WT1030/WT1030M

Digital Power Meter

USER'S MANUAL

YOKOGAWA ◆
Yokogawa Electric Corporation

IM 253620-01E
3rd Edition

Foreword

Thank you for purchasing the YOKOGAWA Model WT1030/WT1030M Digital Power Meter. This User's Manual contains useful information regarding the instrument's functions and operating procedures as well as precautions that should be observed during use. To ensure proper use of the instrument, please read this manual thoroughly before operating it. Keep the manual in a safe place for quick reference whenever a question arises.

Notes

- The contents of this manual are subject to change without prior notice.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your dealer or YOKOGAWA sales office.
- Copying or reproduction of all or any part of the contents of this manual without YOKOGAWA's permission is strictly prohibited.
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Revisions

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3rd Edition: November 1997

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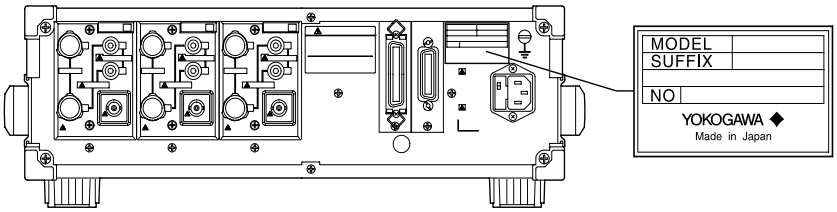
Checking Package Contents

Unpack the box and check the contents before operating the instrument. If the wrong instrument or accessories have been delivered, if some accessories are missing or if they appear abnormal, contact the dealer from which you purchased them.

WT1030/1030M Main Body

Check that the model name and suffix code given on the name plate of the rear panel match those on your order.



MODEL

Logo	Model	Basic Specifications
WT1030	253620	WT1030 253620 Capable of measurement for single-phase, two-wire; single-phase, three-wire; and three-phase, three-wire systems.
WT1030	253630	WT1030 253630 Capable of measurement for single-phase, two-wire; single-phase, three-wire; three-phase, three-wire; three-phase, four-wire; and three-voltage, three-current systems.
WT1030M	253640	WT1030 253640 Capable of measurement for single-phase, two-wire; single-phase, three-wire; three-phase, three-wire; three-phase, four-wire; and three-voltage, three-current systems, and calculation for evaluation of motor.

SUFFIX

Suffix Code	Description
- C1	GP-IB interface
- C2	RS-232-C interface
- 1	Rated AC line voltage: 100-120 VAC
- 5	Rated AC line voltage: 200-240 VAC
- D	UL/CSA standard power cord
- F	VDE standard power cord
- R	SAA standard power cord
- J	BS standard power cord
/B5	Printer incorporated
/INTG	Calculation function incorporated
/HRM	Harmonic analysis function incorporated
/DA	D/A outputs (14 channels)
/WF	Waveform output
/EX2	External input
/U1	Torque unit kgf·m, kgf·cm, ftlb, ozin and lbin

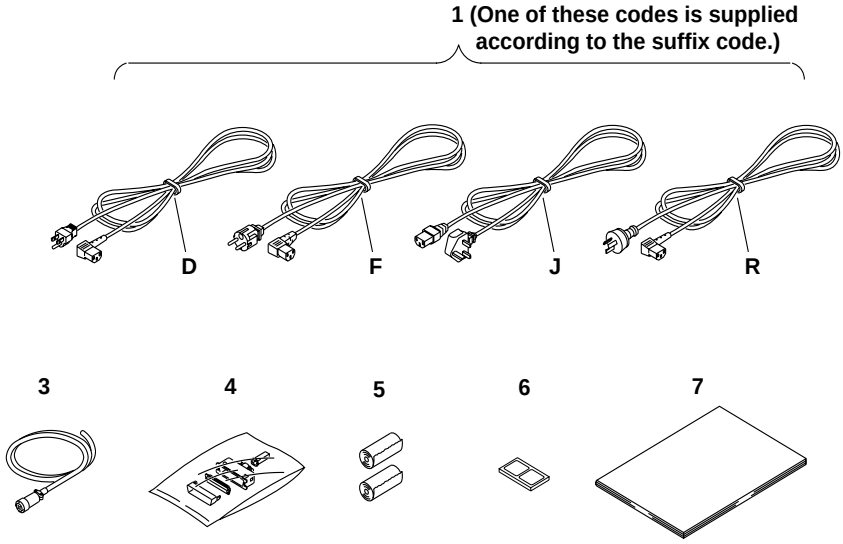
NO

When contacting the dealer, please give this serial number.

Standard Accessories

The following standard accessories are supplied with the instrument.

No.	Name	Part No.	Quantity	Remarks
1	Power cord	Refer to the suffix code.	1	Type of cord is specified by the suffix code.
2	Spare fuse (supplied in the fuse holder)	A1353EF	1	100 VAC/200 VAC common (250 V, 5 A)
3	External sensor connector cable	B9284LK	2 or 3	1 for each element (Supplied when the instrument is equipped with the external input (suffix code: /EX2)
4	36-pin connector	A1005JD	1	External input and output
5	Roll chart	B9293UA	2	Built-in printer (optional), 58 mm x 10 m
6	Rubber feet	A9088ZM	1	A pair of (for back feet)
7	User's Manual	IM253620-01E	1	This manual



Note

- It is recommended that the packing box be kept in a safe place. The box can be used when you need to transport the instrument somewhere.

Safety Precautions

This instrument is an IEC safety class I instrument (provided with terminal for protective grounding).
The following general safety precautions must be observed during all phases of operation, service and repair of this instrument. If this instrument is used in a manner not sepecified in this manual, the protection provided by this instrument may be impaired. Also, YOKOGAWA Electric Corporation assumes no liability for the customer's failure to comply with these requirements.

The following symbols are used on this instrument.


To avoid injury, death of personnel or damage to the instrument, the operator must refer to an explanation in the User's Manual or Service Manual.


Danger, risk of electric shock


Alternating current.

ON(power).


OFF(power).


In-position of a bistable push control


Out-position of a bistable push control


Function grounding terminal. This terminal should not be used as a “Protective grounding terminal”.

Make sure to comply with the following safety precautions. Not complying might result in injury, death of personnel or damage to the instrument.

WARNING

Power Supply
Ensure the source voltage matches the voltage of the power supply before turning ON the power.
Power Cable and Plug
To prevent an electric shock or fire, be sure to use the power cord supplied by YOKOGAWA. The main power plug must be plugged in an outlet with protective grounding terminal. Do not invalidate protection by using an extension cord without protective grounding.
Protective Grounding
Make sure to connect the protective grounding to prevent an electric shock before turning ON the power.
Necessity of Protective Grounding
Never cut off the internal or external protective grounding wire or disconnect the wiring of protective grounding terminal. Doing so poses a potential shock hazard.
Defect of Protective Grounding and Fuse
Do not operate the instrument when protective grounding or fuse might be defective.
Fuse
To prevent fire, be sure to use a fuse with the specified ratings (current, voltage and type). Before replacing the fuse, turn OFF the power and unplug the power cord. Do not use any fuse other than the specified one. Also do not short-circuit the fuse holder.
Do not Operate in an Explosive Atmosphere
Do not operate the instrument in the presence of flammable liquids or vapors. Operation of any electrical instrument in such an environment constitutes a safety hazard.
Do not Remove any Covers
There are some areas with high voltages. Do not remove any cover if the power supply is connected. The cover should be removed by qualified personnel only.
External Connection
To ground securely, connect the protective grounding before connecting to measurement or control unit.

How to Use this Manual

If you are using this instrument for the first time, we suggest that you read Chapter 1 before starting operation.

Chapter	Description
1	Main features, functions and the name of each part of the power meter
2	General precautions for use, installation method, how to turn the power on and off, and setting the date and time
3	How to connect the object to be measured, input element selection, and display using function keys
4	Setting measuring conditions and ranges
5	Operation method for measuring voltage, current, active power and peak values, and for display of computed apparent power, reactive power, power factor and phase angle
6	Operation method for measurement of frequency
7	Setting and operation of efficiency, MATH, scaling and averaging functions
8	Setting and operation for integration of active power and current.
9	Operation method for harmonic analysis functions
10	Operation method for outputting input voltage/current waveforms
11	Operation method for computation of torque, rotating speed, mechanical power, synchronous speed, slip, motor efficiency and total efficiency using the motor evaluation function
12	Setting and operation for printing measured values and set-up information using the built-in printer
13	Setting and operation for remote control and D/A output
14	Storing, recalling and initializing set-up information, key lock operation, and back-up function for set-up information
15	Communications using a GP-IB or RS-232-C interface
16	Possible causes of an alarm and corrective actions, description of error codes and corrective actions, replacement of the power supply fuse, and calibration
17	Specifications of the instrument
Appendix	Description of communication commands, sample programs and print examples (by the built-in printer)
Index	Description of important terms

Conventions Used in this Manual

Symbols used

The following symbols are used in this User's Manual.

To avoid injury or death of personnel, or damage to the instrument, the operator must refer to the User's Manual. In the User's Manual, these symbols appear on the pages to which the operator must refer.

WARNING Describes precautions that should be observed to prevent the danger of serious injury or death to the user.

CAUTION Describes precautions that should be observed to prevent the danger of minor or moderate injury to the user, or the damage to the property.

Note Provides information that is important for proper operation of the instrument.

Key Operation Rules

- To activate the function marked below a key, first press the SHIFT key (to light up the green indicator), then press the key. The sequence for key operation is described as follows in this manual.

***SHIFT* + *ENTER* (KEY LOCK)** ← **Function to be activated (marked below the key)**

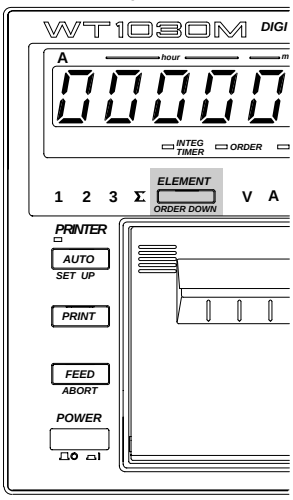
Name of the key marked on top of the key

This means that you must press the *SHIFT* key first, then press the *ENTER* key.

- On the display, " ▯ " means that the digit indicated by " ▯ " is blinking.

This digit is blinking.

- The active key is indicated with a " ▯ " as in the display example shown in the figure below.



Contents

Chapter 9 Harmonic Analysis Function (Optional)

Chapter 13 Using External Input/Output Functions

Chapter 14 Other Functions

Chapter 15 Using the Communications Functions

Chapter 16 Troubleshooting

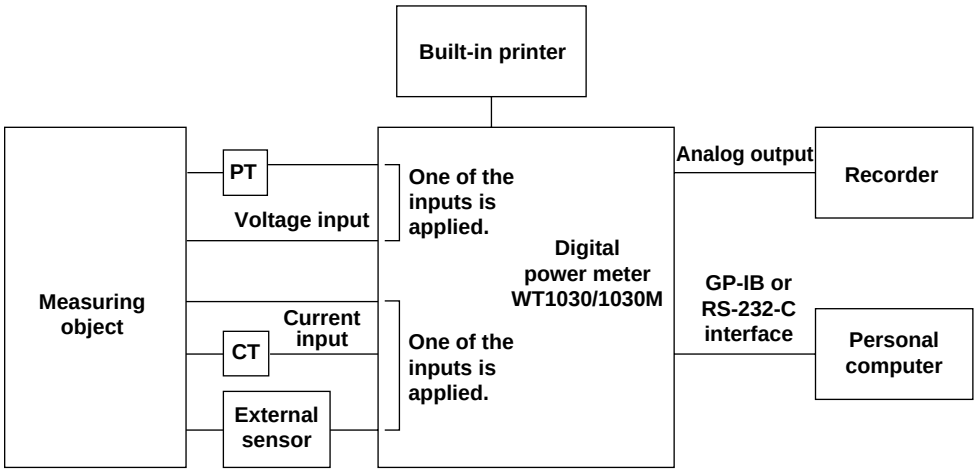
Chapter 17 Specifications

Appendix 1 Communications Commands (Before IEEE488.2-1987)

Appendix 2 Communication Commands (IEEE488.2-1987)

1.1 System Configuration and Functional Block Diagram

System Configuration



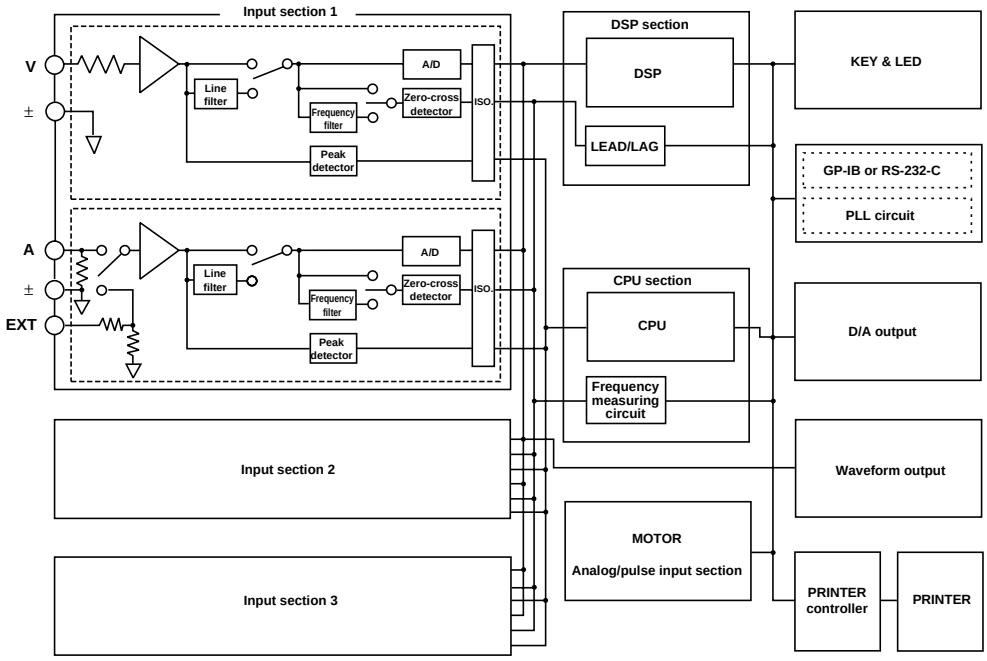
Functional Block Diagram

Operation Principle and Circuit Structure

The WT1030/1030M Digital Power Meter consists of various sections; input, DSP (Digital Signal Processor), CPU and display sections. The Input section consists of the voltage input circuit and the current input circuit, and there are isolated from each other. In the voltage input circuit, the input voltage is normalized by a voltage divider and operational amplifier, then sent to the A/D converter. In the current input circuit, the input current is converted into voltage by a shunt resistor, amplified and normalized by an operational amplifier, and then sent to the A/D converter.

The output from the A/D converter in the current input and voltage input circuits is sent to the DSP via a photo-isolator, which is used to provide insulation between the current input circuit (or voltage input circuit) and the DSP. The DSP performs computation of voltage, current, active power, apparent power, reactive power, power factor and phase angle, using the output data of the A/D converter.

Computation results are then sent from the DSP to the CPU, where computation such as range conversion, sigma computation and scaling is carried out, and the results are then displayed on the displays of the instrument.



1.2 Functions

Measuring Functions

This function enables measurement of voltage (rms value, mean-value rectification calibration, linear averaging), current (rms value, mean-value rectification calibration, linear averaging) and active power.

Voltage range : 15 V, 30 V, 60 V, 100 V, 150 V, 300 V, 600 V and 1000 V

Current range : 0.5 A, 1 A, 2 A, 5 A, 10 A, 20 A and external sensor input range (optional): 250 mV, 500 mV, 1 V, 2.5 V, 5 V and 10 V

Computing Functions

This function enables computation of active power, apparent power, reactive power, power factor and phase angle, using input voltage and current.

When performing measurements with an external PT and shunt connected, the scaling function is very useful. This function enables display of the measured values in terms of the primary-side values by setting the scaling factor according to the primary/secondary ratio. When this function is used, the active power, apparent power, reactive power and integrated power are multiplied by the scaling factor, then displayed.

An averaging function is also available. This function is used to perform exponential or moving averaging on the measured values before displaying them in cases where the measured values are not stable.

Frequency Measurement Functions

This functions enables measurement of the frequency of an input voltage or input current.

Measuring range: 1.5 Hz to 500 kHz

Integrator Functions (Optional)

This function enables integration of active power and current. In addition to integrated values (power or current) and elapsed time of integration, other measured (or computed) values can also be displayed during integration. Furthermore, display of positive and negative integrated values is also possible. This enables the positive watt-hour (i.e. watt-hour consumed only in positive direction) and negative watt-hour (i.e. watt-hour returned in negative direction to the power supply) to be displayed independently.

Harmonic Analysis Functions (Optional)

This function enables measurement of up to the 50th harmonic of voltage, current and power, and relative content for each order, as well as phase angle relative to the reference wave for each order, in accordance with IEC1000-3-2. It also enables computation of total rms value (fundamental waveform + harmonics) of voltage, current and active power, harmonic distortion rate (THD), apparent power and inactive power of the fundamental wave (first order), and phase angle between input elements.

Waveform Output Functions (Optional)

This function isolates the input voltage and current waveforms from the input signals, to enable observation of the waveforms using an oscilloscope.

Motor Evaluation Functions (WT1030M only)

This function enables measurement of active power and frequency and computation of torque, rotating speed, mechanical power, synchronous speed, slip, motor efficiency and total efficiency, by inputting DC voltage proportional to motor's torque and DC voltage or number of pulses proportional to motor's rotating speed.

External Input Functions (Optional)

This function enables measurement of current exceeding 20 A, by using an external voltage-output type current sensor (e.g. clamp sensor, shunt resistor).

Built-in Printer (Optional)

The built-in printer enables printing of set-up items. It can also print voltage, current, active power and phase angle in the form of a bar graph during harmonic analysis. Furthermore, the printer can be set so that it automatically prints at certain intervals.

Communications Function

Either a GP-IB or RS-232-C interface is provided as standard according to the customer's preference. Measured/computed data can be sent to a personal computer through the interface. It is also possible to control this instrument from the personal computer.

Other Useful Functions

Remote Control Signals and D/A Outputs

The following functions can be performed using remote controlled input/output signals (contact or logic-level (TTL, active low).)

External Input Signals

$\overline{\text{EXT HOLD}}$

Holds updating of the displayed values or releases the hold status.

$\overline{\text{EXT TRIG}}$

Updates the displayed values in hold mode.

$\overline{\text{EXT PRINT}}$

Starts printing.

D/A output (optional)

Outputs specified measured items as a DC analog signal with full scale of +/-5V. Output items up to 14 channels can be selected.

Set-up Information Backup Function

The instrument has a function that backs up the set-up information (including integrated values) in case power is cut off accidentally as a result of a power failure or for any other reason.

Set-up Information Initialization Function

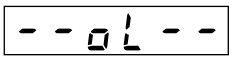
The instrument also has a function that resets the set-up information to the factory settings.

1.3 Over/Error Display during Measurement

Display at Measurement Error

Over range

In normal measurement, an over range occurs if the measured voltage or current exceeds 140% of the rated value for the range used. In auto range setting range, an over range error occurs if **140% of the rated value for the maximum range** is exceeded. The following code will appear on the display in case of an over range.

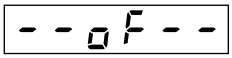


During harmonic analysis, an over range also occurs if the total rms voltage or current value (fundamental waveform + harmonics) exceeds the measuring range as follows.

1000 V range	140%
20 A range	140%
10V range (EXT SENSOR)	140%
Other ranges	200%

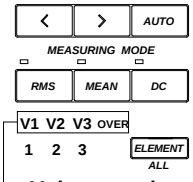
Computation overflow

If a computed value cannot be displayed with the specified decimal point position or unit of measurement, the following code will appear on the display.

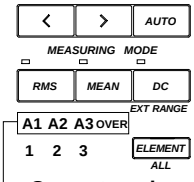


Over range

If the peak value of the input voltage or current exceeds approximately 330% of the range or an over range occured, the OVER LED of the element where the peak overflow is occurring will light up.



Voltage peak overflow



Current peak overflow

When measured voltage or current is below 0.5% of the rated value of the range used

If the measured voltage or current is below 0.5% of the rated value, the following will appear on the display. (Applicable when the measurement mode is RMS or MEAN)

Function	Display
V (voltage) A (current) VA (apparent power) var (reactive power)	"0" is displayed.
PF (power factor)	PFErr
deg (phase angle)	dEGErr

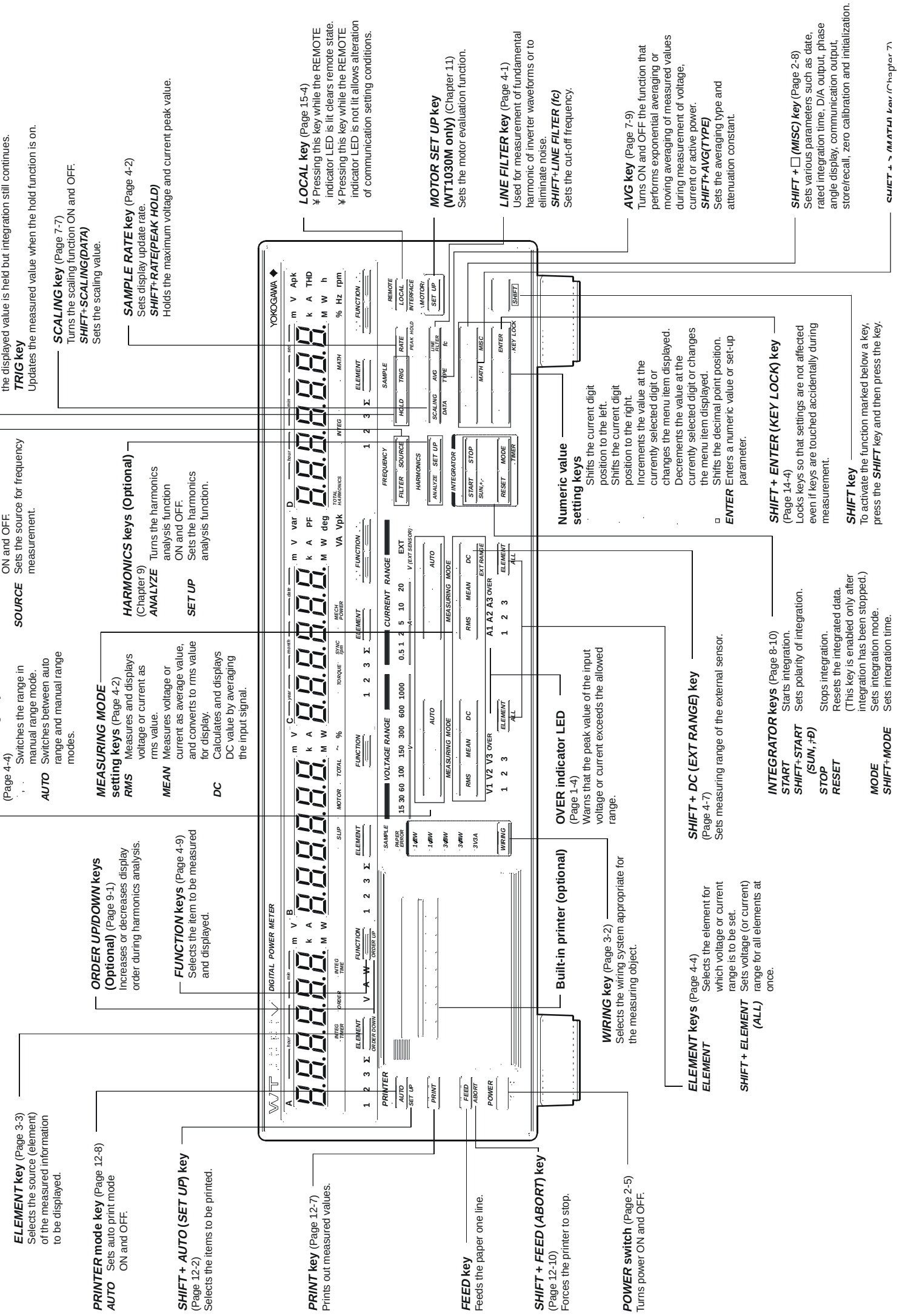
Interruption during measurement

If the measuring range or display item is changed during measurement, the following will appear on the display. It will also appear if no measured or computed value is present due to measurement conditions.

1.4 Part Descriptions and Functions

Front Panel

The number to the right of the name of each key corresponds to the page number where detailed information about the key function can be found.



