**, and repeat the operation in steps (3) and (4).

(7) When the offset calibration of the inputs and ranges finished, press the **ENTER** key to store the offset correction data.

■ Display of gain calibration mode



- Display A : "CALib SET" Indicates the calibration mode.
- Display B : "v1" Indicates the input to be calibrated.
- Display C : "r 1.0" Indicates a range of the input shown on Display **B**.
- Display D : "GAin" Indicates the gain calibration mode.
- Display E : "1.0074V" Measured value of the input **(V1)** shown on Display **B**
  AC measurement is performed (RMS value).
- Display F : "-01.302%" Indicates the gain correction data in percent (%).

■ Gain calibration setting method

To execute the gain calibration, follow the procedure mentioned below:

(1) Connect the AC standard voltage and current generator to the voltage and input terminals as shown on page 8 - 10.

(2) Select a range with the **FUNCTION** keys on Display **C**. The initial value is present range setting. Usually, the auto range may be set. If nothing has been input, the minimum range is set.

(3) Select the input of which gain is to be calibrated. For this purpose, select the voltage input or current input with the **FUNCTION** keys on Display **B**, and the element with **ELEMENT** keys.

(4) Change the gain correction data. Move the cursor with [◄], [►] keys, and change the correction data with [▲], [▼] keys. The range of gain correction data is **-15.000%** to **+15.000%**. At **00.000%**, if the [▼] key is pressed, a minus sign is displayed.

(5) Successively, to execute the calibration of another input, switch the input with the **FUNCTION** and **ELEMENT** keys on Display **B** and perform the operation in step (4).

(6) To execute the calibration of all ranges, switch the range with the **FUNCTION** keys on Display **C** and repeat the operation in steps (3) to (5).

(7) When all the gain calibration finished, press the **ENTER** key to store the gain correction data.

8.5 Performance Testing

■ Checking before performance testing

Before the performance testing, check the following items:

- Warm-up time : 2 hour or more
- Ambient temperature/ humidity : 23±5°C / 20 to 80%RH (no-condensing)
- Power voltage : 100V±2V

■ Required instrument

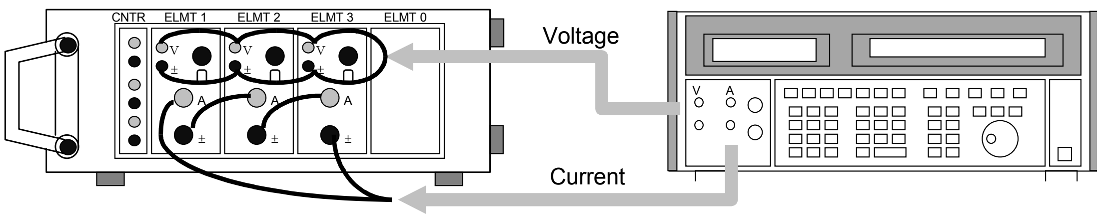
For the performance testing, the following instrument is required:

- AC standard voltage and current generator 1V to 640V, 40mA to 24A (11A)

■ Performance testing

● Connection with AC standard voltage and current generator

Connect the product and AC standard voltage and current generator as shown below:



Connect the voltage output of the generator to the “V, ±” terminals of ELEMENT 1, 2, 3, (0) and the current output to the “A, ±” terminals of ELEMENT 1, 2, 3, (0).
Connect the voltage in parallel, and the current in series.

● Checking voltage and current accuracy

Turn off the auto range setting (manual), and switch the range in the range setting mode, and input full scale value in the set range. The accuracy is normal if the measured value is within ±0.1%.
For the auto range setting, see **“3.3 Setting Measurement Conditions” (p.3-15)**, and for the range switching, see **“6.5 Range Display / Setting (RNG-SET)” (p.6-6)**.

● Checking phase difference accuracy

Since the same signal is input for the phase measurement, the accuracy is normal if a phase difference between voltages is within ±0.05 deg, or a phase difference between currents is within ±0.1 deg.