Current input terminal

Voltage input terminal

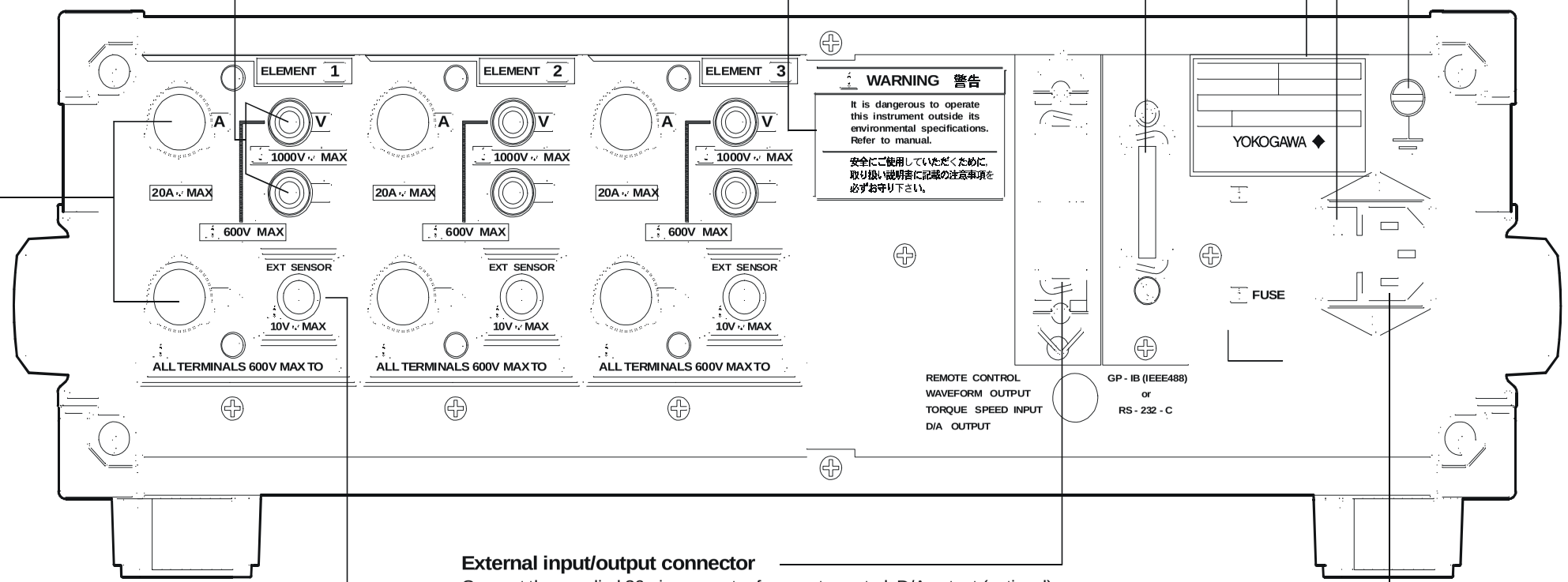
Warning label plate

Power fuse holder
A spare fuse is provided in th

GP-IB connector
Connect the GP-IB interface cable here when communications is performed via GP-IB interface. (An RS-232-C connector can be provided instead according to the user's preference.)

Name plate

Function grounding ter
Used for functional purposes.



External input/output connector
Connect the supplied 36-pin connector for remote control, D/A output (optional), waveform output (optional), motor evaluation input (WT1030M only), external sample clock for harmonic analysis (optional.)

External sensor input connector (Page 3-10)
If you are using an external senser for current measurement, connect the input cord to this connector.

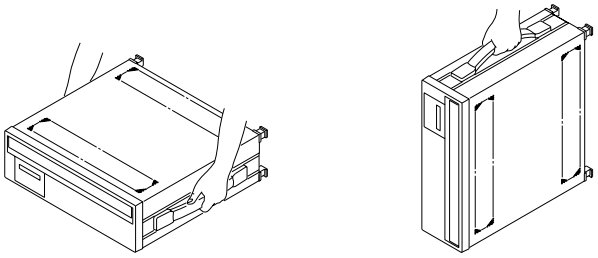
Power connector
3-pin connector providing connection for grounding
Connect the supplied power cord here.
A proper connection to ground is absolutely necessary to prevent electric shock.

2.1 Usage Precautions

General Handling Precautions

Observe the following precautions when handling the instrument.

- Never place anything on top of the instrument, especially objects containing water. Entry of water into the instrument may result in breakdowns.
- Observe the following precautions when moving the instrument.
  Disconnect the power cords and connecting cables.
  Always carry the instrument by the handles as shown below.



- To prevent internal temperature rise, do not block the vent holes in the instrument case.
- Keep input/output terminals away from electrically charged articles as they may damage internal circuits.
- Do not allow volatile chemicals to come into contact with the case or operation panel. Also do not leave any rubber or vinyl products in contact with them for prolonged periods. Doing so may result in breakdowns.
- The operation panel is made of thermoplastic resin, so take care not to allow any heated articles such as a soldering iron to come into contact with it.
- If the instrument will not be used for a long period, unplug the power cord from the AC outlet.
- For cleaning the case and the operation panel, unplug the power cord first, then gently wipe with a dry, soft, clean cloth. Do not use chemicals such as benzene or thinner, since these may cause discoloration or damage.

Safety Precautions

- Do not remove the case from the instrument.
  Some areas in the instrument use high voltages, which are very dangerous.
  When the instrument needs internal inspection or adjustment, contact your dealer or nearest YOKOGAWA representative.
- If you notice smoke or unusual odors coming from the instrument, immediately turn OFF the power and unplug the power cord. Also turn OFF the power to all the objects being measured that are connected to the input terminals. If an such irregularity occurs, contact your dealer or the nearest YOKOGAWA representative.
- Do not place anything on the power cord. Also keep it away from any heat generating articles. If the power cord is damaged, contact your dealer or nearest YOKOGAWA representative.
- When unplugging the power cord from the AC outlet, never pull the cord itself. Always hold the plug and pull it.

Storage Area

Never store the instrument in places where it may be exposed to any of the following conditions.

- Relative humidity of 80% or higher
- Direct sunlight
- Temperature of 60°C or higher.
- Proximity to any high-temperature heat sources
- Excessive vibration
- Corrosive or flammable gases
- Excessive amount of dust, dirt, salt or iron filings
- Splashes of water, oil or chemicals

2.2 Installing the Instrument

Installation Conditions

The instrument must be installed in a place where the following conditions are met.

- **Ambient temperature and humidity**

  Ambient temperature : 5 to 40°C

  Ambient humidity : 20 to 80% RH (no condensation)

- **Well-ventilated place**

  Vent holes are provided on the top and bottom of the instrument. To prevent rise in internal temperature, do not block these vent holes.

Note

- To ensure high measurement accuracy, the instrument should only be used under the following conditions.

  Ambient temperature : 23 ±5°C

  Ambient humidity : 30 to 75% RH (no condensation)

  When using the instrument in the temperature ranges of 5 to 18 or 28 to 40°C, multiply the measured values by the temperature coefficient specified in Chapter 17, "Specifications."
- If the ambient humidity of the installation site is 30% or below, use an anti-static mat to prevent generation of static electricity.
- Internal condensation may occur if the instrument is moved to another place where both ambient temperature and humidity are higher, or if the room temperature changes rapidly. In such cases acclimatize the instrument to the new environment for at least one hour before starting operation.

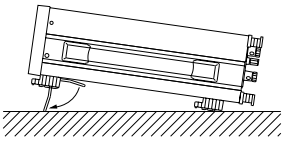
Never install the instrument in the following places. Otherwise, the internal circuits and the case may be affected adversely, hindering accurate measurement.

- **In direct sunlight or near heat sources**
- **Where an excessive amount of soot, steam, dust or corrosive gases is present.**
- **Near magnetic field sources**
- **Near noise sources such as high voltage equipment or power lines**
- **Where the level of mechanical vibration is high**
- **In an unstable place**

Installation Position

Desktop Installation

Place the instrument in a horizontal position or tilted using the stand as shown below.



Rack Mount

To install the instrument in a rack, use one of the following optional rack mount kits.

Rack mount kit (optional)

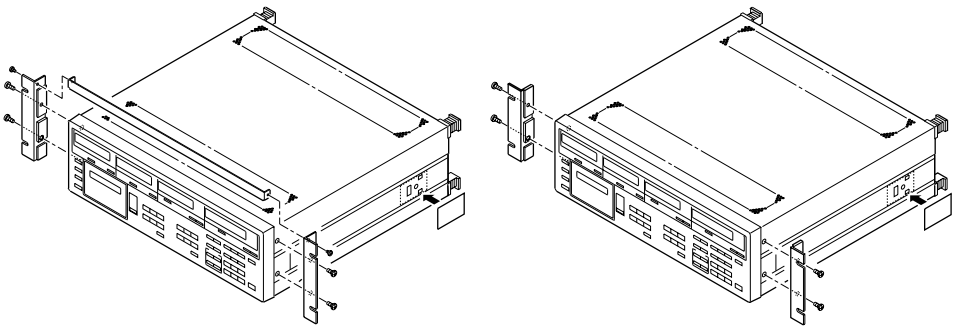
Kit Name	Model	Standard
Rack mount kit	751531	EIA
Rack mount kit	751532	JIS

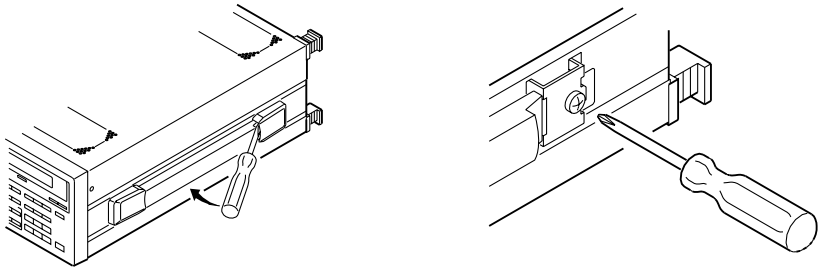
Mounting Procedure

1. Remove the seal cover from the mounting holes on both sides of the instrument. (Four seal covers in total)
2. Attach the mount kit as shown below.
3. Remove the four legs from the bottom of the instrument.
4. Remove the handle from each side of the instrument.
5. Cover each handle mount hole with a seal.
6. Mount the instrument in the rack.
   - When mounting the instrument, support it from underneath.
   - Refer to Chapter 17, "Specifications" for rack mounting dimensions.

Note

- The upper and lower sides of the instrument are equipped with ventilation holes. When these are blocked e.g. due to rack mounting, the specified accuracy may not be met, therefore allow at least 20 mm of space between the ventilation holes and the rack mount.





2.3 Power Supply Connection

Power Supply Requirements

The instrument can be operated with a power supply voltage of between 100 and 120 VAC or between 200 and 240 VAC.

Rated supply voltage	:	100 to 120VAC	200 to 240VAC
Permitted supply voltage range	:	90 to 132VAC	180 to 264VAC
Rated supply voltage frequency	:	50/60Hz	50/60Hz
Permitted supply voltage frequency range	:	48 to 63Hz	48 to 63Hz

CAUTION

- **When checking the power supply fuse, refer to Section 16.3 "Replacing the Power Supply Fuse" (page 16-4).**
- **When checking the power cord, refer to the ratings specified in the suffix code in "Checking Package Contents" (page 2).**

Connecting the Power Cord

WARNING

- **Be sure to connect the protective grounding to prevent an electric shock before turning on the power. Connect the power cord only after having verified that the power switch is turned OFF.**
- **Before plugging in the power cord, make sure that the voltage of the AC outlet is within the specified range.**
- **To prevent electric shock or fire, use only the power cord supplied by YOKOGAWA.**
- **Never use an extension cord without a grounding wire, otherwise the protection feature will be invalidated.**

2.4 Turning the Power ON or OFF

Items to be Checked Before Turning ON the Power

Check that the instrument is installed correctly as instructed in Section 2.2 "Installing the Instrument" (page 2-2).

Location of the Power Switch

The power switch is located in the lower left corner of the front panel.

Turning Power ON/OFF

A pushbutton switch is used as the power switch. The power is turned ON and OFF alternatively as the switch is pressed.

Note

- The instrument uses a lithium battery so that set-up information together with the date and time entered from the operation panel will be backed up and not lost in case of power failure.
- A warm-up time of approximately 30 minutes is required before all specifications of the instrument are met.
- To carry out measurements that conform to the specifications (Chapter 17) without changing measuring mode or range after the power is turned on, carry out zero-level calibration (refer to 14.2, "Carrying Out Zero Level Calibration").

Response and Display at Power ON

When the power switch is turned ON, the test program starts. The test program checks each memory. If the check results are satisfactory, opening messages will appear as shown on page 2-7, and the instrument is ready for measurement.

If an error code appears at the end of the test program, the instrument is not functioning properly. In this case, turn OFF the power immediately, and contact your dealer or the nearest YOKOGAWA representative. Inform them of the model name and serial no. specified on the name plate on the rear panel, as well as the error code that was displayed.

Note

- In the case of an error code, refer to Section 16.2 "Error Codes and Corrective Actions" (page 16-2), and carry out the specified corrective actions.

Response at Power OFF

When the power switch is turned OFF, the set-up information which was in effect just prior to the power switch being turned OFF will be retained. Thus, when the power switch is next turned ON, the operation state of the instrument just prior to the power switch being turned OFF will be resumed.

Note

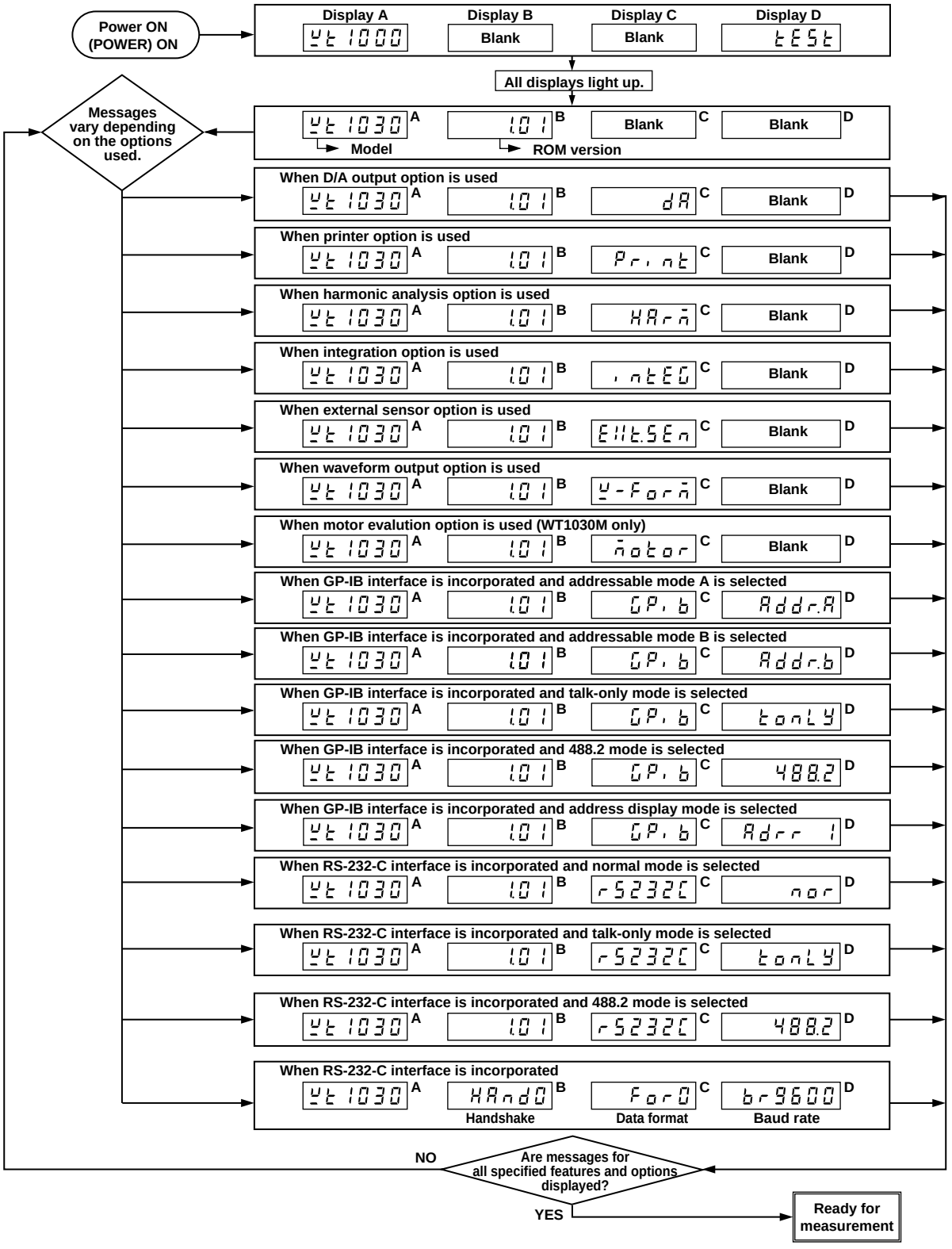
- The set-up information is backed up by a lithium battery. The battery lasts for approximately ten years if it is used at an ambient temperature of 23°C. If the battery runs out, an error code appears when the power switch is turned ON (refer to 16.2, "Error Codes and Corrective Actions"). In this case, the battery needs to be replaced immediately. The battery cannot be replaced by the user. Contact your dealer or the nearest YOKOGAWA representative.

Default Settings (Factory Initialization Settings)

	Display	Factor	LED
Display	A	V1	1, V
	B	A1	1, A
	C	W1	1, kW
	D	W1	1, kW
Measuring range	VOLTAGE	1000V	1000V
	AMP	20A	20A
	External sensor range(optional)	10V	
	External sensor output value(optional)	10.000mV/A	
Measurement mode	RMS/MEAN/DC	RMS	RMS
Measuring conditions	Wiring system	1φ2W	1φ2W
	Hold	OFF	
	Sample rate	500ms	
	Scaling	OFF	
	Averaging	OFF	
	Line filter	OFF	
	Cut-off frequency	0.5kHz	
	Peak hold	OFF	
	Frequency filter	OFF	
	Integration (optional)	Invalid	
	Harmonic analysis (optional)	OFF	
	Measuring object for frequency	V1	
	Phase angle display	180°	
	MATH	Efficiency (EFF,)	
	Key lock	OFF	
Scaling constant	Kv	1.0000	
	Ki	1.0000	
	Kw	1.0000	
Averaging	Averaging method	Exponential averaging(EP)	
	Attenuation constant	8	
Integration	Integration mode	Standard integration mode(nor)	
	Integration timer	0 h 0 min	
	Integration polarity	SUM	
Communications			
Command group	Used to select WT1030, 2531 or 2533E command groups.	CM0 (WT1030 command group)	
GP-IB	Address	1	
	Output interval during talk-only mode	0 s	
	Communication mode	A	
	Status byte	15	
	Delimiter	CR+LF	
RS-232-C	Normal mode		
	Output interval during talk-only mode	0 s	
	Handshake mode	0	
	Format	0	
	Baud rate	9600	
	Delimiter	CR+LF	
	Status byte	15	
GP-IB/RS-232-C Common	Communications output	ASCII	
	Communications output function	dFLt-1	
Harmonic analysis (optional)	PLL source	V1	
	Display format	n-th harmonic	
	Phase angle display format	V1-Vn	
	Anti-aliasing filter	OFF	
	Number of orders	50	
Motor evaluation function (WT1030M only)	Torque scaling	2000.0	
	Torque scaling unit	unit-1(N·m)	
	rpm type	PULSE	
	Number of pulses	60	
	rpm scaling	10000.	
	Number of poles	2	
Printer (optional)	Auto print mode	OFF	
	Print interval	0 min	
	Print synchronization	Synchronize to time	
	Print output function	dFLt-1	
D/A output (optional)	D/A output	dFLt-1	
	Rated integration time for D/A output	1 h 0 min	

Opening Messages

When the power switch is turned ON, the following messages will appear. The messages vary depending on the options used. If the power switch is turned ON with the SHIFT key held down, no message for any optional functions will be displayed. Once this is done, no message for any optional functions will be displayed whenever the power switch is turned ON. To display messages for optional functions, turn ON the power switch again while holding down the SHIFT key.

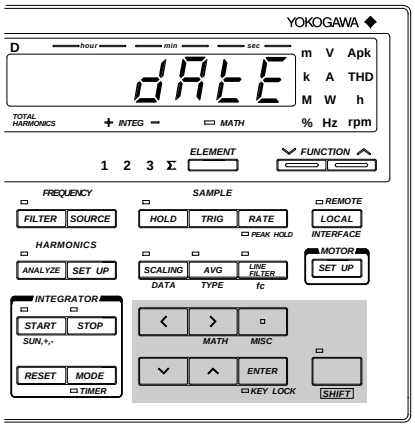


2.5 Setting the Date and Time

Setting the Date/Time Mode

Mode Setting

1. Press the MISC key (SHIFT + □)
   Keep pressing the up ∧ or ∨ key until "dATE" appears on display D.



2. Press the ENTER key.
   "dATE" moves to display A, and the date and time currently set appear on displays C and D respectively. The leftmost digit of display C (date) starts blinking.

Display A **Display B** **Display C** **Display D**

Y M D **H M S**

Setting the Date and Time

3. Set the desired value for the blinking digit using the ∧ or ∨ key. Press the < or > key to move to another digit and set a value. Repeat this step until the entire date has been set.

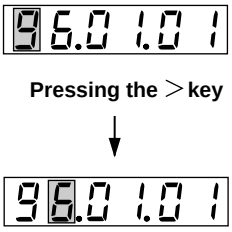
4. When the entire date has been set, press the ENTER key. This causes the leftmost digit of display D (time) to start blinking. Repeat step *3* to set the desired time.

5. When the time has been set, press the ENTER key. The timer begins to operate.

Shifting the Blinking Position

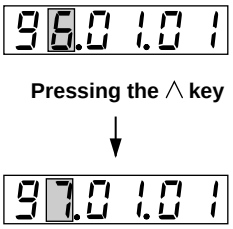
The blinking position can be shifted to the left or right by pressing the < or > key. Pressing the < key causes the digit to the left of the currently blinking digit to blink, and pressing the > key causes the digit to the right of the currently blinking digit to blink. The blinking position wraps around in both directions.

Display



Setting a Value

To select a value for the blinking digit, press the ∧ or ∨ key. Pressing the ∧ key changes the value according to the sequence 1, 2, 3 ... 9, 0 and back to 1. Pressing the ∨ key changes the value in the opposite direction.



Note

- If the time is not set properly, "Err 18" will appear.

3.1 Wiring Precautions

WARNING

- **To prevent hazards, a protective grounding connection must be made as follows. The power cord supplied with the instrument has a 3-pin plug. One of the three pins is used for grounding. The power cord must be connected to a 3-pin AC outlet (including a grounding terminal).**
- **Always turn OFF the power to the object being measured, before connecting it to the instrument. Never connect or disconnect the measurement lead wires from the object while power is being supplied to it, otherwise a serious accident may result.**
- **Be sure that you do not connect a current circuit to the voltage input terminal or vice versa. Incorrect connection may cause damage not only to the circuit or equipment under test and to this instrument, but may also endanger the operator.**
- **When the power switch is ON, never apply a voltage or current exceeding the level specified in the table below to the voltage input terminal or current input terminal. If the power switch is OFF, turn OFF the power to the object.**

Permissible Maximum Input	Voltage Input	Current Input
Maximum Instantaneous Input (for 20 ms)	The peak value is 4.0 kV or RMS value is 2.8 kV, whichever is the lower.	The peak value is 450 A or RMS value is 300 A, whichever is the lower. Peak current of 15 times the rated measuring range or lower in the case where an external input is used
Maximum Instantaneous Input (for 1 s)	The peak value is 2.8 kV or RMS value is 2.0 kV, whichever is the lower.	The peak value is 150 A or RMS value is 40 A, whichever is the lower. Peak current of 10 times the rated measuring range or lower in the case where an external input is used
Maximum Continuous Input	The peak value is 2.0 kV or RMS value is 1.5 kV, whichever is the lower.	The peak value is 100 A or RMS value is 30 A, whichever is the lower. Peak current of 5 times the rated measuring range or lower in the case where an external input is used

- **If the input voltage exceeds 600 V, refer to 3.4, "Wiring Method when Input Voltage Exceeds 600 V".**
- **If you want to use an external current transformer (CT), use one which has a sufficient withstand voltage against the voltage to be measured. (A withstand voltage of 2E + 1000V is recommended, where E is the measurement voltage.) Also be sure not to allow the secondary side of the CT to go open-circuit while power is supplied, otherwise an extremely dangerous high voltage will be generated on the secondary side of the CT.**
- **If the instrument is used in a rack, provide a power switch so that power to the instrument can be shut off from the front of the rack in an emergency.**
- **Make sure that the bare end of the measurement lead wire connected to each input terminal does not protrude from the terminal. Also make sure that the measurement lead wires are connected to the terminals securely. Do not use any plug-in type terminal with protruding bare lead wire (e.g. banana-shaped terminal connector) to connect the object to the voltage terminal. This may lead to a very dangerous situation if the input terminal is disconnected.**
- **The voltage ratings across the measuring (voltage and current) input and the ground for this instrument varies under operating conditions.**
  - **When protective covers are used on GP-IB or RS-232-C and external input/output connectors**
    Voltage across each measuring input terminal and ground 600 Vrms max.
  - **When protective covers are removed from GP-IB or RS-232-C and from external input/output connectors; or when connectors are used**
    Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.
    Voltage across V terminal and ground 600 Vrms max.

CAUTION

- **The lead wires must have a sufficient margin in both breakdown voltage and current against those to be measured. They must also have insulation resistance appropriate to their ratings.**
  Example: If measurement is carried out on a current of 20 A, use copper wires with a conductor cross-sectional area of at least 4 mm².

Note

- After completion of the wiring, the WIRING key needs to be used to select the wiring system before starting measurements. Refer to Section 3.2 "Selecting Wiring System" (page 3-2) for a description of the procedures.
- When measuring high currents, or currents or voltages that contain high-frequency components, wiring should be made with special attention paid to possible mutual interference and noise problems.
- Keep the lead wires as short as possible.
- For current circuits indicated by thick lines in the wiring diagrams shown in Section 3.3 (page 3-4 and subsequent pages), use thick lead wires appropriate for the current to be measured.
- The lead wire to the voltage input terminal should be connected as close to the load of the object under measurement as possible.
- To minimize stray capacitance to ground, route both lead wires and grounding wires so that they are as away from the instrument's case as possible.

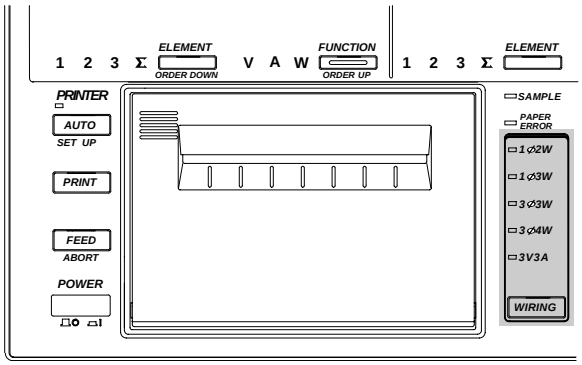
3.2 Selecting Wiring System

Precautions

Make sure that the wiring system that matches the actual wiring is selected, otherwise a measurement error will occur. (Computation method varies according to the wiring system.)

Selecting Wiring System

The wiring system is selected in the sequence shown below each time the WIRING key is pressed. The LED for the selected wiring system lights up. Select the wiring system type that matches the one you have assembled.



Three-phase, three-wire model (253620)

1Φ2W (single-phase, two-wire)

1Φ3W (single-phase, three-wire)

3Φ3W (three-phase, three-wire)

Three-phase, four-wire model (253630, 253640)

1Φ2W (single-phase, two-wire)

1Φ3W (single-phase, three-wire)

3Φ3W (three-phase, three-wire)

3Φ4W (three-phase, four-wire)

3V3A (three-voltage, three-current)

Note

- When measuring apparent power, reactive power, power factor, phase angle or efficiency, selecting a wiring system different from the actual wiring system connected to the input terminals hinders accurate measurement. Make sure that the correct wiring system is selected.
- Selectable wiring systems differ from model to model. Refer to "Wiring System Selection and Selectable Measuring Objects (Elements)" on the next page.

Selecting Element

Element selection can be performed for each display. Press the ELEMENT key located below each display to select a desired element. Elements are selected in the following sequence as the ELEMENT key is pressed. The default setting is "Element 1."

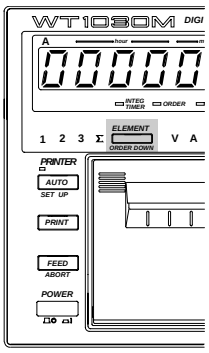
Element

1 : Measured input value for element 1 (V1, A1 or W1) is displayed.

2 : Measured input value for element 2 (V2, A2 or W2) is displayed. (Selection of element 2 is not possible for the three-phase three-wire model (253620).)

3 : Measured input value for element 3 (V3, A3 or W3) is displayed.

Σ : Average (ΣVΣA) of measured voltage or current of elements 1 and 3 or elements 1 to 3, or the sum (ΣW) of active power is displayed. However, no value will be displayed if the wiring system 1Φ2W is selected.



Note

- Display A is shown in the above figure as an example. Selection of element is disregarded for some functions. In this case, changing the element will cause "Err 15". Refer to Section 17, "Specifications" for the equation for each measurement item.

Wiring System Selection and Selectable Measuring Objects (Elements)

The table below shows elements which can be measured with the wiring system selected with the WIRING key.

Model	Wiring System	Element
253620	1Φ2W	1, 3
	1Φ3W	1, 3, Σ
	3Φ3W	1, 3, Σ
253630, 253640	1Φ2W	1, 2, 3
	1Φ3W	1, 2, 3, Σ
	3Φ3W	1, 2, 3 , Σ
	3Φ4W	1, 2, 3, Σ
	3V3A	1, 2, 3, Σ

3.3 Wiring the Measurement Circuit

The table below gives a list of wiring systems and their examples (diagrams) for each wiring system.

Wiring System		1Φ2W	1Φ3W	3Φ3W	3Φ4W	3V3A
WIRING key		1Φ2W	1Φ3W	3Φ3W	3Φ4W	3V3A
Wiring Diagram	When an input is applied directly	Fig.3.1	Fig.3.2	Fig.3.3	Fig.3.4	Fig.3.5
	When PT and CT are used (page 3-8)	Fig.3.8	Fig.3.9	Fig.3.10	Fig.3.11	Fig.3.12
	When an external sensor is used (page 3-10)	Fig.3.15	Fig.3.16	Fig.3.16	Fig.3.17	Omitted

Wiring Method when Voltage and Current are Applied Directly

Fig. 3.1 Wiring Diagram for Single-Phase Two-Wire (1Φ2W)

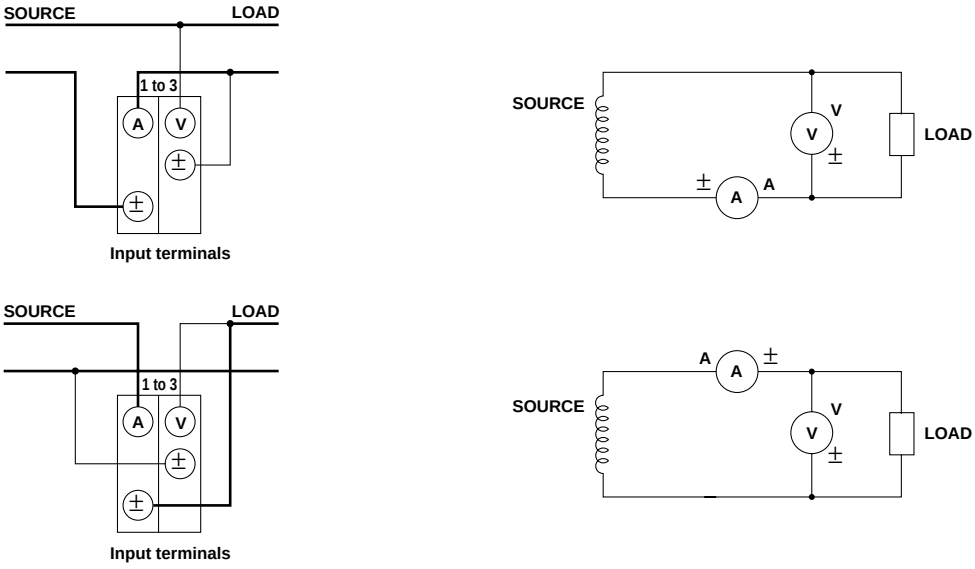
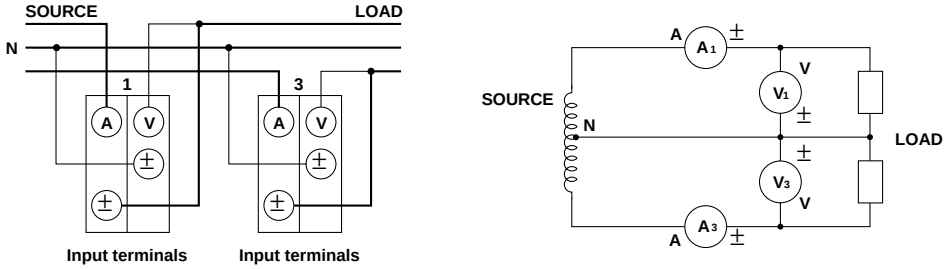


Fig. 3.2 Wiring Diagram for Single-Phase Three-Wire (1Φ3W)



WARNING **When applying a current to be measured directly to the input terminals of the instrument, make sure that the external sensor cable is not connected to the instrument.**

CAUTION **A load current flows in the thick lines shown in the diagrams, therefore a wire with sufficient current capacity must be used for these lines. The wire connected from the source to the ± current terminal must be routed as close as possible to the ground potential in order to minimize measurement error. (Refer to "Note" on page 3-6.)**

Fig. 3.3 Wiring Diagram for Three-Phase Three-Wire (3Φ3W)

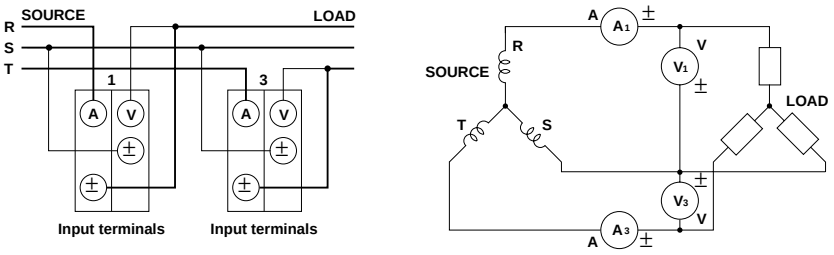


Fig. 3.4 Wiring Diagram for Three-Phase Four-Wire (3Φ4W)

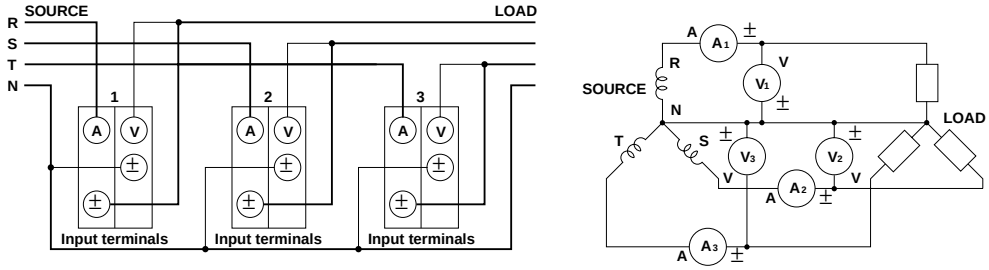
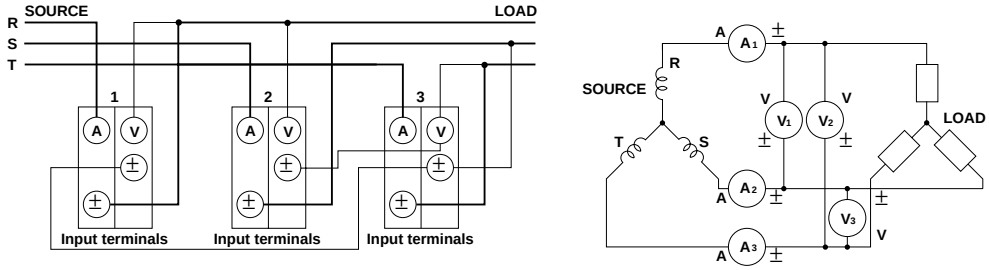


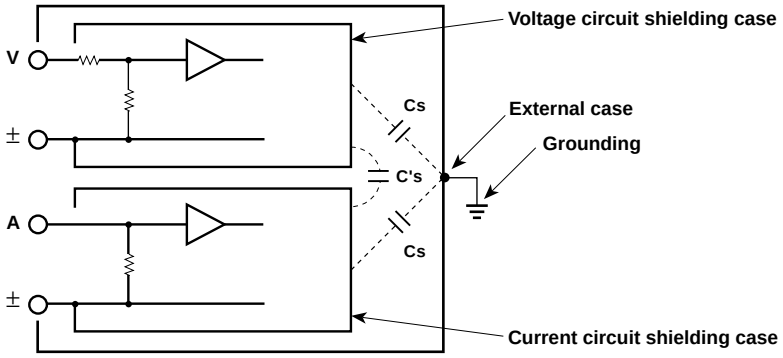
Fig. 3.5 Wiring Diagram for Three-Voltage Three-Current (3V3A)



Note

- The wire connected from the source to the ± current terminal must be routed as close as possible to the ground potential in order to minimize measurement error. Fig. 3.6 shows the input circuit diagram of the instrument.

Fig. 3.6 Input Circuit of the Instrument

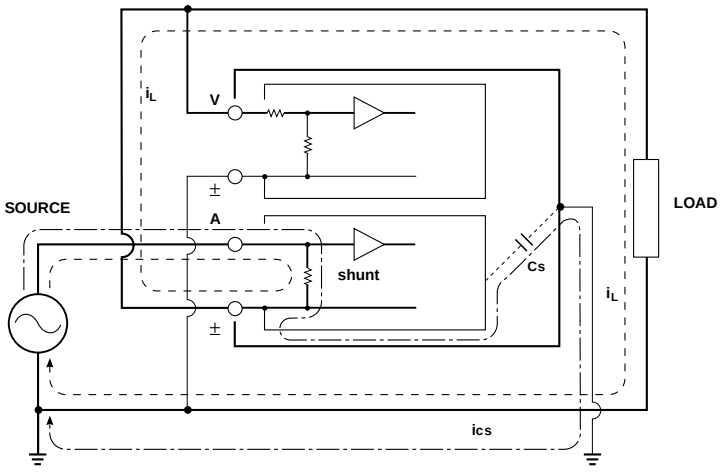


The voltage circuit is enclosed in its own shielding case, and the current circuit is also enclosed in its own shielding case. Both shielding cases are then enclosed in the external case. The voltage circuit shielding case is connected to the ± voltage terminal, whilst the current circuit shielding case is connected to the ± current terminal.

Although insulation is provided between the shielding cases as well as between the external case and each shielding case, stray capacitance Cs and C's are still present. Cs is approximately 100 pF. With power meters such as this instrument that are capable of measurement of current, voltage etc. of high frequency, these stray capacitance cannot be ignored as they cause measurement errors.

As an example, let's imagine the circuit shown in Fig. 3.7, where one end of the SOURCE (power source) and the external case are grounded. Current iL from the power source enters the current terminal (A), passes the shunt, comes out from the current terminal (±), then returns via the LOAD (load) to the power source, as indicated by the dotted line. The other route (iCS) is indicated by the dashed line; from the power source, through the shunt, stray capacitors, external case grounding, and power source grounding.

Fig. 3.7



From this, it is obvious that the sum (vector sum) of the load current iL and ics, which flows through the stray capacitors, is always measured even though we want to measure load the current iL only. The current ics, which flows through the stray capacitor Cs, is calculated as follows.

Where, the common-mode voltage applied to Cs is V_{Cs}

$$i_{CS} = V_{Cs} \times 2\pi f \times C_S$$

In the upper circuit shown in Fig. 3.1, no measurement error will occur since V_{Cs} is zero because both current terminal (±) and voltage terminal (±) are close to the ground potential. Effects of the stray capacitance are calculated below for reference.

$C_S = 100pF = 100 \times 10^{-12}F = 10^{-10}F$

Therefore,

$i_{CS}[A] = V_{Cs}[V] \times 2\pi f[Hz] \times C_S = V_{Cs} \times 2\pi f \times 10^{-10}$

$= 2\pi \times 10^{-4} \times V_{Cs} \times f[kHz]$ [mA]

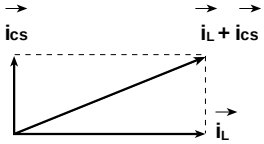
Assuming f = 100kHz, $V_{Cs} = 100V$, $i_{CS} \cong 6.28mA$

If iL = 1A, the current is expressed as a vector sum, as below, where the load consists of resistance only (i.e. COSφ = 1),

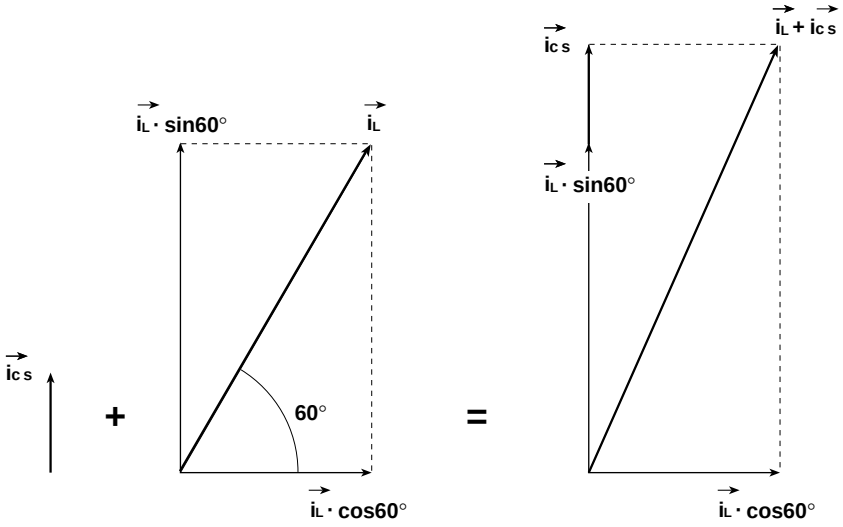
$$\left|\vec{i}_L + \vec{i}_{cs}\right| = \sqrt{1^2 + 0.00628^2}$$

$$\cong 1.00002$$

Therefore, the measurement error is 0.0002%, indicating that the effect on the measurement of the stray capacitance is very slight.



If COSφ = 0.5, the current can be obtained as follows.



$$\left|\vec{i}_L + \vec{i}_{cs}\right| = \sqrt{(i_L\cos 60°)^2 + (i_{cs} + i_L\sin 60°)^2}$$

$$= \sqrt{(0.5)^2 + (0.00628 + 0.866)^2}$$

$$\cong 1.00542A$$

Therefore, the measurement error is 0.542%.

If COSφ = 0, $i_L + i_{CS} = 1 + 0.00628 = 1.00628$, therefore, the measurement error is 0.628%. Since active power is obtained using the equation W = VA COSφ, the error is the same as that in the measurement of the current.

Wiring Method when PT and CT are Used

Use of a PT (or CT) enables measurement of voltage or current even if the maximum voltage or maximum current of the object to be measured exceeds the maximum measuring range.

- If the maximum voltage of the object to be measured exceeds 1000 V, connect an external potential transformer (PT), and connect the secondary side of the PT to the voltage input terminals.
- If the maximum current of the measuring object exceeds 20 A, connect an external current transformer (CT), and connect the secondary side of the CT to the current input terminals.
  In the diagrams below, the thick lines represent the current circuit, and the thin lines represent the voltage circuit.

Fig. 3.8 Wiring Example for Single-Phase Two-Wire (1Φ2W) System with PT and CT Connected

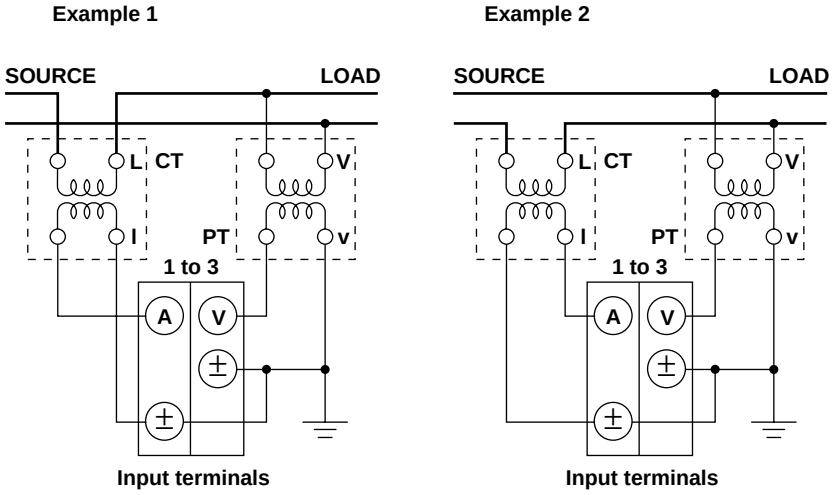
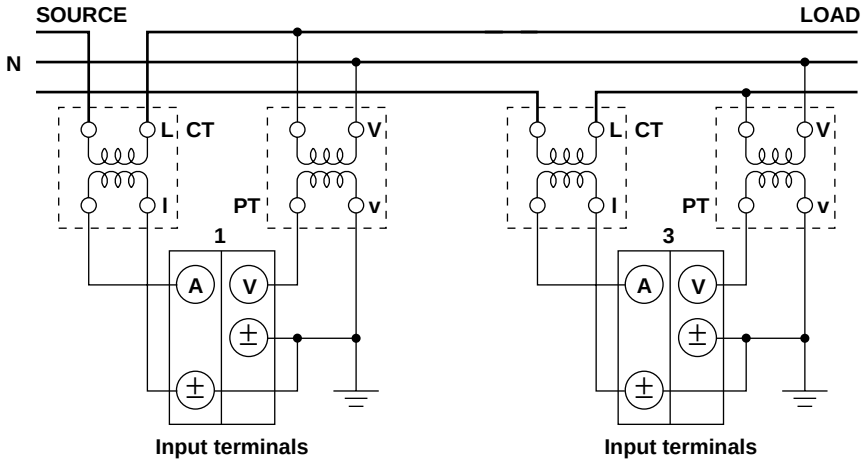


Fig. 3.9 Wiring Example for Single-Phase, Three-Wire (1Φ3W) System with PT and CT Connected



WARNING **When using an external CT, do not allow the secondary side of the CT to go open-circuit while power is supplied, otherwise an extremely dangerous high voltage will be generated on the secondary side of the CT.**

Note

- Use of the scaling function enables direct reading of measured values on the display. For a description of how to set the scaling function, refer to Section 7.4 "Using the Scaling Function" (page 7-7).
- It must be noted that measured values are affected by the frequency and phase characteristics of PT and CT.

Fig. 3.10 Wiring Example for Three-Phase, Three-Wire (3Φ3W) System with PT and CT Connected

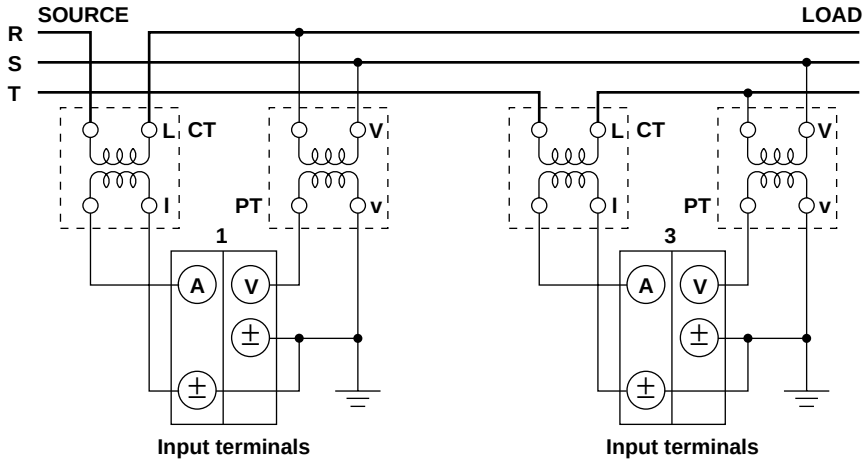


Fig. 3.11 Wiring Example for Three-Phase, Four-Wire (3Φ4W) System with PT and CT Connected

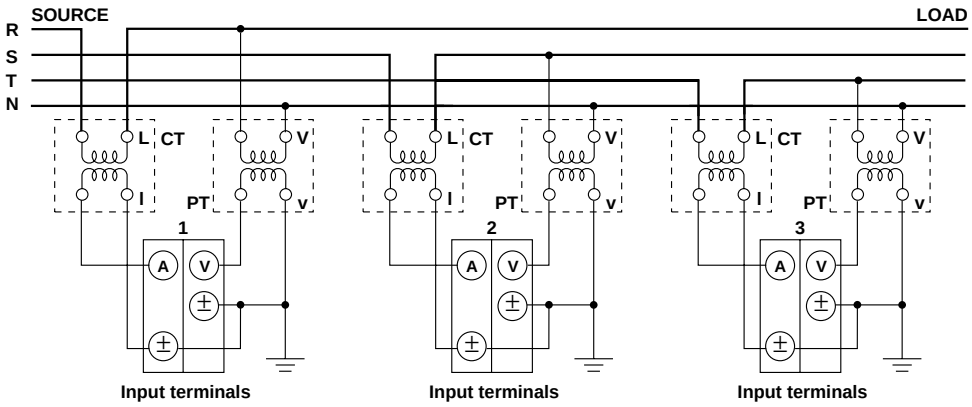
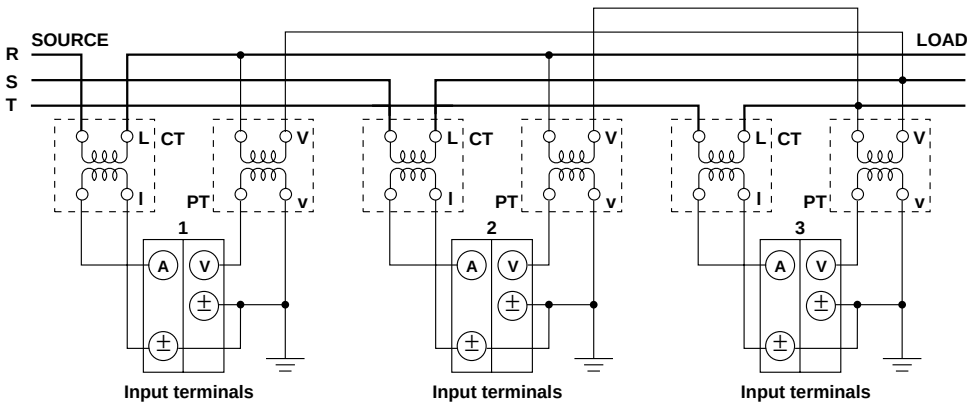


Fig. 3.12 Wiring Example for Three-Voltage, Three-Current (3V3A) System with PT and CT Connected

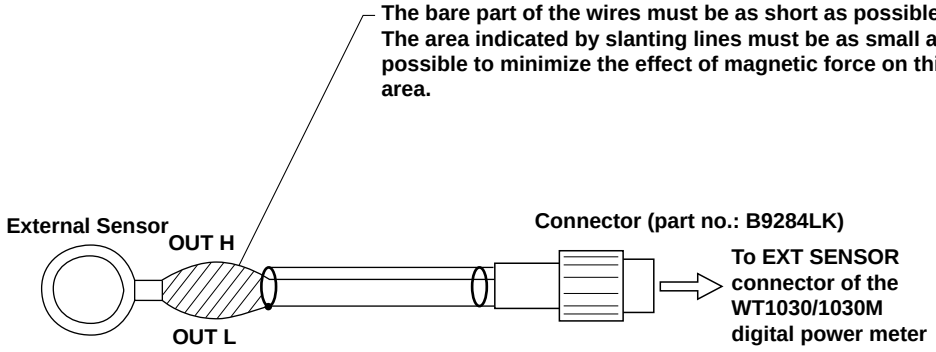


Wiring Method when External Sensor is Used

In cases where the maximum current of the object to be measured exceeds 20 A, connect a voltage-output type current sensor having the desired rated current to the external sensor input connector. The sensor must have appropriate frequency and phase characteristics.