9. SPECIFICATIONS

■ Electrical rating

● Voltage input block

• Input format	Floating input (resistance potential dividing type)
• Number of inputs	3 phases + 1 phase (option: 2725 Input unit)
• Input terminal format	Binding post
• Measurement range	20% to 110% of each input range However, maximum measurement voltage 650Vrms (±920V)
• Max. allowable input	Continuous: ±920V or 650Vrms whichever small
• Input range	1V, 2.5V, 5V, 10V, 20V, 40V, 80V, 160V, 320V, 640V
• Input impedance	About 1MΩ (full range)
• Withstand voltage	AC2kV, one minute/±920V, continuous (between voltage input terminal and case, between voltage and current input terminals)

● Current input section

• Input format	Floating input (Shunt input system) or external voltage probe input
• Number of inputs	3 phases + 1 phase (option: 2725 Input unit)

• Input terminal format (the following two inputs are changed over by panel switch)

Shunt input:	Large type binding post
External input:	Current probe input connector RM515EPA-10PC : HIROSE

• Measurement range

Shunt input	20% to 110% of each input range However, maximum measurement current 25Vrms (35Apeak)
External input	±2V F.S

• Max. allowable input

Shunt input:	Instantaneous (1 sec): ±60A or less / Continuous: ±35A or 25Arms whichever smaller
External input:	Maximum ±10V or less

• Input range

Shunt input:	0.04A, 0.1A, 0.2A, 0.4A, 0.8A, 1.6A, 3.2A, 6.4A, 12A, 24A
External input:	2A, 5A, 10A, 20A when 20A clamp is used 20A, 50A, 100A, 200A when 200A clamp is used 1mA, 2.5mA, 5mA, 10mA when “2726 Micro-current probe” is used

• Input impedance

Shunt input:	About 5mΩ (full range)
External input:	About 30kΩ (full range)

• Withstand voltage	AC2kV, one minute/±920V, continuous (between current input terminal and case, between voltage and current input terminals)

- Connectable external current probe
  2726 Micro-current probe (option)

Rated current	: 10mA
Measurement range	: 200μA to 11mA
Amplitude accuracy	: ±(0.1% of rdg +0.1% of range) (40 to 100Hz)
Phase accuracy	: ±0.2deg(40 to 100Hz)

Voltage measurement accuracy *

- 40Hz to 100Hz ±(0.05% of rdg + 0.05% of range)
- 10Hz to 40Hz,100Hz to 1kHz
  ±(0.1% of rdg + 0.1% of range)
- DC ±(0.5% of rdg + 0.5% of range)

Current measurement accuracy *

- 40Hz to 100Hz ±(0.05% of rdg + 0.05% of range + 40μA)
- 10Hz to 40Hz,100Hz to 1kHz
  ±(0.1% of rdg + 0.1% of range + 40μA)
- DC ±(0.5% of rdg + 0.5% of range + 40μA)
- 40Hz to 100Hz (External current probe input)
  ±(0.05% of rdg + 0.05% of range)
  (Error in probe not included)

Phase measurement accuracy *

- 40Hz to 100Hz ±0.05deg (voltage-to-voltage phase difference)
  ±0.1deg (voltage-to-current, current-to-current phase difference)
- 10Hz to 40Hz,100Hz~1kHz
  ±0.2deg

Active power measurement accuracy *

- 40Hz to 100Hz ±(0.1% of rdg + 0.1% of range + ΔF% of rdg)
- 10Hz to 40Hz,100Hz to 1kHz
  ±(0.2% of rdg + 0.2% of range + ΔF% of rdg)
- DC ±(1% of rdg + 1% of range)

The error increase amount ΔF (%) due to power factor is obtained by the following expression.

$$\Delta F = \frac{\Delta\phi \times 2\pi}{360} \times \tan(\phi) \times 100(\%)$$

ϕ is measurement phase difference (deg), and $\Delta\phi$ is phase error (deg) in this device.