Connecting an External Sensor to an External Sensor Input Cord

Connect the shielding wire of the cord to the output terminal (OUT L) of the sensor, as shown below, to minimize measurement error.



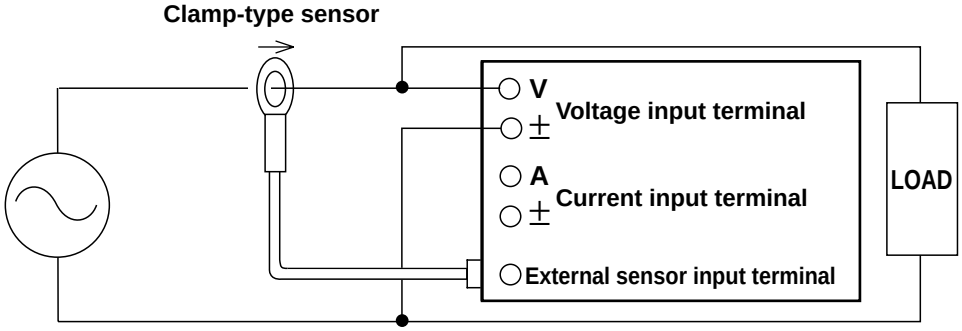
WARNING

- **For safety, use an external sensor that is enclosed in a case and whose wires are isolated from the case. Also make sure that the sensor has a sufficient withstand voltage against the voltage to be measured. Use of a bare sensor may cause an electric shock if the sensor is touched accidentally.**
- **If you are going to use a clamp-type sensor, make sure you are fully aware of the voltage to be measured, sensor's specifications and handling method, so that the possibility of dangers such as electric shocks are avoided.**
- **A voltage is present on the current terminal of the instrument while power is supplied to the measurement circuit, so the current terminal should never be touched nor should the measurement lead wire be connected to it.**
- **The connector to be connected to the external sensor input connector (EXT SENSOR) must be constructed in such a way that no lead wires are exposed. It is dangerous not to follow this instruction since a voltage is present on the lead wires while power is supplied to the measurement circuit.**
- **Do not connect anything to the input current terminals (A, ±) of the instrument, otherwise damage to the instrument or personnel injury may result.**
- **Before connecting an external shunt, make sure that the power to the shunt is turned OFF. A voltage is present on the external shunt while power is supplied to it, so do not touch the shunt with your hands.**

Note

- The external sensor must be selected carefully and its frequency and phase characteristics taken into account.
- The external sensor must be wired so that the area between the wires connected to both ends of the sensor is minimized, in order to reduce the effect of the magnetic field generated by the current to be measured. Measurement is affected by magnetic field lines entering this area. Minimizing this area also reduces the effects of external noise.
- To reduce measurement error caused by increase of stray capacitance or impedance, the wires connected from the external sensor to the instrument must be as short as possible.

Fig. 3.13



- If you are going to use an external shunt, connect it to the grounding side of the power source as shown below. If you are obliged to connect the external shunt to the non-grounding side, use AWG18 (cross-sectional area: approx. 1 mm^2) or thicker lead wires between the shunt and instrument, to avoid the effects of common-mode voltage.

Fig. 3.14

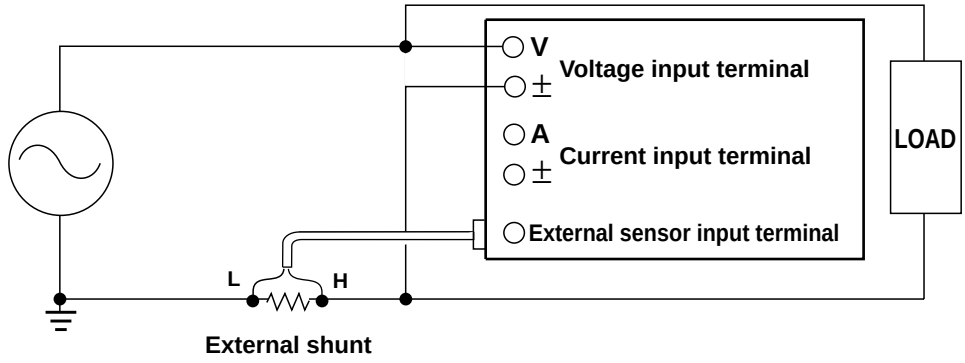


Fig. 3.15 Wiring Example for Single-Phase, Two-Wire (1Φ2W) System with Voltage-Output Type Isolation Sensor (CT, DC-CT, Clamp) Connected

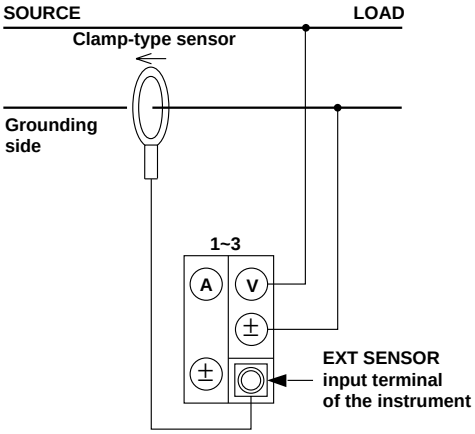


Fig. 3.16 Wiring Example for Single-Phase, Three-Wire (1Φ3W) System or Three-Phase, Three-Wire (3Φ3W) System with Voltage-Output Type Isolation Sensor (CT, DC-CT, Clamp) Connected

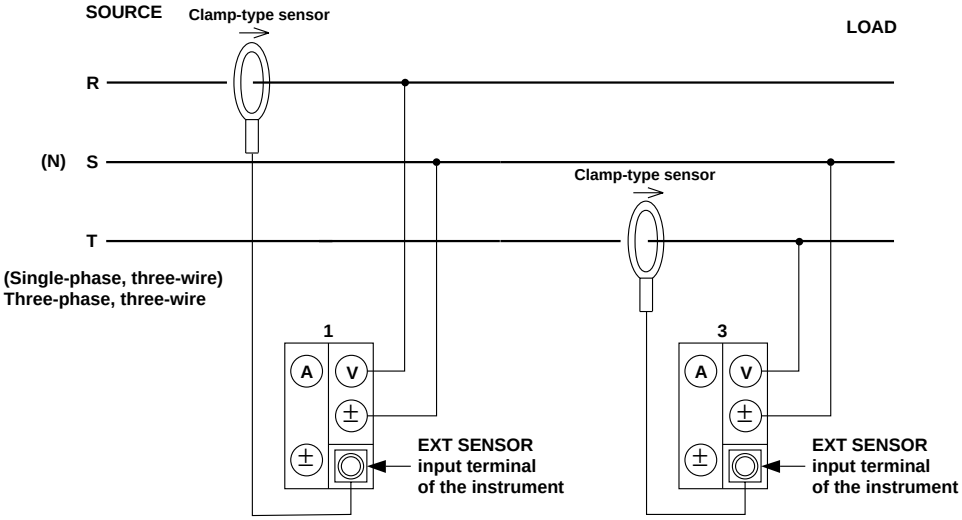
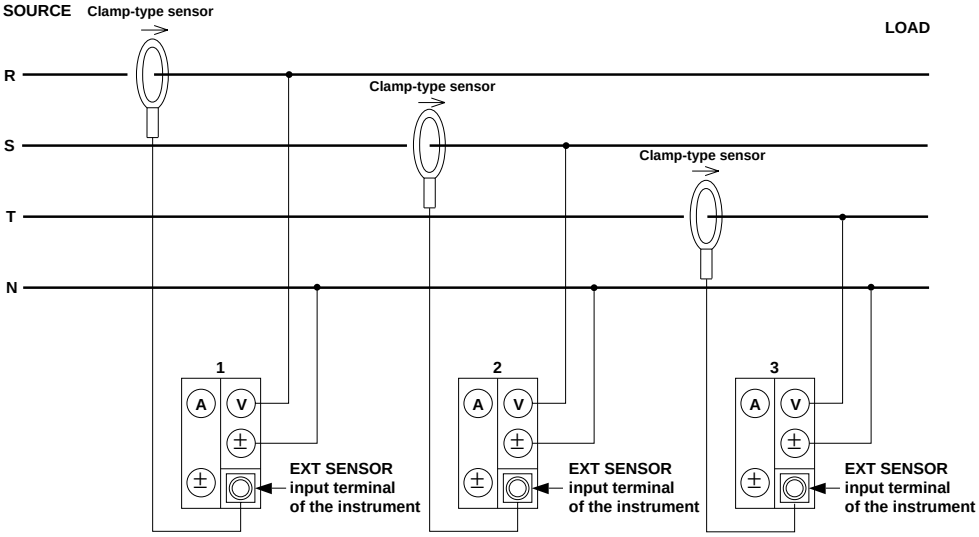


Fig. 3.17 Wiring Example for Three-Phase, Four-Wire (3Φ4W) System with Voltage-Output Type Isolation Sensor (CT, DC-CT, Clamp) Connected

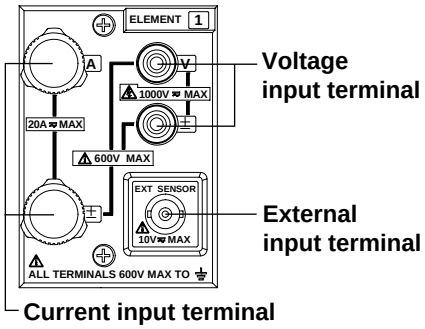


3.4 Wiring Method when Input Voltage Exceeds 600 V

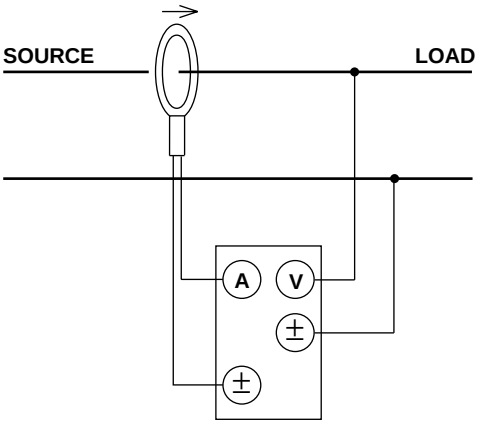
WARNING

- **The rated voltage between the voltage input terminal and current input terminal and between the voltage input terminal and external sensor input terminal is 600 V. If the input voltage to the voltage input terminal is above 600 V, do not input current directly. Use an external sensor and connect it as shown below to prevent a voltage exceeding 600 V from being applied between the voltage input terminal and current input terminal and between the voltage input terminal and external sensor input terminal.**

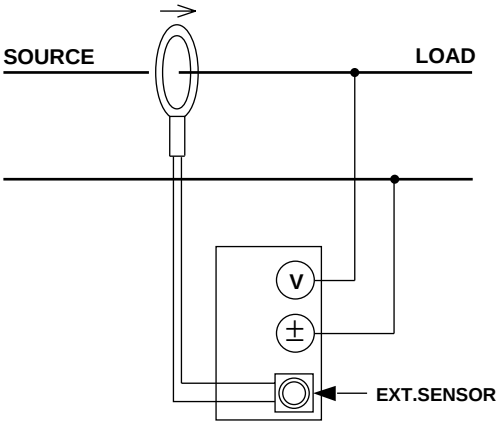
Input terminal



When Current is Output from the External Sensor



When Voltage is Output from the External Sensor



- **The rated voltage between the input terminals and the ground is 600 V. Make sure that no voltage exceeding 600 V is applied between the input terminals and the ground.**
- **The maximum rated voltage between the voltage input terminal and ± terminal is 1000 V. However, the maximum allowable input voltage between terminals of different input type (voltage, current, external sensor input) is 600 V.**
- **When using an external sensor, adhere to the WARNING and Note given on pages 3-10 to 3-11.**

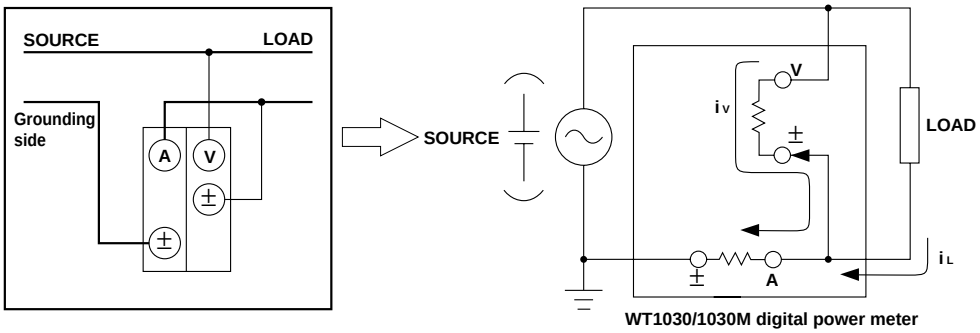
3.5 Improving Measurement Accuracy

Recommended Wiring Method

This instrument is designed so that voltage input impedance is high and current input impedance is low to reduce the effect of instrumental loss on measurement accuracy.

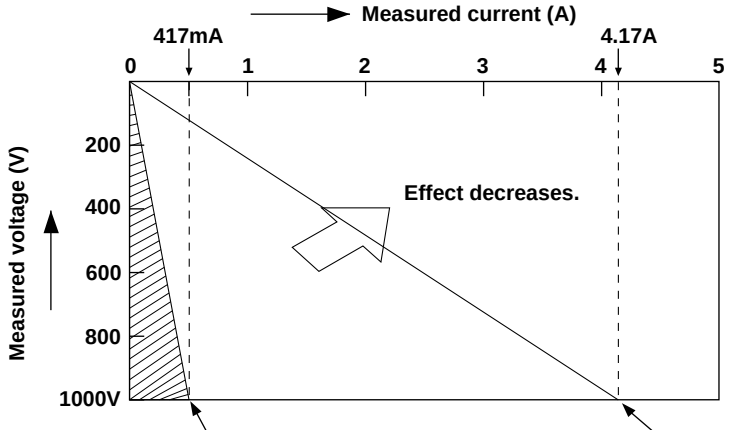
Voltage input impedance : Approximately 2.4 MΩ (all ranges), with a capacitance of approximately 13 pF connected in parallel
Current input impedance : Approximately 6 mΩ + 0.07 µH (all ranges)

Fig. 3.18



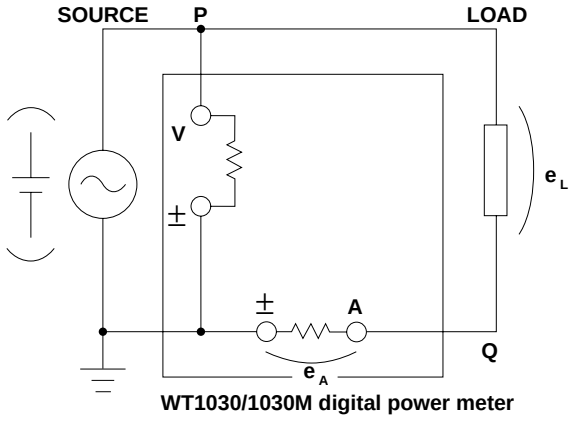
In the above diagram, the voltage measurement circuit is connected to the load side. The effects of instrumental loss on measurement accuracy are explained below. To simplify understanding, it is assumed that a DC power source and resistive load are used. The current measurement circuit measures the sum of the current iL that flows to the load (object being measured) and the current iV that flows to the voltage measurement circuit. This means that the current iV is erroneous since the current to be measured is iL. Since the input impedance of the voltage measurement circuit is high (approximately 2.4 MΩ), and even if the input voltage is 600 V iV becomes approximately 0.25 mA (=600 V/2.4 MΩ). If the instrumental error is assumed to be below 0.1%, the measured current (iL) will be 250 mA or higher (load resistance: 2.4 Ω or lower). If the input voltage is 10 V, iL is 4.2 mA or higher. The relationship between the input voltage and the measured current in cases where instrumental error is within 0.1% and 0.01% is given on the next page as a reference.

Fig. 3.19 Effects of Instrumental Error



In many cases the recommended wiring method is suitable. For instance, when the input voltage and current are 100 V and 5 A, iV is 0.04 mA (=100 V/2.4 MΩ), therefore the effect on measurement accuracy is 0.0008% (=0.04 mA/5 A), which is low. On the other hand, measurement accuracy is significantly affected when the measured current is low (i.e. high load resistance). In this case, make the connections as follows so that the current measurement circuit is located on the load side. The voltage measurement circuit measures the sum of the voltage drop eL at the load and eA at the current measurement circuit, therefore eA is erroneous. However, the effect of this error is small since the input impedance of the current measurement circuit is low. For instance, if the load resistance is 600 Ω, the input impedance is approximately 6 mΩ, therefore the error in measurement is approximately 0.001% (=eA/(eL + eA)), which is low.

Fig. 3.20



From the above explanation, it can be understood that the effect of instrumental loss on measurement accuracy can be reduced by wiring according to the load resistance.

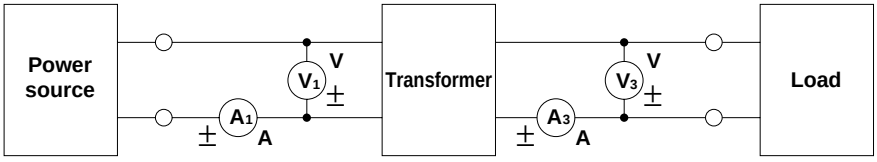
3.6 Wiring System and Equations of Efficiency

Pay attention to the following when measuring efficiency. Measurement of efficiency is possible only with the following wiring systems. Make sure that the input element no. matches the affix no. (for instance, "1" of W1) of the variable used in the equation.

Wiring Systems and Equations

Two-wire system for both input and output:

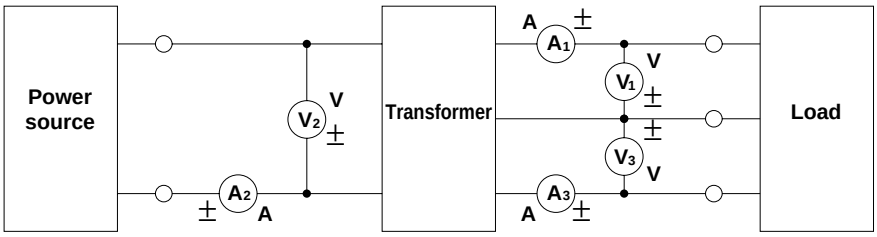
Select 1Φ2W, 1Φ3W (for 253620 only) or 3Φ3W (for 253620 only).



Equation: $\eta = \frac{W3}{W1} \times 100(\%)$

Single-phase for input and three-phase for output:

Select 1Φ3W, 3Φ3W, 3Φ4W or 3V3A. (Applicable only to 253630/253640)

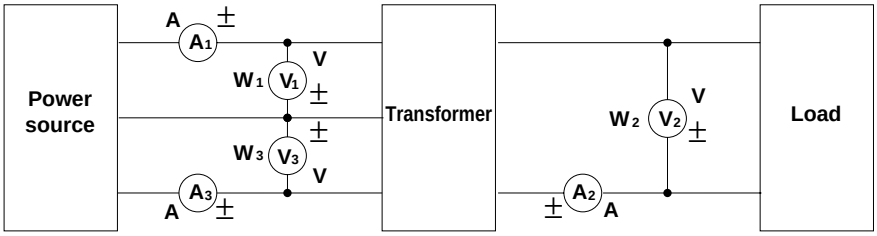


Equation: $\eta = \frac{W1+W3}{W2} \times 100(\%)$

Measuring Efficiency Using the MATH Function

It is not possible to measure efficiency directly with the following wiring method. However, use of the MATH function (A ⇒ B) enables computation of efficiency. For a description of how to set the MATH function, refer to Section 7.3, "Four Arithmetical Operations Using Display D" (page 7-4).

Display A	Display B	Equation
W2	ΣW	$\eta = \frac{W2}{\Sigma W}$
		$\frac{W2}{W1+W3}$



3Φ3W

Note

- Refer to Section 7.1 "Measuring Efficiency" (page 7-1) for a description of the measurement method.
- The efficiency is not displayed as a percentage (%), but displayed as a value (1.0000 is equivalent to 100%) when the MATH function is used.

4.1 Setting Measuring Conditions

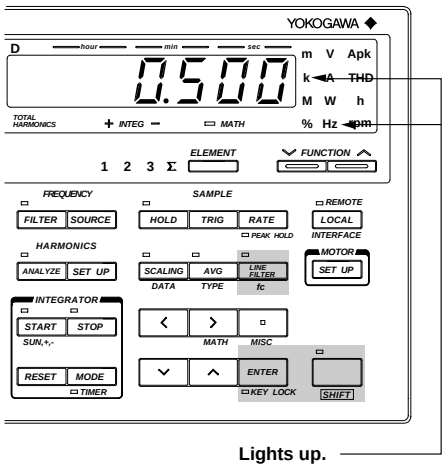
Measuring with Line Filter ON

Use of a line filter during normal measurement of PWM waveforms, such as inverter waveforms, has the following advantages.

- In the case of measurement of voltage and current, similar results to those obtained in the measurement of fundamental waveforms can be obtained. Measured values are also the same as those obtained in the MEAN measurement mode.
- In the case of measurement of power, similar results to those obtained in the measurement of fundamental waveforms can also be obtained.
  It is also possible to select cut-off frequency suitable for the fundamental component of the waveform to be measured.
- A 5th order butterworth lowpass filter is used.

Setting the Cut-off Frequency (for Normal Measurement)

1. Press the fc key (SHIFT + LINE FILTER).
   Display C displays "FC" and display D displays the currently selected cut-off frequency.
2. The cut-off frequency on display D changes in the following order each time the ∧ key is pressed, so select the desired cut-off frequency.
   0.500 ∅ 1.000 ∅ 2.000 ∅ 6.500 ∅ 0.500 ∅. . .
   Pressing the ∨ key causes the cut-off frequency to change in the opposite order. The cut-off frequency is displayed in units of kHz. The default is 0.500.
3. Press the ENTER key.



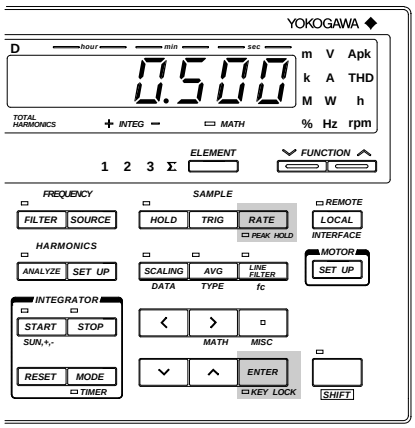
Turning Filter ON or OFF

Press the LINE FILTER key. The LED above the LINE FILTER key is lit when the filter is ON.

Note

- The line filter cannot be turned ON and OFF during integration
- **Pressing the fc key (*SHIFT* + *LINE FILTER*) during harmonic analysis will allow you to turn the anti-aliasing filter ON and OFF.** The cut-off frequency of the anti-aliasing filter is 6.5 kHz.

Setting the Display Update Cycle (Sample Rate)



1. Press the RATE key. Display C displays "S-rAtE" and display D displays the currently selected sample rate.
2. The sample rate on display D changes in the following order each time the ∧ key is pressed, so select the desired sample rate.
   0.500 (500 ms) ∅ 2.000 (2 s) ∅ 5.000 (5 s) ∅ 0.100 (100 ms) ∅ 0.250 (250 ms) ∅ 0.500 ∅. . .
   Pressing the ∨ key causes the sample rate to change in the opposite order

Sample Rate	Lower Limit Frequency (for Measurement of V, A and W)	Frequency Range
100ms	25Hz	40Hz - f - 500kHz
250ms	10Hz	20Hz - f - 500kHz
500ms	5Hz	10Hz - f - 500kHz
2s	1.5Hz	2Hz - f - 100kHz
5s	0.5Hz	1.5Hz - f - 90kHz

Default setting is 0.500 (500 ms)

3. Press the ENTER key.

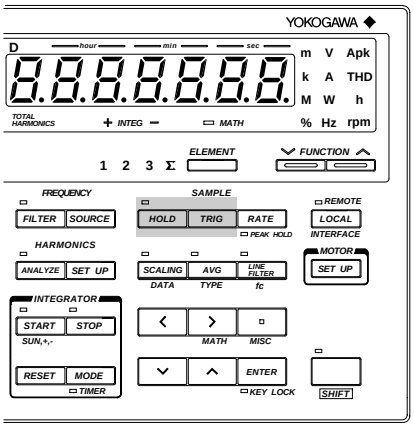
Note

- The sample rate cannot be turned ON and OFF during integration.
- The sample rate is not effective during harmonic analysis.

Display and Data Output

Holding Display and Output

To hold the currently displayed measured values, press the HOLD key. The LED above the HOLD key will light up, indicating that the hold function is currently on. Pressing the HOLD key again causes the LED to go out, indicating that the hold function is now off.



Updating the Data

When the HOLD indicator LED is lit, to update the measured values, press the TRIG key. The measured values are also updated when the external trigger signal is received.

If the measured values are output (by means of a communications channel or the D/A converter), the output values are also updated when the TRIG key is pressed.

Voltage and Current Measurement Modes

One of the following measurement modes can be selected for measurement of voltage and current.

RMS : Measures and displays true rms value.
MEAN : Displays rectified mean value calibrated to the rms value.
DC : Displays DC value obtained by averaging the input signal.

The default setting for measurement mode is RMS.

RMS

This mode is used to display input voltage or current as a true rms value. The theoretical equation is given below.

$$\sqrt{\frac{1}{T}\int_0^T f(t)^2\,dt}$$

f(t) : Input signal
T : One period of the input signal

MEAN

This mode is used to display input voltage or current as a rectified mean value calibrated to the rms value. Since a sine wave is used for calibration, the value displayed will be the same as that obtained in RMS mode if a sine wave is measured. However, the value displayed will be different from that obtained in RMS mode if a distorted or DC waveform is measured. The theoretical equation is given below.

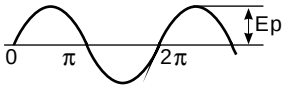
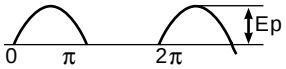
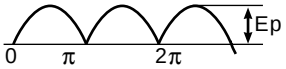
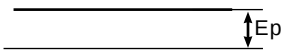
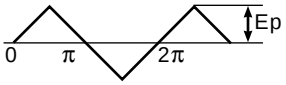
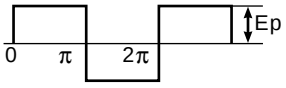
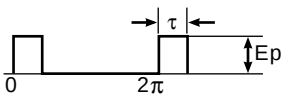
$$\frac{\pi}{2\sqrt{2}} \cdot \frac{2}{T} \int_0^{\frac{T}{2}} |f(t)| dt$$

f(t) : Input signal
T : One period of the input signal

DC

This mode is used when the input voltage or current is DC. The input signal is averaged and the result is displayed.

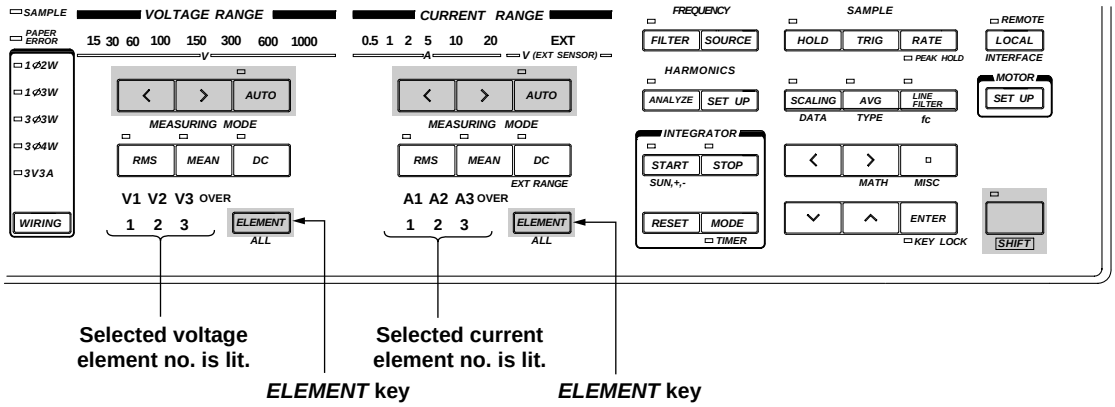
Typical Waveform Types and Differences in Measured Values Between Measurement Modes

Name	Measurement mode / Display / Waveform	rms value	Mean value	Mean-value rectification	Linear averaging
		RMS	—	MEAN	DC
Sine Wave		$\frac{Ep}{\sqrt{2}}$	$\frac{2}{\pi} \cdot Ep$	$\frac{Ep}{\sqrt{2}}$	0
Half-wave rectification		$\frac{Ep}{2}$	$\frac{Ep}{\pi}$	$\frac{Ep}{2\sqrt{2}}$	$\frac{Ep}{\pi}$
Full-wave rectification		$\frac{Ep}{\sqrt{2}}$	$\frac{2}{\pi} \cdot Ep$	$\frac{Ep}{\sqrt{2}}$	$\frac{2}{\pi} \cdot Ep$
Direct current		Ep	Ep	$\frac{\pi}{2\sqrt{2}} \cdot Ep$	Ep
Triangular wave		$\frac{Ep}{\sqrt{3}}$	$\frac{Ep}{2}$	$\frac{\pi}{4\sqrt{2}} \cdot Ep$	0
Square wave		Ep	Ep	$\frac{\pi}{2\sqrt{2}} \cdot Ep$	0
Pulse		$\sqrt{\frac{\tau}{2\pi}} \cdot Ep$	$\frac{\tau}{2\pi} \cdot Ep$	$\frac{\pi \cdot \tau}{4\pi\sqrt{2}} \cdot Ep$	$\frac{\tau}{2\pi} \cdot Ep$
		When duty D ($= \frac{\tau}{2\pi}$) is applied:			
		$\sqrt{D} \cdot Ep$	$D \cdot Ep$	$\frac{\pi \cdot D}{2\sqrt{2}} \cdot Ep$	$D \cdot Ep$

4.2 Setting Measuring Ranges

Setting Voltage/Current Measuring Ranges for Each Element

Voltage and current measuring range can be set for each element.



Selected voltage element no. is lit.

Selected current element no. is lit.

***ELEMENT* key**

***ELEMENT* key**

Setting the Measuring Range for Each Element

1. Keep pressing the ELEMENT key until the desired element no. lights up.
2. Press the range setting key (< , > or AUTO) to set the desired measuring range.
3. Repeat steps *1* and *2* to set the desired measuring range for other elements.

Setting the Same Measuring Range for All Elements at Once

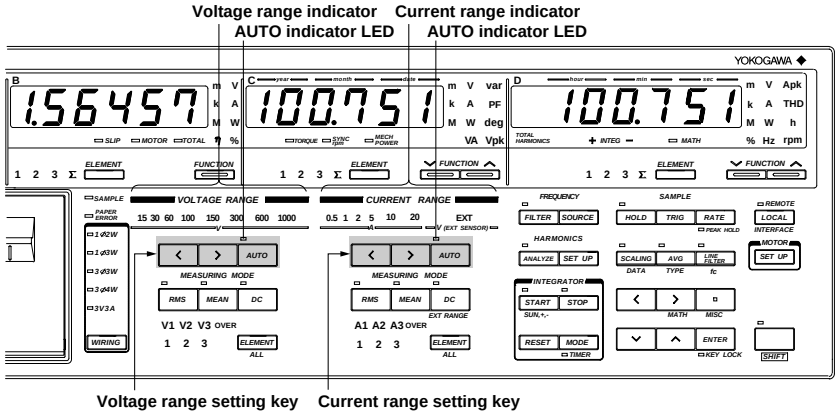
To set the same measuring range for all elements at once, carry out the following steps.

1. Press the ALL key (SHIFT + ELEMENT).
   All element nos. will light up.
2. Press the range setting key (< , > or AUTO) to set the desired measuring range.

Manual and Auto Range Setting

Measuring Range Setting Method

There are two methods of setting the measuring range; auto range setting, in which the most suitable range is selected automatically, and manual range setting, in which the range is selected manually.



Manual Range Setting

When the AUTO indicator LED is not lit, manual range setting mode is valid. In this mode, the next lowest or highest range can be selected manually by pressing the < or > key respectively.
If the AUTO indicator LED is lit, press the < or > key. This will cause the AUTO indicator LED to go out, indicating that manual range setting mode is valid.

Auto Range Setting

When the AUTO indicator LED is lit, auto range setting mode is valid. The measuring range is switched automatically according to the input voltage or current.

Range Up : A higher range is selected immediately if the instantaneous input voltage or current exceeds approximately 330% of the rated value during sampling. If the measured voltage or current exceeds 110% of the rated value, or if an over range for the measured value occurs during harmonic analysis, a higher range will be selected at the end of the current measurement cycle (i.e. at the next update).

Range Down : A lower range is selected if the measured voltage or current drops below 30% of the rated value.

Switching from Auto Range Setting to Manual Range Setting (when the AUTO Indicator LED is Lit)

Switching to manual range setting can be performed using one of the following procedures. Procedure

- Press the < or > key.
  The AUTO indicator LED will go out, and manual range setting mode becomes valid. The next highest or lowest range relative to the range set in auto range setting mode will be selected.

- Press the AUTO key.
  The AUTO indicator LED will go out and manual range setting mode becomes valid.

Note

- In auto range setting mode, the range may be switched frequently if a waveform such as a pulse, which has a high crest factor, is input. In this case, set the range manually.
- Auto range setting mode for current measuring range is available for both normal current range and external sensor current range. If auto range setting mode is selected while normal current range is used, switching between normal current ranges will be performed. Similarly, if auto range setting mode is selected while external sensor current range (EXT) is used, switching between external sensor current ranges will be performed. Refer to page 4-7 for a description of external sensor measuring range.
- "- - - - - -" will be displayed if no measured data is present, measuring range will not be selected automatically even if auto range setting mode is selected.
- If the measuring range is changed during harmonic analysis, PPL synchronization will be disabled, then re-enabled. As a result no correct measured value will be obtained, therefore the measuring range changes all the time. In this case, carry out measurement in manual range setting mode.
- Refer to Section 17, "Specifications", for measurement accuracy.

Display Resolution and Power Range

The measuring range for active power, apparent power and reactive power is determined as follows.

Wiring System	Power Range
Single-phase, two-wire (1Φ2W)	Voltage range x Current range
Single-phase, three-wire (1Φ3W) Three-phase, three-wire (3Φ3W) Three power meter method (3V3A)	Voltage range x Current range x 2 (When the same voltage and current measuring ranges are used for all elements)
Three-phase, four-wire (3Φ4W)	Voltage range x Current range x 3 (When the same voltage and current measuring ranges are used for all elements)

Display resolution is given below, based on the above specifications.

1. The lowest display digit will not be used when the frequency exceeds 199999 counts or when computed result or efficiency exceeds 30000 counts.

2. When the voltage range x current range exceeds 1000 W, the display unit will switch to "kW", and when it exceeds 1000 kW, the display unit will switch to "MW".

Note

- In auto range setting mode, the measuring range switches according to range up/range down conditions as described on page 4-5. Therefore, the range may vary even if the measured values remain the same.

The decimal point position and unit for voltage, current and power are shown below in the case of direct input range. ΣW indicates that the same voltage and current ranges are used for all the input elements.

W for 1Φ2W System

		Current Range					
		500.0mA	**1.0000A**	**2.0000A**	**5.000A**	**10.000A**	**20.000A**
Voltage Range	**15.000V**	7.500W	15.000W	30.000W	75.00W	150.00W	300.00W
	30.000V	15.000W	30.000W	60.00W	150.00W	300.00W	600.0W
	60.00V	30.000W	60.00W	120.00W	300.00W	600.0W	1.2000kW
	100.00V	50.00W	100.00W	200.00W	500.0W	1.0000kW	2.0000kW
	150.00V	75.00W	150.00W	300.00W	750.0W	1.5000kW	3.0000kW
	300.00V	150.00W	300.00W	600.0W	1.5000kW	3.0000kW	6.000kW
	600.0V	300.00W	600.0W	1.2000kW	3.0000kW	6.000kW	12.000kW
	1000.0V	500.0W	1.0000kW	2.0000kW	5.000kW	10.000kW	20.000kW

ΣW for 1Φ3W, 3Φ3W and 3V3A Systems

		Current Range					
		500.0mA	**1.0000A**	**2.0000A**	**5.000A**	**10.000A**	**20.000A**
Voltage Range	**15.000V**	15.00W	30.000W	60.00W	150.00W	300.00W	600.0W
	30.000V	30.000W	60.00W	120.00W	300.00W	600.0W	1.2000kW
	60.00V	60.00W	120.00W	240.00W	600.0W	1.2000kW	2.4000kW
	100.00V	100.00W	200.00W	400.0W	1.0000kW	2.0000kW	4.000kW
	150.00V	150.00W	300.00W	600.0W	1.5000kW	3.0000kW	6.000kW
	300.00V	300.00W	600.0W	1.2000kW	3.0000kW	6.000kW	12.000kW
	600.0V	600.0W	1.2000kW	2.4000kW	6.000kW	12.000kW	24.000kW
	1000.0V	1.0000kW	2.0000kW	4.000kW	10.000kW	20.000kW	40.00kW

ΣW for 3Φ4W System

		Current Range					
		500.0mA	**1.0000A**	**2.0000A**	**5.000A**	**10.000A**	**20.000A**
Voltage Range	**15.000V**	22.500W	45.00W	90.00W	225.00W	450.00W	900.0W
	30.000V	45.00W	90.00W	180.00W	450.0W	900.0W	1.8000kW
	60.00V	90.00W	180.00W	360.0W	900.0W	1.8000kW	3.600kW
	100.00V	150.00W	300.00W	600.0W	1.5000kW	3.0000kW	6.000kW
	150.00V	225.00W	450.0W	900.0W	2.2500kW	4.500kW	9.000kW
	300.00V	450.0W	900.0W	1.8000kW	4.500kW	9.000kW	18.000kW
	600.0V	900.0W	1.8000kW	3.600kW	9.000kW	18.000kW	36.00kW
	1000.0V	1.5000kW	3.0000kW	6.000kW	15.000kW	30.000kW	60.00kW

Measuring Range for External Sensor (Applicable when External Input Option is Used)

The maximum current measuring range of this instrument is 20 A. If the current to be measured is higher than this maximum, an external voltage-output type sensor can be used.

Setting Measuring Range

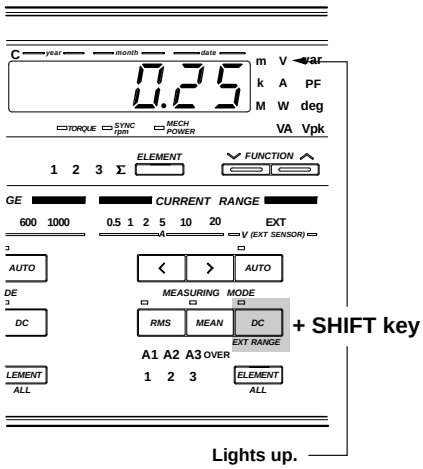
1. Press the > key located below display C to select EXT (V(EXT SENSOR)).

Setting External Sensor Range

1. Press the **EXT RANGE** key (**SHIFT** + **DC**). "EXT.RNG" will be displayed on display A. The element currently selected is displayed on display B. Press the ∧ or ∨ key until the desired element is displayed on display B.

The display changes in the order of ALL (all elements) ∅ EL 1 (element 1) ∅ EL 2 (element 2, applicable only for the 253630 and 253640) ∅ EL 3 (element 3) ∅ End (to end making setting) and back to ALL.

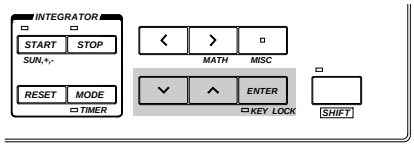
After the desired element has been selected, press the **ENTER** key.



2. Display C displays the external sensor range for the element which is currently selected for display B, with the digit on the extreme left blinking. Press the ∧ or ∨ key until the desired external sensor range is displayed on display C.

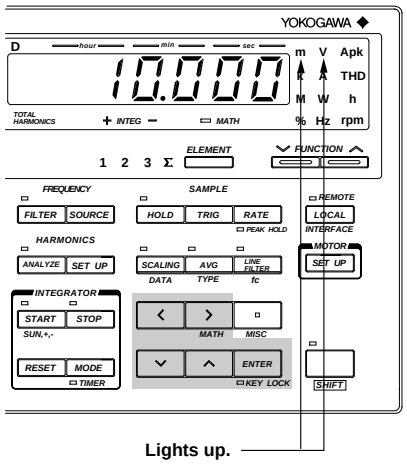
The display changes in the order of 0.25 ∅ 0.50 ∅ 1.00 ∅ 2.50 ∅ 5.00 ∅ 10.0 and back to 0.25. The default setting is 10.0 V.

After the desired external sensor range has been selected, press the **ENTER** key.



3. Display D displays the sensor output value (mV/A), with the digit on the extreme left blinking. You can change the value at the blinking digit. Pressing the ∧ key changes the value in the order 1, 2, 3 ... 9, 0 and back to 1. Pressing the ∨ key changes the value in the opposite direction. The blinking position can be shifted to the left or right by pressing the < or > key respectively. To shift the decimal point, press the ▫ key.

The sensor output value can be set within the following range.



Setting range : ROM version before 2.01 0.9000 to 10000.
ROM version 2.01 or later 0.1000 to 10000.
Default : 10.000 mV/A

After the sensor output value has been set, press the **ENTER** key.

If "ALL" is selected as the element in step *1*, the setting procedure is now complete.

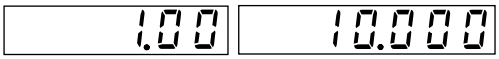
4. If the **ENTER** key is pressed at the end of step *3*, the next element will be displayed on display B, unless "ALL" has been selected in step *1*. Repeat steps *2* to *3*.

5. To exit from setting mode, select "End" on display B and then press the **ENTER** key. To exit from setting mode in the middle of making settings, press the **SHIFT** key or **DC (EXT RANGE)** key.

Setting Example for External Sensor Output Value (mV/A)

For the external sensor output value (mV/A), set a voltage (units of mV) to be output from the external sensor when 1A is applied to the sensor. For instance, if you want to measure 100 A using an external sensor which outputs 10 mV when 1 A is applied to the sensor, select the 1V measuring range and set the sensor output value to 10 mV because 10 mV/A x 100 = 1 V.

Display C **Display D**



Measuring range (V) **Sensor output value (mV/A)**

Note

- If an attempt is made to set a external sensor output value that is outside the setting range, error code "Err 12" is displayed. In this case, re-enter the correct value.
- To read the measured value directly when an external sensor is being used, SCALING must be set to OFF. If SCALING is ON, the measured value will be further multiplied by the CT ratio (scaling value for current) before it is displayed.

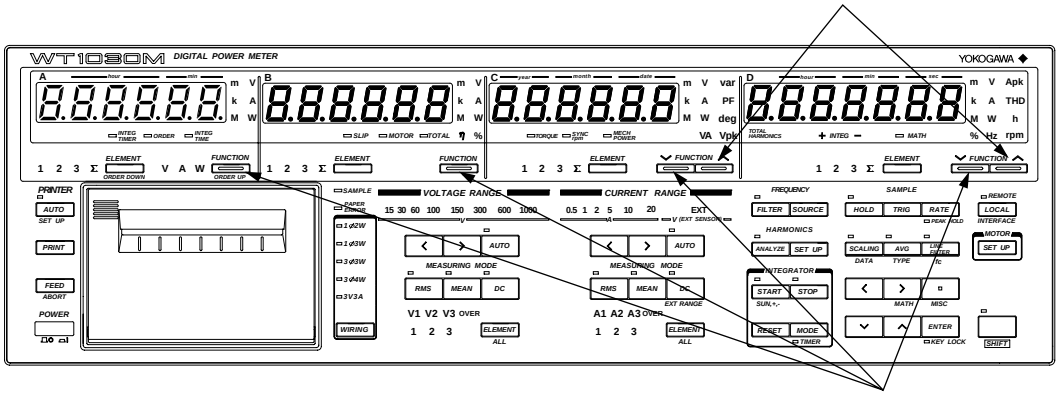
Auto Range

If EXT(V(SENSOR)) has been selected as the current range, auto range setting mode will be turned on when the AUTO key is pressed to light up the AUTO indicator. For a description of auto range setting, refer to "Auto Range Setting" (page 4-5).

4.3 Selecting What to Display on Digital Displays

The instrument has four digital displays as shown below. The information to be displayed on each display can be selected with the FUNCTION key and ELEMENT key below the display. Each display has its own FUNCTION key and ELEMENT key.

The specific type of information to be displayed is shifted upwards each time the *FUNCTION* key is pressed.



The specific type of information to be displayed is shifted downwards each time the *FUNCTION* key is pressed.

Operating the FUNCTION Key

Pressing the FUNCTION key switches the display in the following order. In the case of displays C and D (refer to next page), the sequence below shows the order in which the display information type is switched when the left-side FUNCTION key is pressed. Pressing the right-side FUNCTION key switches display information type in the opposite order.

Display A

Default setting for display A is "V" (voltage).

The harmonic order is displayed during harmonic analysis.

V (voltage) → A (current) → W (power) → INTEG TIME (integration time)*

***: Available only when the integration option is incorporated.**

Display B

Default setting for display B is "A" (current).

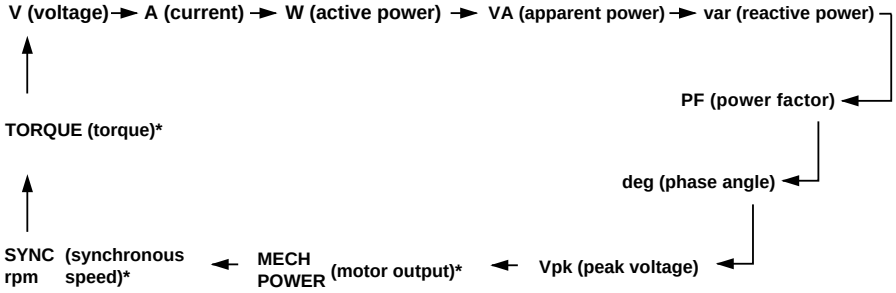
V (voltage) → A (current) → W (power) → TOTALη (total efficiency)*

SLIP (slip)* ← MOTORη (motor efficiency)*

*** : Available with WT1030M only**

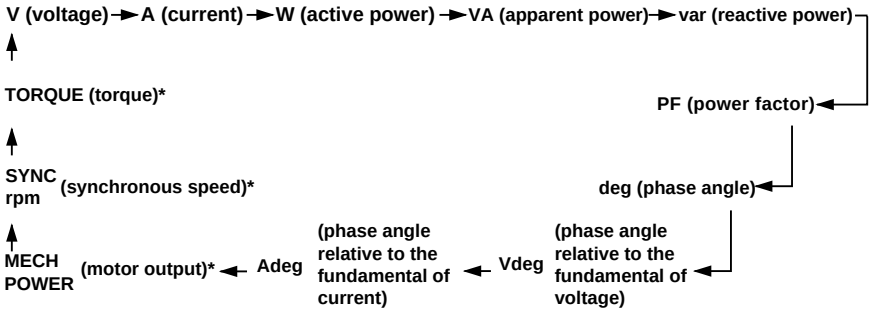
Display C

Default setting for display C is "W" (power).