Power range = Voltage range × Current range

*: Standard condition
20 to 100% input of range, ambient temperature 23±5°C, supply voltage 100V±2%, input waveform: sine wave, average wavenumber 16, current input: internal shunt, after offset calibration after heat run

*: Distorted wave measurement accuracy

When the voltage and current are distorted waves, the measurement accuracy of voltage, current, power, and phase is same, provided that the following conditions are satisfied.

- Harmonic 10-order or less
- Harmonic frequency 20kHz or less
- Harmonic content rate 40% or less

● Impedance measurement

- Function — Calculation result by the following expression of each phase can be displayed

$$Z_1 = \frac{V_n}{I_n}, Z_2 = \frac{V_n}{\sqrt{3} \times I_n}, Z_3 = \frac{V_n}{2 \times I_n \times \sin\phi}$$

V_n: Voltage value, I_n: Current value, ϕ: Phase difference

- Phase selection — Select with element keys on Display D

● Frequency measurement

- Measurement range — 10Hz to 20kHz
- Display digits — 5 digits (10.000 to 20.000k)
- Measurement input — Input set as SYNC signal (SYNC signal is V1, V2, V3, V0, A1, A2, A3, A0, LINE)
- Accuracy — ±(0.05% of rdg + 1digit)

● Counter function

- Measurement mode — Single interval mode (Single-operation time difference measurement)
  Dual interval mode (Dual-operation time difference measurement)
  Multi interval mode(Dual-operation time difference measurement, max. & min. values hold)
  One shot mode (Pulse width measurement)
  Train mode (Pulse width integration measurement)
- Start input (counter start signal)
  - Input format — Voltage input or contact input, floating
    Withstand voltage: AC500V, one minute/±85V continuous
    Input terminal format: Binding post
  - Voltage input — Voltage input range: ±200V
    Threshold value voltage: 2.5V
    Input impedance : about 200kΩ
  - Contact input — Open circuit voltage: About 12V
    Short-circuit current: 15mA or less
    Output impedance: about 1kΩ
  - Input format switching — By front panel key
  - Operation mode switching — By front panel key
    Make ➔ Break / Break ➔ Make
    Make: 0V at voltage input, Short at contact input
    Break: 2.5V or more voltage at voltage input, Open at contact input
  - Monitor — Input state is displayed on the front panel

- Trip input (Counter stop signal)

Input format	Voltage input or contact input, floating Withstand voltage: AC500V, one minute/±85V continuous
Input terminal format	Binding post
Voltage input	Voltage input range: ±200V Threshold value voltage: 3 ranges of (1) about ±2.5V, (2) about ±8V, (3) about ±50V Input impedance : about 200kΩ
Contact input	Open circuit voltage: about 12V Short-circuit current: 15mA or less Output impedance : about 1kΩ
Input format switching	By front panel key
Operation mode switching	By front panel key Make ➔ Break / Break ➔ Make Make: 0V at voltage input, Short at contact input Break: Threshold value or more voltage at voltage input, Open at contact input
Monitor	Input state is displayed on the front panel

- Reset input (counter reset signal)

Input format	TTL input (DC voltage, decision voltage about 2.5V), either side connected to the case
Input terminal format	Binding post

- Chattering time 1 to 100ms 1ms resolution
- Time measurement accuracy ±(0.1% of rdg + 1digit)
±(0.1% of rdg + 1digit) + 1ms when the chattering eliminating function works
- Time measurement range (resolution)

0.1ms	to	1677s	(auto range)
0.1m	to	999.9ms	(0.1ms)
1.0000	to	9.9999s	(0.0001s)
10.000	to	99.999	(0.001s)
100.00	to	999.99	(0.01s)
1000.0	to	1677.0	(0.1s)

● Integration function

- Measurement item: Active power integration, reactive power integration, current integration
- Measurement mode

Manual integrate mode	Integration starts with START key and stops with STOP key Integrated value is reset with RESET key
Time integrate mode	Integration starts with START key and stops after the time set to timer elapsed. Maximum integrated time: 999H59M (resolution: 1 minute)
Real time integrate mode	Integration starts at reserved start time and stops at stop time.