*: Available with WT1030M only

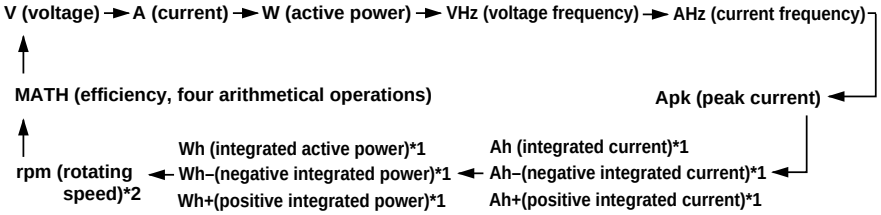
- **During harmonic analysis**



*: Available with WT1030M only

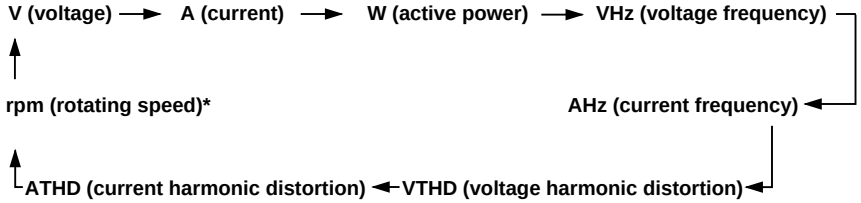
Display D

Default setting for display D is "W" (power).



*1: Available only when the integration option is incorporated.
*2: Available with WT1030M only

- **During harmonic analysis**



*: Available with WT1030M only

5.1 Measuring Voltage, Current and Active Power

Selecting What to Display and Element to be Measured

1. Select **V (voltage measurement)**, **A (current measurement)** or **W (active power measurement)** by pressing the FUNCTION key for the display on which the measured value is to be displayed. For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-9).
2. Press the ELEMENT key below the same display to select the element to be measured. For details, refer to Sections 3.2 "Setting Wiring System" (page 3-2) and 4.2 "Setting Measuring Ranges" (page 4-4).

Setting Measuring Ranges

3. Press the voltage range or current range setting key to set the desired measuring range. For details, refer to 4.2 "Setting Measuring Ranges" (page 4-5).

Setting Voltage/Current Measurement Mode (RMS, MEAN or DC)

4. Press the measurement mode setting key (RMS, MEAN or DC key) to set the desired measurement mode. For details, refer to Section 4.1 "Setting Measuring Conditions" (page 4-2).

Power Range

- The power measuring range is determined according to the selected voltage and current ranges. For details, refer to Section 4.2 "Setting Measuring Ranges" (page 4-6).
- For power measuring range, refer to Section 17. "Specifications."

5.2 Measuring Peak Voltage and Current

Measured peak voltage is displayed on display C, whilst measured peak current is displayed on display D.

Setting Element to be Measured

1. Select **Vpk (peak voltage)** by pressing the FUNCTION key below display C, and select **Apk (peak current)** by pressing the FUNCTION key below display D. For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-9).
2. Press the ELEMENT key below the same display to select the element to be measured. For details, refer to Sections 3.2 "Setting Wiring System" (page 3-2) and 4.2 "Setting Measuring Ranges" (page 4-4).

Setting Measuring Ranges

3. Press the voltage range or current range setting key to set the desired measuring range. For details, refer to 4.2 "Setting Measuring Ranges" (page 4-5).

Setting Voltage/Current Measurement Mode (RMS, MEAN or DC)

Measured peak voltage or current is independent of the measurement mode.

Setting Peak Hold Mode

Press the PEAK HOLD (SHIFT + RATE) key. The PEAK HOLD indicator will light up and the maximum Vpk and Apk values are on hold. To cancel the peak hold mode, press the PEAK HOLD (SHIFT + RATE) key again.

Note

- Peak hold mode will be canceled if the range, measuring mode, line filter or averaging setting is changed.

5.3 Displaying Computed Apparent Power

Basic Computing Equation

For details, refer to Section 17 "Specifications."

Computing Accuracy

For details, refer to Section 17 "Specifications."

Computing Range for Apparent Power

For details, refer to Section 17 "Specifications."

Rated Value for Apparent Power

Voltage and current ranges are combined to measure apparent power.

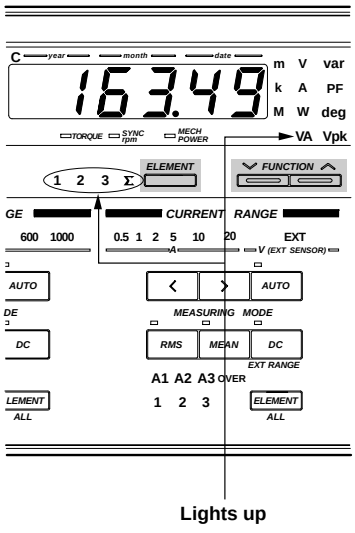
For details, refer to Section 4.2 "Setting Measuring Ranges" (page 4-6).

Function Setting

Operating the FUNCTION Key

Computed apparent power is displayed on display C. Press the FUNCTION key below display C to select **VA (apparent power)**.

For details, refer to Section 4.3 " Selecting What to Display on Digital Displays" (page 4-10).



Setting Element to be Measured

Operating the ELEMENT Key

Press the ELEMENT key below display C to select the element to be measured.

Setting WIRING System

For details, refer to Section 3.2 "Setting Wiring System" (page 3-2).

Note

- Even if the measurement mode for voltage is different from that for current, computation is still carried out with the modes unchanged.
  For instance, if the voltage measurement mode is Vrms and the current measurement mode is Amean, the computed apparent power will be the result of Vrms x Amean.

5.4 Displaying Computed Reactive Power

Basic Computing Equation

For details, refer to Section 17, "Specifications."

Computing Accuracy

For details, refer to Section 17, "Specifications."

Computing Range for Reactive Power

For details, refer to Section 17, "Specifications."

Rated Value for Reactive Power

Voltage and current ranges are combined to measure reactive power.

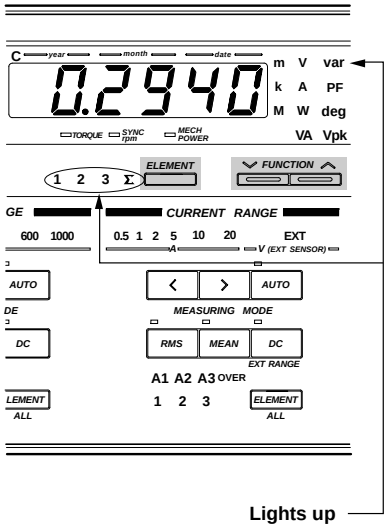
For details, refer to Section 4.2 "Setting Measuring Ranges" (page 4-6).

Function Setting

Operating the **FUNCTION** Key

Press the FUNCTION key below display C to select **var (reactive power)**.

For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-10).



Setting Element to be Measured

Operating the **ELEMENT** Key

Press the ELEMENT key below display C to select the element to be measured.

Setting **WIRING** System

For details, refer to Section 3.2 "Setting Wiring System" (page 3-2).

Note

- Even if the measurement mode for voltage is different from that for current, computation is still carried out with the modes unchanged.
  For instance, if the voltage measurement mode is Vrms and the current measurement mode is Amean, the apparent power will be obtained using the equation "var = $\sqrt{(\text{Vrms} \times \text{Amean})^2 - \text{W}^2}$."

5.5 Displaying Computed Power Factor

Basic Computing Equation

For details, refer to Section 17, "Specifications."

Computing Accuracy

For details, refer to Section 17, "Specifications."

Display Range

Display range: –1.0000 to 1.0000

If the computation result exceeds "1" due to inputs being outside the effective operating input range, the following will be displayed.

Computation Result	Display
1.0001 to 2.0000	10000
2.0001 or higher	PFErr

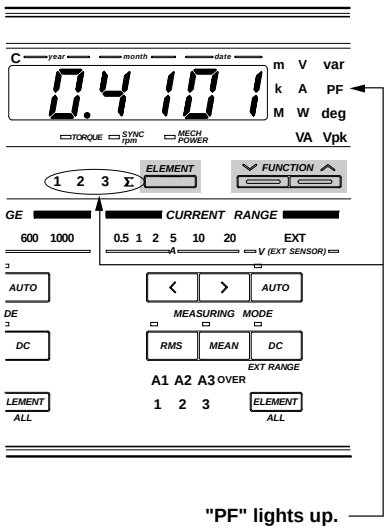
If either input voltage or input current is below 0.5% of the rated value of the range used, "PFErr" will be displayed.

Function Setting

Operating the **FUNCTION** Key

Press the FUNCTION key below display C to select **PF (power factor)**.

For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-10).



Setting Element to be Measured

Operating the **ELEMENT** Key

Press the ELEMENT key below display C to select the element to be measured.

Setting **WIRING** System

For details, refer to Section 3.2 "Setting Wiring System" (page 3-2).

Note

- Even if the measurement mode for voltage is different from that for current, computation is still carried out with the modes unchanged.
  For instance, the voltage measurement mode is Vrms and the current measurement mode is Amean, the power factor will be obtained using the equation "PF = $\frac{W}{Vrms \times Amean}$."

5.6 Displaying Computed Phase Angle

Basic Computing Equation

For details, refer to Section 17, "Specifications."

Computing Accuracy

For details, refer to Section 17, "Specifications."

Computing Range for Phase Angle

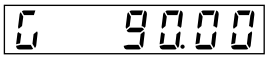
For details, refer to Section 17, "Specifications."

Display Resolution

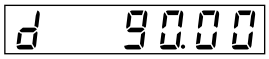
For details, refer to Section 17, "Specifications."

Distinction between phase lag and lead is indicated as below.

Phase Lag



Phase Lead



If the power factor exceeds "1", the following will be displayed.

Power Factor	Display
1. 0001 to 2.0000	000 deg
2. 0001 or higher	dEGErr

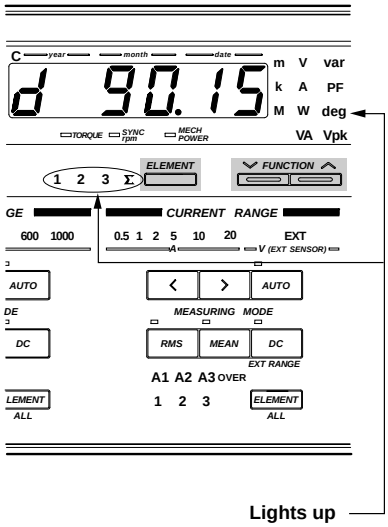
Note

- Before computing the phase angle (deg), make sure that both the voltage and current are within the effective measurement range.
- Distinction between phase lag and lead is made properly only when both voltage and current are sine waves.
- If either the measured voltage or current is below 0.5% of the rated value of the range used, "dEGErr" will be displayed.
- Even if the measurement mode for voltage is different from that for current, computation is still carried out with the modes unchanged.
  For instance, if the voltage measurement mode is Vrms and the current measurement mode is Amean, the phase angle (deg) will be obtained using the equation
  "$\text{deg} = \cos^{-1}\left(\frac{W}{\text{Vrms} \times \text{Amean}}\right)$."

Function Setting

Operating the **FUNCTION** Key

Press the FUNCTION key below display C to select **deg (phase angle)**. For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-10).



Lights up

Setting Element to be Measured

Operating the **ELEMENT** Key

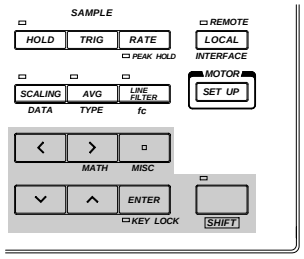
Press the ELEMENT key below display C to select the element to be measured.

Setting **WIRING** System

For details, refer to Section 3.2 "Setting Wiring System" (page 3-3).

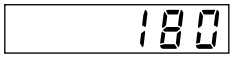
Setting Phase Angle Display Method

1. Press the MISC key (SHIFT + ▫.)
Press the ∧ or ∨ key until "dEG" appears on display D.



2. Press the ENTER key.
"dEG" will disappear from display D, and instead will appear on display A. The phase angle currently set will appear on display B.
Default setting: 180°

Display B



3. Press the ∧ or ∨ key to set the phase angle display method (180° or 360°).

4. Press the ENTER key.

Note

The phase angle is displayed as follows when the 360° display method is selected.
Calculation is performed using $\cos^{-1}\left(\frac{W}{VA}\right)$, which gives a phase angle between 0° and 180°.
Distinction of phase lag/lead is then made, and computed results are displayed.
In the case of phase lag : phase angle calculated using $\cos^{-1}\left(\frac{W}{VA}\right)$ is displayed.
In the case of phase lead : phase angle calculated using $360° - \cos^{-1}\left(\frac{W}{VA}\right)$ is displayed.
No phase lag or lead code (L or d) is indicated.

6.1 Measuring Frequency

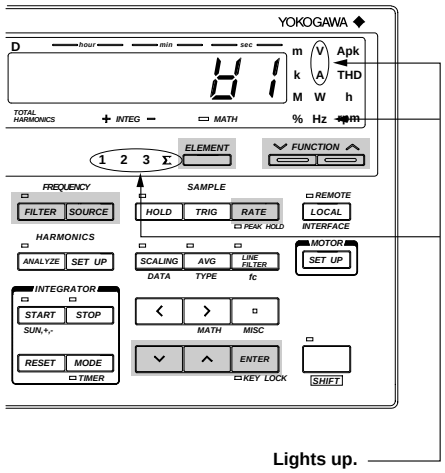
Display Range

For display range, refer to Section 17."Specifications."

- If the input signal level is low or the input frequency is below the measurement range, the error code "Err-Lo" will be displayed. The same error code will also be displayed if no input signal is input to the element.
- If the input frequency is above the measurement range, error code "Err-Hi" will be displayed.

Function Setting

1. Press the FUNCTION key below display D to select **VHz (voltage frequency)** or **AHz (current frequency)**.
For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-10).



Setting Element to be Measured

2. Press the ELEMENT key below display D to select element 1, 2, 3, or Ý.

Selecting the Input to be Measured

3. Press the SOURCE key.
"Frq rC" will be displayed on display C. The input currently selected is displayed on display D.
Press the ∧ or ∨ key until the desired input is displayed on display D.
The display changes in the order of V1 ∅ A1 ∅ (V2) ∅ (A2) ∅ V3 ∅ A3 and back to V1. V2 and A2 are available with the three-phase, four-wire models (253630 and 253640) only. The default setting is V1.
PLL source will be selected for harmonic analysis.

4. Press the ENTER key.

Setting the Sample Rate

5. Press the RATE key to set the desired sample rate. The measurable frequency range varies according to the sample rate. For a detailed description of how to set the sample rate. refer to Section 4.1, "Setting Measuring Conditions" (page 4-1).

Sample Rate	Measurable Frequency Range
100ms	40Hz - f - 500kHz
250ms	20Hz - f - 500kHz
500ms	10Hz - f - 500kHz
2s	2Hz - f - 100kHz
5s	1.5Hz - f - 90kHz

Measuring Frequency with Filter ON

The frequency filter can be used to eliminate noise or harmonics, such as those that appear in inverter waveforms, when measuring the fundamental frequency. To eliminate noise during measurement of frequencies below 100 Hz, it is also recommended that you turn ON the filter.

1. Press the **FILTER** key. The FILTER indicator LED will light up, indicating that the filter is ON.
   To turn the filter OFF, press the **FILTER** key again.

Note

- If the filter is ON and a signal with a frequency of 440 Hz or higher is input, an error code "Err-Lo" may be displayed depending on the frequency and level of the signal. This is because the signal is attenuated by the filter and therefore its presence is not recognized. In this case, turn the filter OFF.

7.1 Measuring Efficiency

Display Resolution

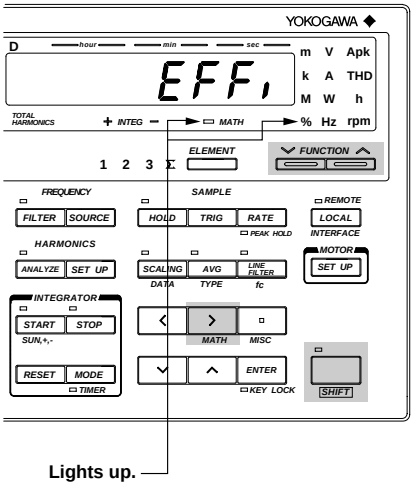
The display resolution for efficiency measurement is 0.01.

Displaying the Computed Value

The computed result is displayed on display D as a percentage (%).

Function Setting

Operating the **FUNCTION** Key



1. Press the FUNCTION key below display D to select MATH. For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-10.).

2. Press the MATH key (SHIFT + >.)
"MATH" will be displayed on display C.

3. Press the ∧ or ∨ key until "EFF," is displayed on display D. The symbol displayed on display D changes in the following order.

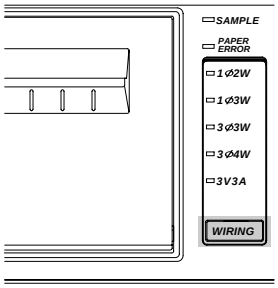
EFF, ∅ CF U1 ∅ (CF U2) ∅ CF U3 ∅ CF A1 ∅ (CF A2) ∅ CF A3 ∅ A+b ∅ A-b ∅ A..b ∅ A-b ∅ EFF,---

Symbols within brackets are displayed only on the three-phase, four-wire model (253630, 253640).

4. Press the ENTER key.

Setting Wiring System

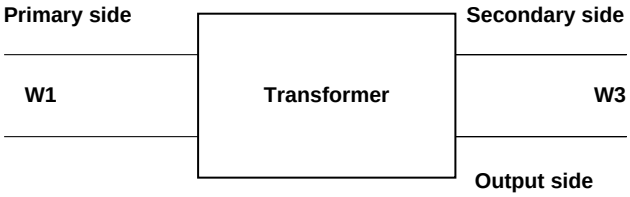
5. Set the wiring system by pressing the WIRING key. Computing equations for efficiency are given on the next page. Make sure that the correct wiring system is selected, otherwise incorrect computed values will be obtained.



Wiring Systems and Basic Computing Equations

- **When both the input and output wiring systems are two-wire system**

  Select 1Φ2W, 1Φ3W or 3Φ3W for three-phase, three-wire model (253620) and select 1Φ2W for three-phase, four-wire model (253630, 354640).



Computing equation

$$\text{Efficiency } (\eta) = \frac{W3}{W1} \times 100$$

- **When the input is two-wire and the output is a three-wire system**

  Select 1Φ3W, 3Φ3W, 3Φ4W or 3V3A. This is only applicable for the 253630 and 253640.

Computing equation

$$\text{Efficiency } (\eta) = \frac{W1+W3}{W2} \times 100$$

Note

- For the basic computing equations and the wiring method, refer to Section 3.6 "Wiring System and Equations of Efficiency" (page 3-16).

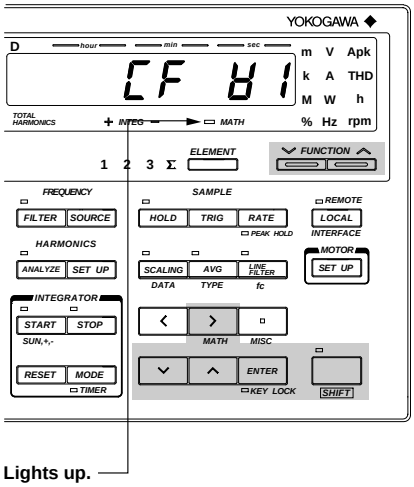
7.2 Measuring the Crest Factor

The MATH function is used to calculate the crest factor and display it on display D.

Function Setting

Operating the FUNCTION Key

1. Press the FUNCTION key below display D to select MATH. For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-10.).



Setting the Computing Equation

2. Press the MATH key (SHIFT + >).
   "MATH" will be displayed on display C.

3. Press the ∧ or ∨ key. The computing equation displayed on display D changes in the following order. Select one of the computing equations from CF U1 to CF U3 or CF A1 to CF A3.

   EFF,∅CF U1∅(CF U2)∅CF U3∅CF A1∅(CF A2)∅CF A3∅A+b∅A-b∅A*b∅A/b∅EFF,---

   Symbols within brackets are displayed only on the three-phase, four-wire model (253630, 253640).

4. Press the ENTER key.

Crest Factor Computing Equations and Display

- CF U1 : (Peak value of V1) / (rms value of V1)
- CF U2 : (Peak value of V2) / (rms value of V2) (Available only for 253630 and 253640)
- CF U3 : (Peak value of V3) / (rms value of V3)
- CF A1 : (Peak value of A1) / (rms value of A1)
- CF A2 : (Peak value of A2) / (rms value of A2) (Available only for 253630 and 253640)
- CF A3 : (Peak value of A3) / (rms value of A3)

Note

- Crest factor is defined as peak value / rms value.
- "------" will be displayed if the measuring mode is MEAN or DC.

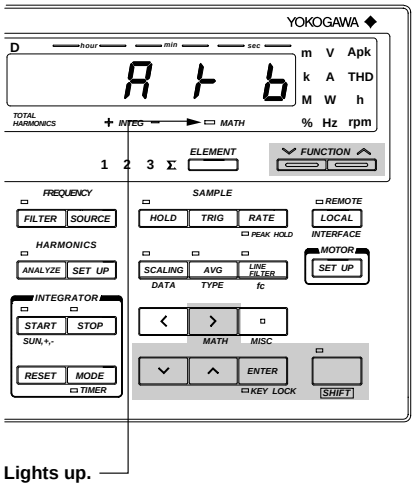
7.3 Four Arithmetical Operations Using Display D

The MATH function enables the four arithmetical operations on the measured values displayed on displays A and B, and displays the result on display D.

Function Setting

Operating the **FUNCTION** Key

1. Press the FUNCTION key below display D to select MATH. For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-10).



Setting the Computing Equation

2. Press the MATH key (SHIFT + ＞).
"MATH" will be displayed on display C.

3. Press the ∧ or ∨ key. The computing code on display D changes in the following order. Select one of the computing equations from "A + b", "A - b", "A ,, b", and "A ⁻ b".

EFF,∅CF U1∅(CF U2)∅CF U3∅CF A1∅(CF A2)∅CF A3∅A + b∅A - b∅A ,, b∅A ⁻ b∅EFF,---

Symbols within brackets are displayed only on the three-phase, four-wire model (253630, 253640).

4. Press the ENTER key.

Note

- The computing codes displayed on display D are described as follows.
  - + : + (addition)
  - - : – (subtraction)
  - ,, : x (multiplication)
  - ⁻ : / (division)
- If INTEG TIME (elapsed time of integration) is selected on display A, "------" (no data) will be displayed as the computation result.

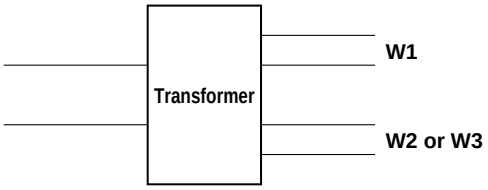
Application Examples

Addition of two measured values (power)

A + b : Result of display A + display B is displayed.

Example:

Display A	Display B	Display D	Wiring System
W1	W2 or W3	W1 + W2 or W1 + W3	Any

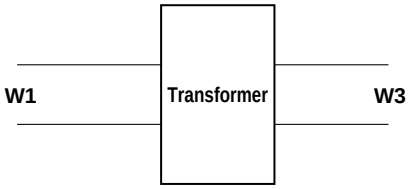


Computation of power loss

A - b : Result of display A – display B is displayed.

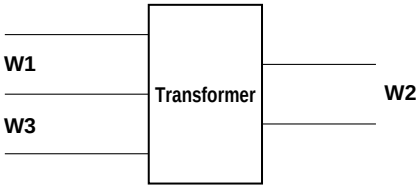
Example 1:

Display A	Display B	Display D	Wiring System
W1	W3	W1 – W3	Any



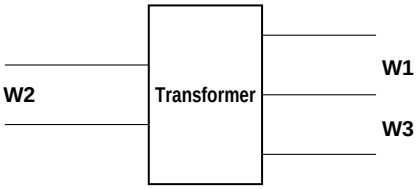
Example 2:

Display A	Display B	Display D	Wiring System
$\Sigma W(= W_1 + W_3)$	W2	ΣW – W2	3Φ3W



Example 3:

Display A	Display B	Display D	Wiring System
W2	$\Sigma W(= W_1 + W_3)$	W2 – ΣW	3Φ3W



A ,, b : Result of display A x display B is displayed.

This can be used when a function other than VA (apparent power) is set for display C to display computed apparent power (VA) on display D.

Example:

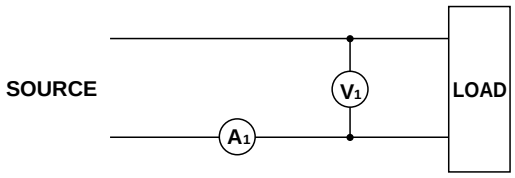
Display A	Display B	Display D	Wiring System
V1rms	A1rms	V1rms ∞ A1rms	Any

A - b : Result of display A / display B is displayed.

This can be used to calculate impedance load.

Example 1:

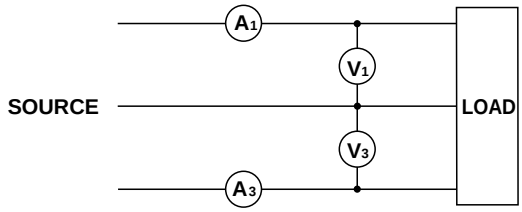
Display A	Display B	Display D	Wiring System
V1rms	A1rms	$Z = \frac{V1rms}{A1rms}$	Any



This can be also used to calculate the line voltage ratio or the phase current ratio of a three-phase wiring system.

Example 2:

Display A	Display B	Display D	Wiring System
V1rms	V3rms	$\frac{V1rms}{V3rms}$	3Φ3W
A1rms	A3rms	$\frac{A1rms}{A3rms}$	



7.4 Using the Scaling Function

Overview of the Scaling Function

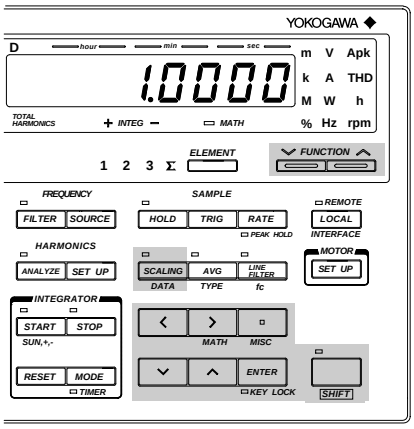
The scaling function multiplies measured values such as voltage, current and power by the scaling value and then displays the results. When measuring inputs that exceed the measuring range, an external potential transformer (PT) or current transformer (CT) is used. In this case, setting the scaling value to the PT ratio or CT ratio converts measured values to the corresponding values for the transformer primary side before they are displayed.

Display Item	Measured/Computed	Value Scaled Value
Voltage	V	Kv ∞ V
Current	A	Ki ∞ A
Active power	W	Kv ∞ Ki ∞ Kw ∞ W
Reactive power	var	Kv ∞ Ki ∞ Kw ∞ var
Apparent power	VA	Kv ∞ Ki ∞ Kw ∞ VA

Kv : Voltage scaling value (PT ratio)
Ki : Current scaling value (CT ratio)
Kw : Scaling factor

Setting Scaling Values

Setting the PT/CT Ratio and Scaling Factor



1. Press the DATA key (SHIFT + SCALING). "SCALE" will be displayed on display A. The currently selected element (for which the ratio and scaling value are to be set) is displayed on display B. Press the ∧ or ∨ until the desired element is displayed on display B.

   The display changes in the order of ALL (all elements) ∅ EL 1 (element 1) ∅ EL 2 (element 2, applicable only for the 253630 and 253640) ∅ EL 3 (element 3) ∅ End (to end making setting) and back to ALL.

   After the desired element has been selected, press the ENTER key.

2. The currently selected scaling item will be displayed on display C. Press the ∧ or ∨ until the desired scaling item is displayed on display C.

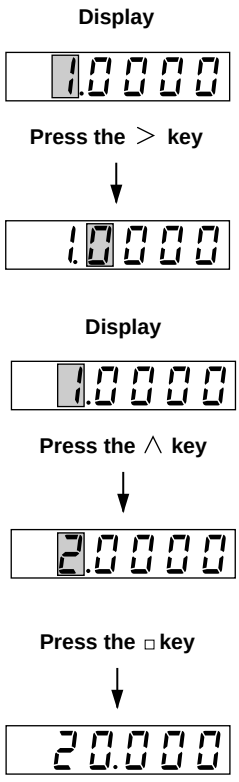
   The display changes in the order of PT (PT ratio) ∅ CT (CT ratio) ∅ ScFAc (scaling factor) ∅ End and back to PT.

   After the desired scaling item has been selected, press the ENTER key.

3. Display D displays the currently set scaling factor, with the digit on the extreme left blinking. You can change the value at the blinking digit.
   Pressing the ∧ key changes the value in the order 1, 2, 3 ... 9, 0 and back to 1.
   Pressing the ∨ key changes the value in the opposite direction. The blinking position can be shifted to the left or right by pressing the < or > key respectively. To shift the decimal point, press the ▫ key.
   The scaling factor can be set within the following range.
   Setting range : 0.0001 to 10000
   Default : 1.0000
   After the scaling factor has been set, press the ENTER key.

4. When the ENTER key is pressed in step *3*, the next scaling item will be displayed on display C. The element displayed on display B will also switch to the next element, unless "ALL" has been selected. Repeat steps *2* to *3*. If "ALL" has been selected, the same value will be set to the scaling items for all the elements.

5. To exit from setting mode, select "End" and press the ENTER key. To exit from setting mode in the middle of making settings, press the SHIFT key or SCALING (DATA) key.



Turning the Scaling Function ON

Press the SCALING key. The SCALING indicator LED will light up. To turn OFF scaling, press the SCALING key again. This causes the SCALING indicator LED to go out.

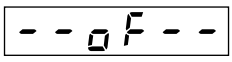
	Voltage	Current
Scaling OFF	PT secondary side	CT secondary side
Scaling ON	PT primary side	CT primary side

Note

- If an attempt is made to set a scaling value that is outside the setting range, error code "Err 12" is displayed. In this case, enter a valid value.
- When an external sensor is used, refer to Section 4.2 "Setting Measuring Ranges" (page 4-8).

Precautions When Setting Measuring Ranges with Scaling Function ON

If the scaled measured value exceeds 30000M (or 300000M in the case of integration), the following code will be displayed.



7.5 Using Averaging Functions

If reading measured values (power) is difficult due to fluctuations in the power source or load, or due to the low frequency of the measured signal, averaging functions can be used to stabilize the displayed values to make reading easier. Two types of averaging function are available with this instrument; exponential averaging and moving averaging.

Exponential Averaging

Exponential averaging is expressed by the following equation.

$$Dn = D_{n-1} + (Mn - D_{n-1})/K$$

Dn (the value at the "n"th display) is obtained by subtracting Dn – 1 (obtained by applying exponential averaging to the values up to the "n – 1"th) from the measured value Mn, dividing the result by K (the attenuation constant), then adding the quotient to Dn – 1.

Moving Averaging

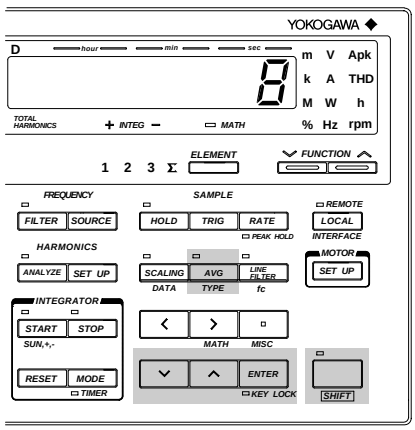
Moving averaging is expressed by the following equation.

$$Dn = (M_{n-(m-1)} + \ldots + M_{n-2} + M_{n-1} + Mn)/m$$

Dn is obtained by simply dividing the sum of the measured values including Mn by m (the number of data).

Setting Averaging Type (effective only for normal measurement)

1. Press the TYPE key (SHIFT + AVG.)
   "AVG" will be displayed on display B, indicating that averaging type selection mode is now active.



2. The currently selected averaging type will be displayed on display C.
   Press the ∧ or ∨ key until the desired averaging type ("EP" or "Lin") is displayed on display C.
   - EP : Exponential averaging
   - Lin : Moving averaging

3. Press the ENTER key.

Setting the Attenuation Constant or Averaging Sample Number (effective only for normal measurement)

4. Press the ∧ or ∨ key to set an attenuation constant (K) or sample number (m).
   Exponential averaging : selectable attenuation constant (K) : 8, 16, 32, 64, 128, 256
   Moving averaging : selectable sample number (m) : 8, 16, 32, 64, 128, 256

5. Press the ENTER key.

Averaging during Harmonic Analysis

With exponential averaging, the attenuation constant (K) will be 5.625 if the PLL synchronous source's frequency is 55 Hz or higher and below 75 Hz. Otherwise, it will be 4.6875. This provides a 1st-order low-pass filter with time constant of 1.5 s if the fundamental frequency is 50/60 Hz.

Starting Averaging Process

6. Press the AVG key.

   The AVG indicator LED lights up, indicating that the averaging function is ON. To turn OFF the averaging function, press the AVG key again. This causes the AVG indicator LED to go out.

Note

- If the ROM version of the instrument is 2.01 or later and the averaging function is turned ON, the torque and the rotating speed of the Motor evaluation functions (optional) are averaged. However, only when moving averaging is set, the averaging count of the rotating speed and torque is fixed to 8. If the ROM version is before 2.01, the torque and the rotating speed are not averaged.

8.1 Overview of Integrator Functions (Optional)

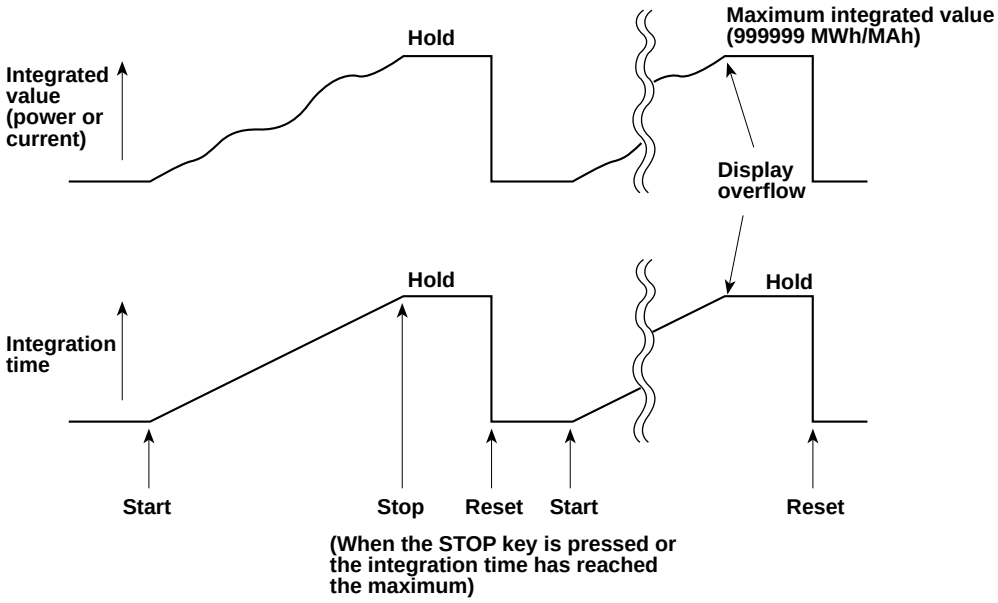
Integration Modes

The integration function can be started and stopped at any time, except when harmonic analysis is in progress. It is possible to change the function displayed on each display.

	Integration Mode	Start	Stop	Repeat	Integration Time
1.	Manual integration	START key or through communications	STOP key	No	From start to stop
2.	Standard integration	START key	Integration timer	No	Time set on integration timer
3.	Continuous integration	START key	STOP key	Yes	Time set on integration timer
4.	Real time counting				
	Standard integration	Reserved start time	Reserved stop time	No	Reserved time duration
	Continuous integration	Reserved start time	Reserved stop time	Yes	Time set on integration timer

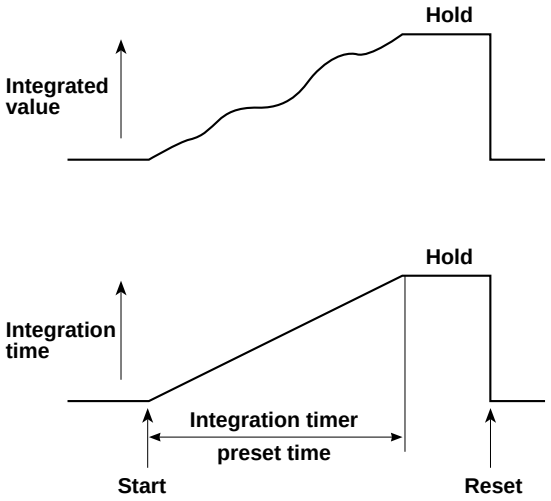
Manual Integration Mode

In this mode, integration starts when the START key is pressed, and stops when the integration time reaches the maximum (999 hours and 59 minutes) or the integrated power (Wh) or current (Ah) reaches the maximum (999999 MWh/MAh). The instrument holds the integration time and power (or current) of the stop point.



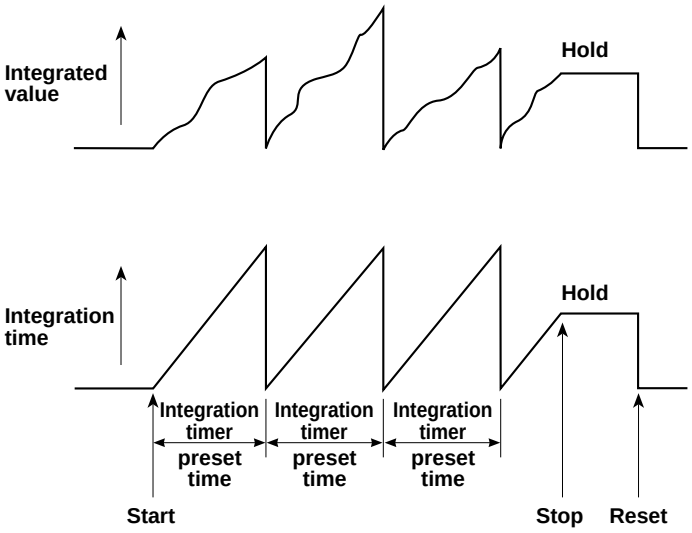
Standard Integration Mode (Timer Mode)

In this mode, integration starts when the START key is pressed, and stops when the timer preset time is reached or the integrated value reaches the maximum, whichever is first. The instrument holds the integration value and integration time of the stop point.



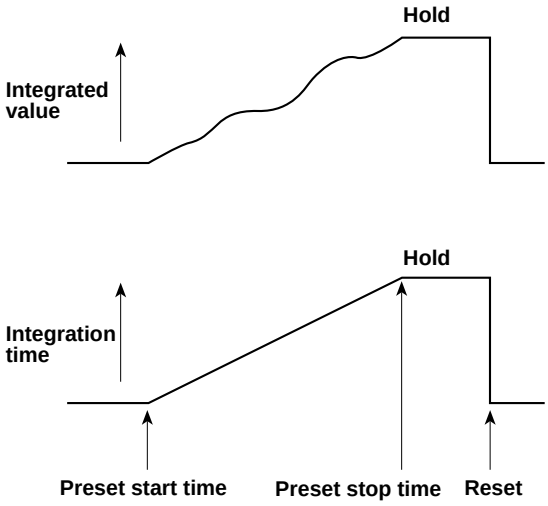
Continuous Integration Mode (Repeat Integration)

In this mode, integration starts when the START key is pressed. When the timer preset time is reached, the integrated value and integration time are reset automatically and restarted immediately. This is repeated continuously until the STOP key is pressed. If the integrated value reaches the maximum before the timer preset time is reached, integration stops and the instrument holds the integration value and integration time.



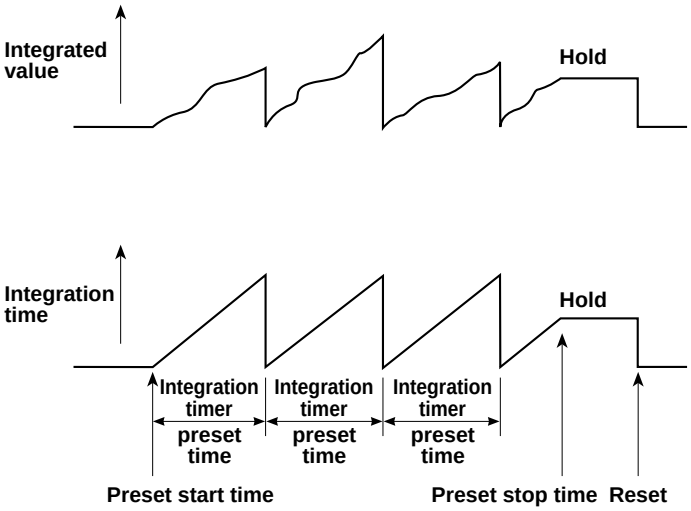
Real Time Counting Standard Integration Mode

In this mode, integration start/stop time can be set to an actual time. Integration starts at the preset start time, and it stops when the preset stop time is reached or the integrated value reaches the maximum. The instrument holds the integrated value and integration time of the stop point. If preset time has been set on the integration timer and this preset time is reached before the preset stop time is reached, the instrument will hold the integrated value and integration time.



Real Time Counting Continuous Integration Mode (Repeat Integration)

In this mode, integration start/stop time can be set to an actual time. Integration starts at the preset start time, and is repeated at intervals (timer preset time) until the preset stop time is reached. When the timer preset time is reached, the integrated value and integration time are reset automatically and restarted immediately. When the preset stop time is reached or the integrated value reaches the maximum, integration stops and the instrument holds the integrated value and integration time.



There are two ways to start, stop and reset integration.

For details, refer to the pages given below.

- Using the START, STOP and RESET keys (Integrator):
  refer to Section 8.3 "Displaying Integrated Value" (8-10).

- Using GP-IB/RS-232-C commands:
  refer to Sections 15.2 "Using the GP-IB Interface" (page 15-4) and 15.3 "Using the RS-232-C Interface" (page 15-7).

Display Update Rate (Sample Rate)

Once integration is started, it is not possible to change the display update rate during integration. If the RATE key is pressed in an attempt to change the display update rate during integration, an error code "Err 13" will be displayed.

Note

- If the display update rate is set to 100 ms (refer to page 4-2), integration cannot be started and an error code "Err 16" will be displayed. Thus, make sure that the display update rate is set above 250 ms.

Integration Method

Computing equations are given below. The results are converted to time before they are displayed.

Power integration		$\sum_{i=1}^{n} v_i \cdot i_i$
Current integration	RMS	$\sum_{I=1}^{N} A_I$
	MEAN	$\sum_{I=1}^{N} A_I$
	DC	$\sum_{i=1}^{n} i_i$

V_i, I^i: Instantaneous voltage, current data

n: No. of samples

A_i: Measured current value for each display update cycle

N: No. of updates

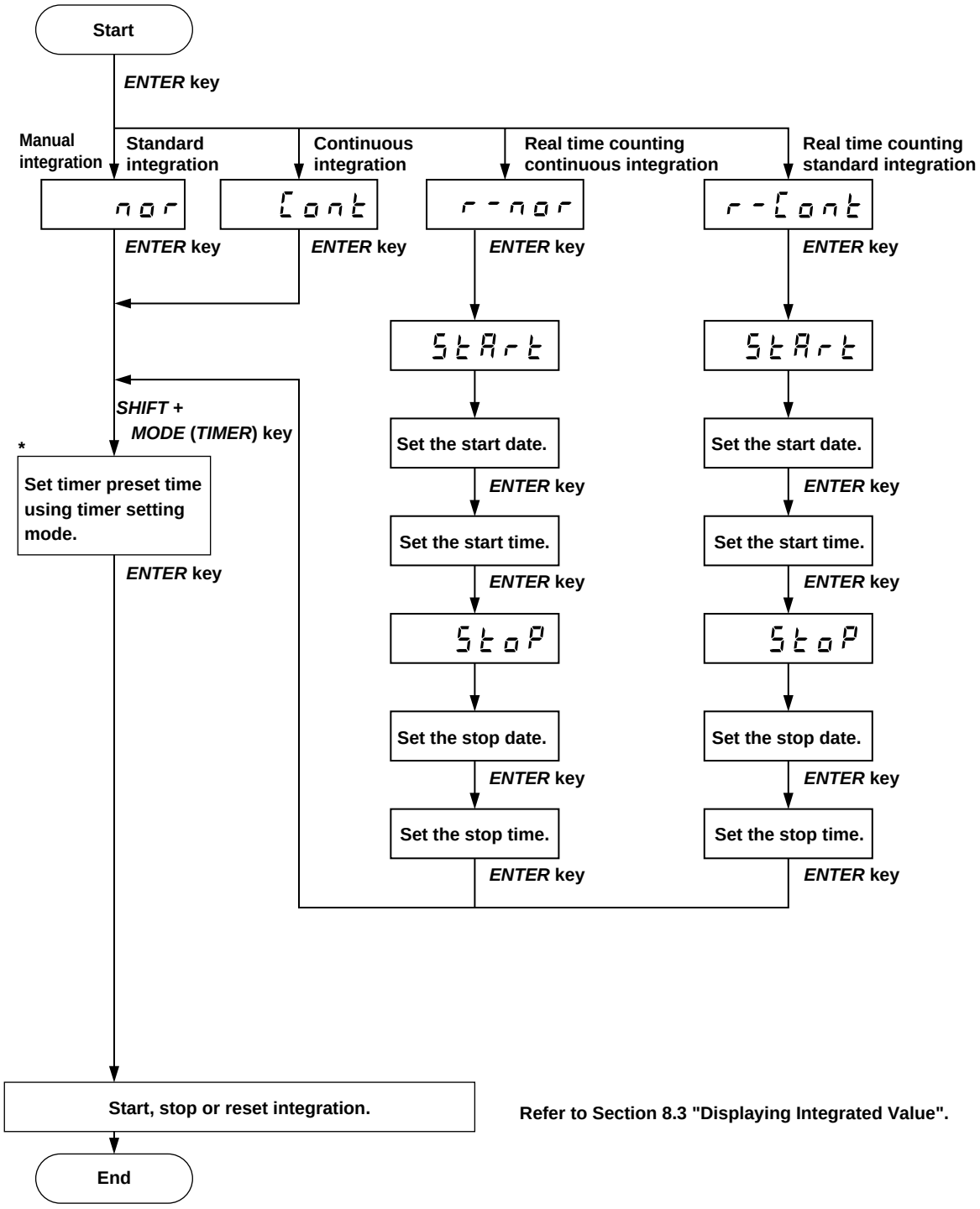
If DC has been selected for power integration and measurement mode, current integration will be performed on instantaneous power and instantaneous current. If RMS or MEAN has been selected as the measurement mode, integration will be performed on the current value measured for each display update cycle. A description is given for polarity integration. Ah+ and Ah– are used when the measurement mode is DC.

Wh+ : Performs integration on instantaneous power with both Vi and Ii being positive.
Wh– : Performs integration on instantaneous power with both Vi and Ii being negative.
Ah+ : Performs integration on instantaneous power with Ii being positive.
Ah– : Performs integration on instantaneous power with Ii being negative.

Note

- The integration results may differ from those obtained by another instrument having a different integration method, if load fluctuates considerably.

Flow of Operations



Refer to Section 8.3 "Displaying Integrated Value".

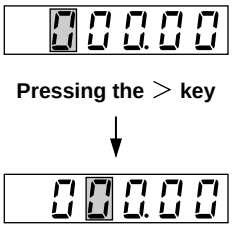
* If you are using manual integration mode, set the timer preset time to "000" hour and "00" minute.

Common Operations for All Integration Modes (Setting the Date, Time and Integration Timer)

Shifting the Blinking Position

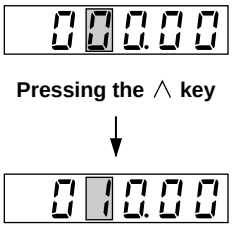
The blinking position can be shifted to the left or right by pressing the < or > key. Pressing the < key causes the digit to the left of the currently blinking digit to blink, and pressing the > key causes the digit to the right of the currently blinking digit to blink. The blinking position wraps around in both directions.

Display



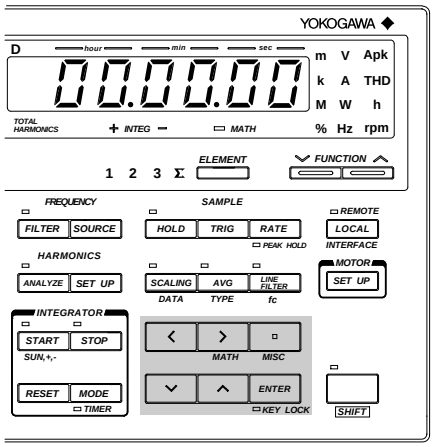
Setting a Value

To set a value of the blinking digit, press the ∧ or ∨ key. Pressing the ∧ key changes the value in the order 1, 2, 3 ... 9, 0 and back to 1. However, in the time setting, the value of the second lowest digit changes in the order 1, 2, 3, 4, 5, 0 and 1. Pressing the ∨ key changes the value in the opposite direction.



Confirming Entry

After setting the date (or time or integration timer), press the **ENTER** key.



Display Resolution during Integration

The display resolution for integrated values is 300000 counts. The decimal point shifts automatically according to the elapsed time of integration, constantly maintaining high measurement accuracy.