- Display update cycle: About 1 sec (average function is turned off at integrating operation)
- Measurement range (resolution)

00.001mWh	to	99.999mWh	(0.001m)
100.00mWh	to	999.99mWh	(0.01m)
1.0000Wh	to	9.9999Wh	(0.0001)
10.000Wh	to	99.999Wh	(0.001)
100.00Wh	to	999.99Wh	(0.01)
1.0000kWh	to	9.9999kWh	(0.0001k)
10.000kWh	to	99.999kWh	(0.001k)
100.00kWh	to	999.99kWh	(0.01k)
1.0000MWh	to	9.9999MWh	(0.0001M)

- **Scaling function**

• Setting range	0.001m to 999.9k (m = 10^{-3}, k = 10^{3})

- **Average function**

• Averaging count	Moving average: 1, 2, 4, 8, 16, 32, 64 times Wavenumber average: 1, 2, 4, 8, 16, 32 times

- **Sampling (display update cycle)**

• Cycle	0.2 to 1s(variable depending on averaging count or setting of measurement items)

- **Remote control function**

• Communication system	GPIB or RS-232C (cannot be used at the same time)
• Setting items	Items settable with operation panel can all be set
• Data reading items	24 data can be read at a time Communication data and display data can be set separately

■ Environmental conditions

• Temperature and humidity range	Performance guaranteed: 0 to 40°C / 20 to 80%RH Note: 23±5°C for some items Storage: -10 to 50°C (no-condensing)
• Warm-up time	about 30 mini.

■ Power supply

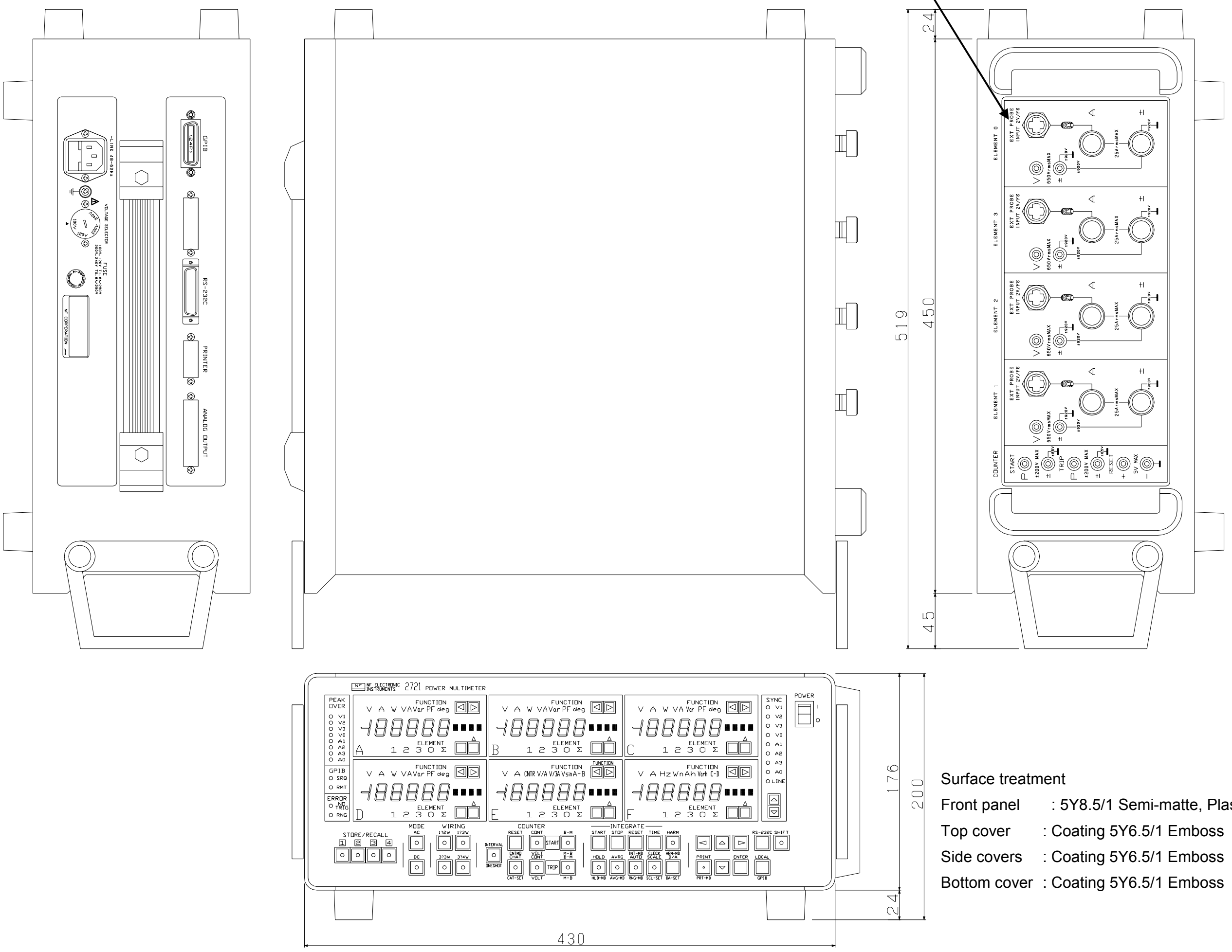
• Power supply	Voltage range	AC100V / 120V / 220V / 240V±10% (250V or less)
	Frequency range	48 to 62Hz
	Power consumption	About 53VA (main unit only) About 62VA (with 2725 input unit)
• Withstand voltage	AC1.5kV, one minute	(case and input terminals together to power supply input)

■ Mechanical rating

• External dimensions	Portable type: 430(W) × 176(H) × 450(D) (mm) Rack mount type: 434(W) × 177(H) × 500(D) (mm) (not including prongs and front panel cover)
• Weight	2721: About 16kg (main unit only), about 17kg (with 2725) (not including front panel cover) 2722: About 16kg (main unit only), about 17kg (with 2725)

■ 2721 External dimensions (Portable type)

[Optional when placing an order]
2725 Input Unit



Surface treatment

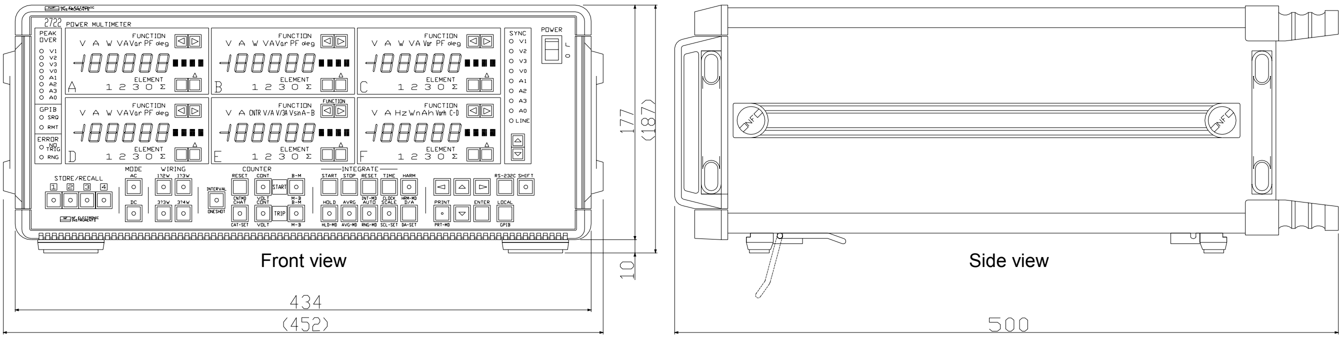
Front panel : 5Y8.5/1 Semi-matte, Plastic sheet

Top cover : Coating 5Y6.5/1 Emboss

Side covers : Coating 5Y6.5/1 Emboss

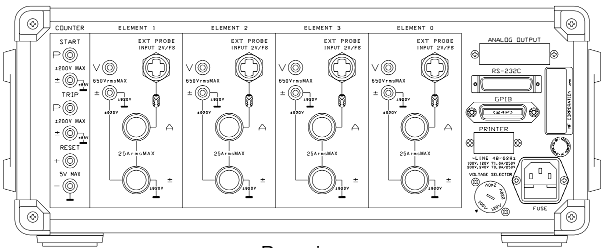
Bottom cover : Coating 5Y6.5/1 Emboss

■ 2722 External dimensions (Rack mount type)



Front view

Side view



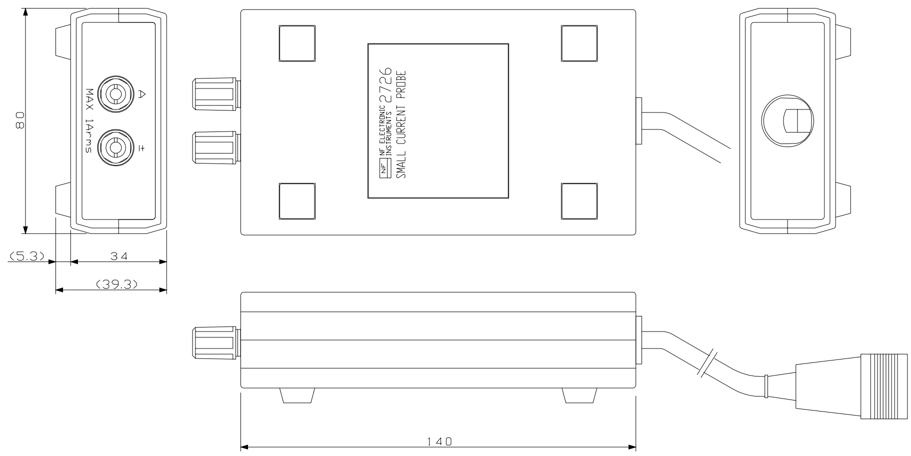
Rear view

[Optional when placing an order]
2725 Input Unit

Surface treatment

Front panel	: 5Y8.5/1 Semi-matte, Plastic sheet
Rear panel	: Coating 5Y6.5/1 Semi-matte
Top cover	: Vinyl chloride decorated steel sheet 5Y6.5/1 Emboss
Side covers	: Vinyl chloride decorated steel sheet 5Y6.5/1 Emboss
Bottom cover	: Vinyl chloride decorated steel sheet 5Y6.5/1 Emboss

■ 2726 Micro-current probe /External dimensions



Cable length 1M

Surface treatment
Panel: Munsell 5Y8.5/1 Plastic sheet
Case: Munsell 5Y8.5/1 Leather tone

MEMO

WARRANTY

NF CORPORATION certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from our factory.

All **NF** products are warranted against defects in materials and workmanship for a period of one year from the date of shipment. During the warranty period of, **NF** will, at its option, either will repair the defective product without any charge for the parts and labor, or either repair or replace products which prove to be defective. For repair service under warranty, the product must be returned to a service center designated by **NF**. Purchaser shall prepay all shipping cost, duties, and taxes for the product to **NF** from another country, and **NF** shall pay shipping charge to return the product to purchaser.

This warranty shall not apply to any defect, failure or damage caused by improper use, improper or inadequate maintenance and care or modified by purchaser or personnel other than **NF** representatives.

NF CORPORATION

<u>2721/2722 Instruction Manual</u>

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