The decimal point shifting timing is determined automatically according to the selected voltage and current measuring ranges. After the rated value is set for both voltage and current measuring ranges, the decimal point shifts when the integrated value exceeds 300000 counts. However, the minimum measurement unit is 1/1000 times the power range which is determined by the rated voltage and current ranges, and the maximum measurement unit is "MWh". For instance, the elapsed time of integration and integrated value are displayed as follows when the voltage and current measuring ranges are 100 V and 5 A respectively.

Elapsed Time			Integrated Value	
H	M	S		
		0	0.00000	mWh
		2	277.778	mWh
		3	416.67	mWh
		⋮		
		7	972.22	mWh
		8	1.11111	Wh
		⋮		
		21	2.91667	Wh
		22	3.0556	Wh
		⋮		
	3	36	30.0000	Wh
	3	37	30.139	Wh
		⋮		
1	0	0	500.00	Wh
		⋮		
2	0	0	1.00000	kWh
		⋮		
6	0	0	3.00000	kWh
		⋮		
10	0	0	5.0000	kWh

Current Integration

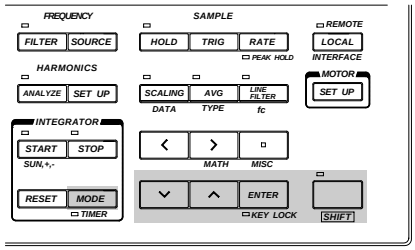
- As explained earlier, there are three measurement modes for measurement of current; RMS, MEAN and DC. Likewise, there are three types of current integration, corresponding to the three types of measurement. (Refer to Section 8.1 "Overview of Integrator Functions" (page 8-4).) When the measuring mode is DC, the polarity is also displayed. This feature is convenient for measuring battery charging/discharging.
- If the current measuring range is RMS or MEAN and the input current is below 0.5% of the rated value of the range, integration will be carried out with the input current considered to be "0".

8.2 Setting Integration Modes (Optional)

Setting Integration Mode and Integration Timer

Setting the Mode

1. Press the MODE key.
"InTEG" will be displayed on display A. The currently selected integration mode is displayed on display B. Pressing the ∧ key changes the mode in the following order, and pressing the ∨ key changes it in the opposite direction.



Display B	Description
nor (default)	Manual or standard integration mode
Cont	Continuous integration mode
r-nor	Real time counting standard integration mode
r-Cont	Real time counting continuous integration mode

After the desired integration mode has been selected, press the ENTER key.

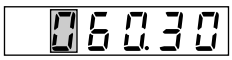
2. If "r-nor" (real time counting standard integration mode) or "r-Cont" (real time counting continuous integration mode) is selected as integration mode, the following will be displayed on each display.

Display A	Display B	Display C	Display D
r-nor (Real time counting standard integration mode)	StArt	96.01	00.00.00
	StoP	96.01	00.00.00
r-Cont (Real time counting continuous integration mode)	StArt	96.01	00.00.00
	StoP	96.01	00.00.00

Setting the Timer Preset Time

3. Press the TIMER key (SHIFT + MODE.)
The timer setting mode is now in operation. The time currently set will be displayed on display A, with the digit on the extreme left blinking, and the INTEG TIMER indicator LED will light up.

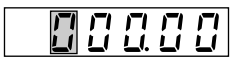
Display A



hours **minutes**

4. Set the desired time as follows.
Press the < or > key until the digit for which you wish to set a value is blinking, then press the < or > key to set the desired value. Refer to Section 8.1 "Overview of Integrator Functions" (page 8-6). (When using manual integration mode, set the time to "000.00".)
Maximum time allowed: 999 (hours) 59 (minutes)

Display A



hours **minutes**

5. When the desired time has been set, press the ENTER key.
The TIMER indicator LED located below the MODE (TIMER) key will be lit, indicating that the time has been confirmed.

Integration Using Real Time Counting Standard Integration Mode (r-nor) or Real Time Counting Continuous Integration Mode (r-Cont)

When real time counting continuos mode is used, an error occurs if integration is started with the timer preset time set to "000.00".

Setting the Start and Stop Date and Time

Setting the Start Date

Display C

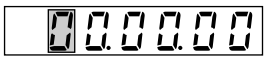
year month day

1. "StArt" is displayed on display B and the start date currently set is displayed on display C. Use the ∧, ∨, < and > keys to set the desired start date.
   Refer to Section 8.1 "Overview of Integrator Functions" (page 8-6).

2. Press the ENTER key.

Setting the Start Time

Display D



hours minutes second

3. The start time currently set is displayed on display D. Use the ∧, ∨, < and > keys to set the desired start time.

4. Press the ENTER key.
   "StoP" is now displayed on display B.

Setting the Stop Date

Display C

5. The stop date currently set is displayed on display C. Use the ∧, ∨, < and > keys to set the desired stop date.

6. Press the ENTER key.

Setting the Stop Time

Display D

7. The stop time currently set is displayed on display D. Use the ∧, ∨, < and > keys to set the desired stop time.

8. Press the ENTER key.

When both start and stop times have been set, set the timer preset time as described in "Setting the Timer Preset Time" on the previous page.

Note

- If the stop date or time is before the start date or time, an error code "Err 12" will be displayed. It is not possible to set a stop date or time that is before the start date or time.
- Years whose final two digits are less than "96" will be treated as 21st century years.

00	∅	2000
⋮	⋮	⋮
95	∅	2095
96	∅	1996
⋮	⋮	⋮
99	∅	1999

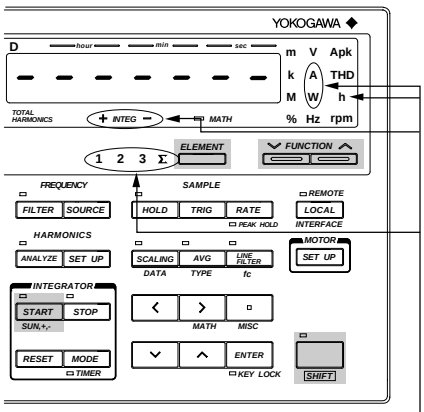
8.3 Displaying Integrated Value (Optional)

Function Setting

Operating the FUNCTION Key

Press the FUNCTION key below display A to light up the **INTEG TIME** indicator LED.

Press the FUNCTION key below display D to select **Wh** or **Ah**. For details, refer to Section 4.3 " Selecting What to Display on Digital Displays " (page 4-10.)



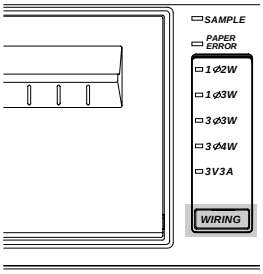
Lights up.

Operating the ELEMENT Key

Press the ELEMENT key below display D to select the element to be measured. For details, refer to Section 3.2 "Setting Wiring System" (page 3-2.)

Setting WIRING System

Press the WIRING key to select the correct wiring system. For details, refer to Section 3.2 "Setting Wiring System" (page 3-2).

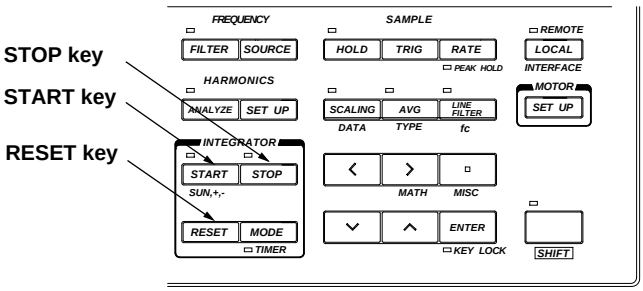


Displaying Polarity of Integration

Polarity can be changed each time the SUM, +, − key (SHIFT + START) is pressed. When + or - is selected, the corresponding polarity indicator LED below display D lights up.

Starting, Stopping and Resetting Integration

The elapsed time of integration is displayed on display A, and the integrated value is displayed on display D.



Starting Integration

Press the START key.

Integration will start. Make sure that the START indicator LED is lit. In real time counting standard or continuous mode, the START indicator LED blinks, indicating that the instrument is in standby state. (Integration will start automatically when the start date and time is reached.) If the stop date and time has already passed, integration will not start even if the START key is pressed, and an error code "Err48" will be displayed.

Stopping Integration

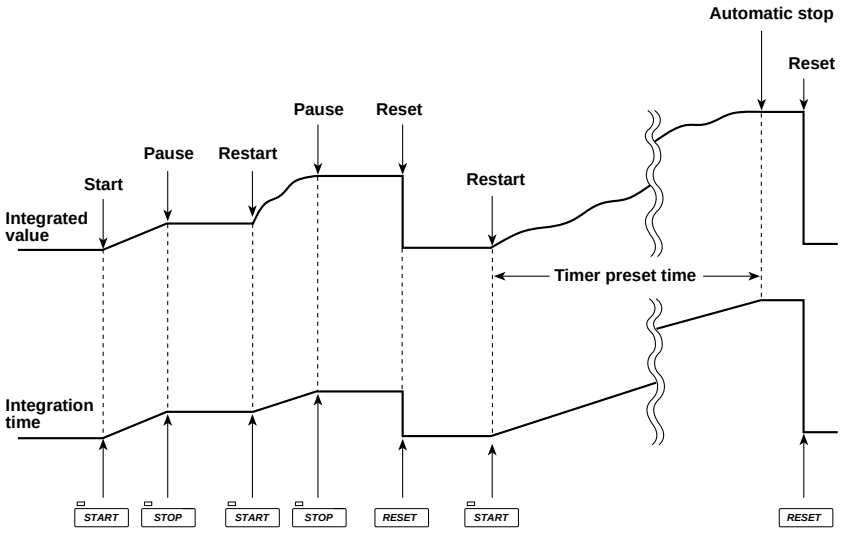
Press the STOP key.

- If the STOP key is pressed while integration is in progress, integration will be paused. The instrument holds the integration time and integrated value of the stop point until the START key is pressed again.
- The STOP indicator LED lights up when the STOP key is pressed.
- When the integrated power reaches the maximum, integration will stop and the instrument holds the integrated value and integration time.

Resetting Integration

Press the RESET key after integration has been stopped.

- The integrated value and integration time will be reset.



Integration Overflow Display

If the integrated value reaches the maximum (±999999 MWh or ±999999 MAh), integration will stop and the instrument will hold that value.

Holding the Integrated Value

Pressing the HOLD key during integration will light up the HOLD indicator LED and hold the integrated value of the time at which the HOLD key is pressed. To update the displayed value, press the TRIG key. For details, refer to Section 8.4 "Precautions Regarding Use of Integrator Function" (page 8-12.)

Displaying the Polarity of the Integrated Value

Integrated active power sometimes decrease in the case of battery discharge. If the integrated power is negative, "–" will be displayed in front of the integrated value.

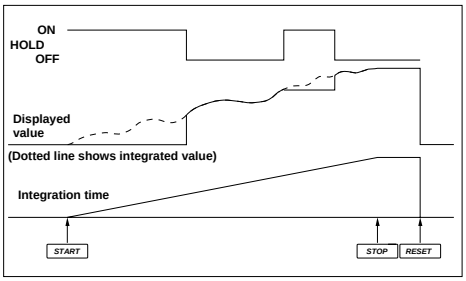
8.4 Precautions Regarding Use of Integrator Function (Optional)

Integration When Display Hold is ON

When the HOLD key has been pressed to activate the display update hold function, i.e. when the HOLD indicator LED is lit, integrated values displayed and output through a communications interface are on hold, but integration is still carried out whether the display update hold function is ON or OFF. The SAMPLE indicator LED continues to blink.

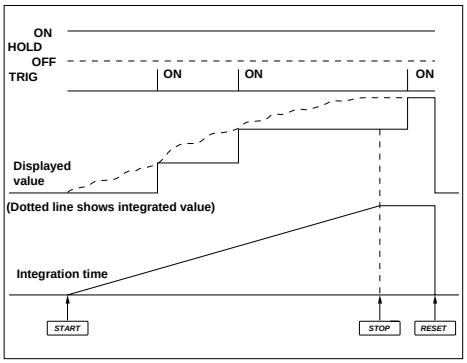
- As shown in Fig. (a), if integration is started while the display update hold function is ON, the displayed integrated value remains unchanged. However, as soon as the display update hold function is turned OFF or the TRIG key is pressed, the integrated value accumulated up to that moment will be displayed.

Fig. (a)



- As shown in Fig. (b), if integration is stopped while the display update hold function is ON, the displayed integrated value remains unchanged. However, as soon as the display update hold function is turned OFF or the TRIG key is pressed, the integrated value obtained when the STOP key was pressed will be displayed.

Fig. (b)



Backup During Power Failures

If there is a power failure while integration is in progress, the integrated value and integration time will be backed up.

- In this case, integration will remain stopped even if power is restored or the START key is pressed. To restart integration, first press the RESET key to cancel integration, then press the START key.
- When power is restored after a power failure, the integrated value and elapsed time of integration up to the time of the power failure will be displayed.

Panel Key Operation During Integration Mode

During integration mode, certain key operations are restricted so that settings are not accidentally changed when operating keys are pressed. The table below show these restrictions.

Operation key		Integration stopped	Integration in progress: Integration state	Integration in progress: Integration paused
	(START LED)	Not lit	Lit	Not lit
	(STOP LED)	Not lit	Not lit	Lit
MODE	***RMS,MEAN,DC***	○	V : × A : ×	V : × A : ×
	AVG	○	×	×
	SCALING	○	○	○
SAMPLE	***HOLD***	○	○	○
	TRIG (display update hold ON)	○	○	○
	RATE	○	×	×
RANGE	***VOLTAGE AUTO*** <, >	○	×	×
	CURRENT AUTO <, >	○	×	×
LINE FILTER		○	×	×
FILTER		○	○	○
DATA SETTING	***SCALING (DATA)*** ***MODE (TIMER)*** ∧, ∨, <, > ***ENTER***	○	○ In the case of the ***TIMER*** key, key operation is not possible, but the timer preset time can be displayed.	○ In the case of the ***TIMER*** key, key operation is not possible, but the timer preset time can be displayed.
FUNCTION (Displays A, B, C, D)		○	○	○
WIRING SYSTEM	***WIRING***	○	○	○
INTEGRATOR	***START***	○	×	○
	STOP	×	○	×
	RESET	○	×	○

∞ : Key operation is not possible.
● : Key operation is possible.

- Error code "Err 13, 42, 44, 45" will appear on display D if any key that cannot be operated is pressed.
- It is not possible to reset the integrated value while integration is in progress. To reset the integrated value, press the STOP key to interrupt integration, then press the RESET key.
- To use keys whose operation is invalidated while integration is in progress, press the STOP key to interrupt integration, then press the RESET key to reset the displayed integrated value.
- If integration is started while auto range setting mode is active, the range setting mode will be switched to manual range setting mode, but the measuring range will remain unchanged.

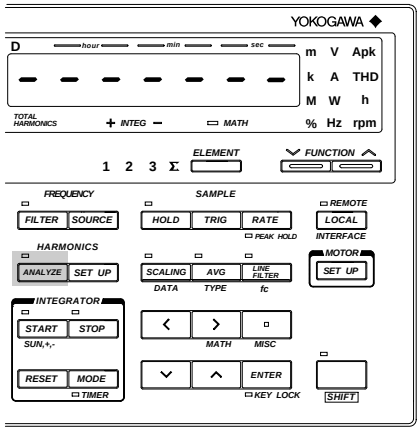
9.1 Operating the Harmonic Analysis Function (Optional)

To operate the harmonic analysis function from within a normal measurement operation, you have to set the harmonic analysis mode first, then make PLL source (input to be used as the fundamental frequency), display type and harmonic order settings.

Setting the Harmonic Analysis Mode

Operating the ANALYZE key

Press the ANALYZE key. The ANALYZE indicator LED will light up, indicating that the harmonic analysis mode is activated.
To return to the normal measurement mode, press the ANALYZE key once more. The ANALYZE indicator LED will go out, indicating that the normal measurement mode is now active.



In the harmonic analysis mode, RMS mode is always selected as the measuring mode. Even if the mode is switched from the harmonic analysis mode to the normal measurement mode, RMS mode stays as the measuring mode.

Note

- It is not possible to activate the harmonic analysis mode while integration is in progress (i.e. START indicator LED: lit) or integration is being interrupted (i.e. STOP indicator LED: lit). If such attempt is made, an error "Err 13" will occur. In this case, press the STOP key (to interrupt integration) then RESET key, and finally press the ANALYZE key.
- It is not possible to start integration if the harmonic analysis mode is active. If such an attempt is made, an error "Err 16" will occur.

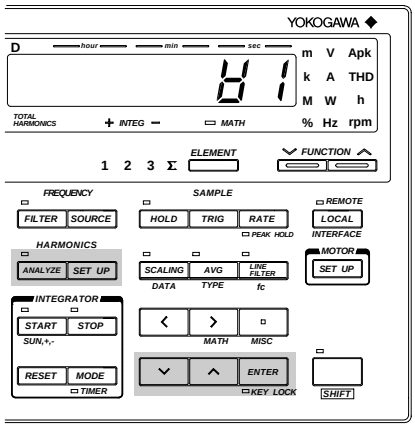
Setting the PLL Source

For harmonic analysis, it is necessary to select the input to be used as the fundamental frequency (PLL source) for PLL synchronization. (PLL stands for Phase Locked Loop.)

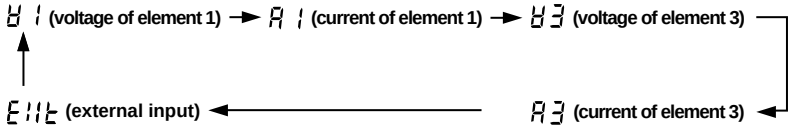
1. Press the SET UP key.
   Press the ∧ or ∨ key until "SYnC" is displayed on display C.

2. Press the ENTER key.

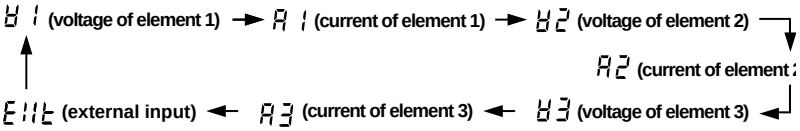
3. Pressing the ∧ or ∨ key changes the PLL source displayed on display D in the following order, so select the desired source. (Default is U1.)



Model 253620



Model 253630 or 253640



4. Press the ENTER key.

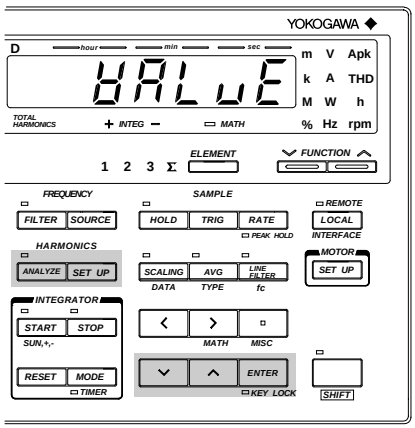
Note

- The PLL source has the same value as the frequency source to be measured (expect EXT). Thus, the frequency source to be measured will also be changed if the PLL source is changed.
- If the fundamental frequency of PLL source cannot be measured due to fluctuations or distortions, it is not possible to obtain correct measurement results. In this case, it is suggested voltage with relatively small distortion be selected as the PLL source or turn the filter ON.
- If the amplitude of the input signal selected as the PLL source is smaller than the rated range value, PLL synchronization may sometimes fail. In this case, it is suggested a suitable measurement range be selected so that the input level exceeds 30% of the rated range value.
- If there is no input for the PLL source, "FrqErr" will be displayed on display B.

Setting the Display Type

The fundamental component and each harmonic component of voltage, current or active power is displayed on display B. They are displayed either as measured value or relative harmonic content, so it is necessary to select either measured value or relative harmonic content beforehand. This setting can be made on display D.

1. Press the **SET UP** key.
   Press the ∧ or ∨ key until "dISP" is displayed on display C.
2. Press the **ENTER** key.
3. Pressing the ∧ or ∨ key changes the display type displayed on display D in the following order, so select the desired type.
   VALUE (displays measured value) ∅ CONT (displays relative harmonic content) ∅ VALUE ∅ . . .
4. Press the **ENTER** key.



The equation used to calculate the harmonic content is given below.

$$\text{Harmonic content} = \frac{\text{Each harmonic component}}{\text{Fundamental component}} \times 100\ (\%)$$

Note

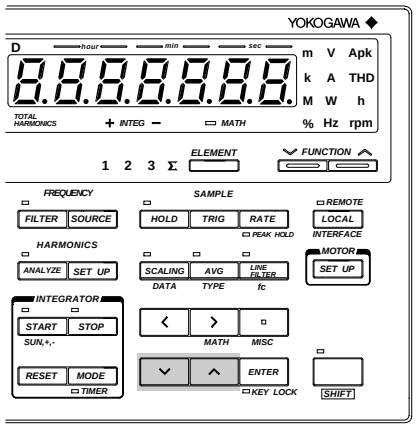
- If relative harmonic content is selected, "------" will be displayed on display B if harmonic order 1 (fundamental) has been selected.
- When "CONT" is selected, the % LED on display B will light up.

Setting the Harmonic Display Order

Display A is used to select the order of the harmonic data to be displayed on display B and C.

Operating the ∧ or ∨ Key

Press the ∧ and ∨ keys to select the order of the harmonic data to be displayed on display B or C. Orders from the 1st to the one set in "Setting the Upper Limit of the Harmonic Order" (page 9-4) can be set (maximum order: 50th).



However, due to the fundamental frequency of the PLL source becoming large or from turning the anti-aliasing filter to ON, the Maximum analysis order changes, sometimes resulting in the upper limit of the harmonic order to become larger than the Maximum analysis order. In this case, if the display order is set to a value between the Maximum analysis order and the upper limit of the harmonic order, "------" will be displayed on display B or C.

For details of the maximum order, refer to Section 17, "Specifications".

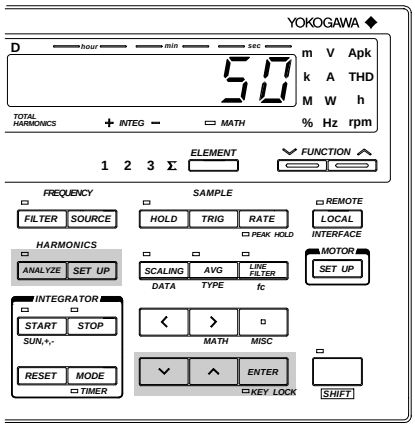
Note

- The **ELEMENT** and **FUNCTION** keys located below display A can be used to decrease (**ORDER DOWN**) and increase (**ORDER UP**) the harmonic order respectively. However, it is not possible to change harmonic order fast.

Setting the Upper Limit of the Harmonic Order

The upper limit of the harmonic order can be set as follows. This setting will be reflected in the equations used to calculate fundamental wave + harmonics and harmonic distortion for voltage, current and power.

Operating the SET UP Key



1. Press the SET UP key.
   Press the ∧ or ∨ key until "order" is displayed on display C.
2. Press the ENTER key.
3. Pressing the ∧ or ∨ key changes the harmonic order displayed on display D in the following order, so select the desired upper limit of the harmonic order.
   50 ∅ 1 ∅ 2 ∅ 3 ∅ . . . ∅ 49 and back to 50
4. Press the ENTER key.

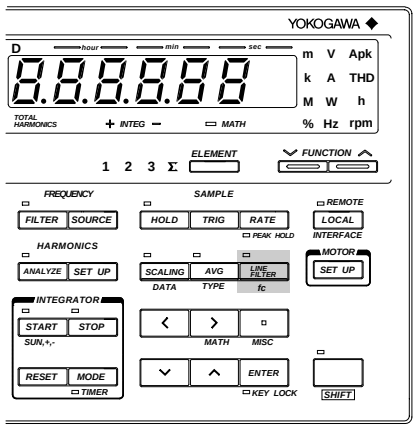
An order from 1st to 50th can be set.
If the maximum harmonic order determined by the anti-aliasing filter is smaller than the upper limit of the harmonic order, "------" will be displayed on display B or C for the harmonic display order exceeding the maximum harmonic order determined by the anti-aliasing filter.
For details of the maximum order, refer to Section 17, "Specifications".

Setting the Anti-aliasing Filter

When waves are input continuously and converted to digital data using A/D converter, if a wave having a frequency of less than 1/2 of the sampling frequency is input, this wave is recognized as a wave in low-frequency band that does not exists. This symptom is known as aliasing. Aliasing causes various problems, including an increase in measurement error and improper measurement of the phase angle. To prevent this aliasing, an anti-aliasing filter is used.

Operating the LINE FILTER key

Press the LINE FILTER key once. The FILTER indicator LED will light up, indicating that the anti-aliasing filter is active.
To deactivate the filter, press the LINE FILTER key once more. The FILTER indicator LED will go out, indicating that the filter is not active any more.
If the anti-aliasing filter is active, analysis accuracy and the maximum harmonic order change. For details, refer to Section 17, "Specifications".



Note

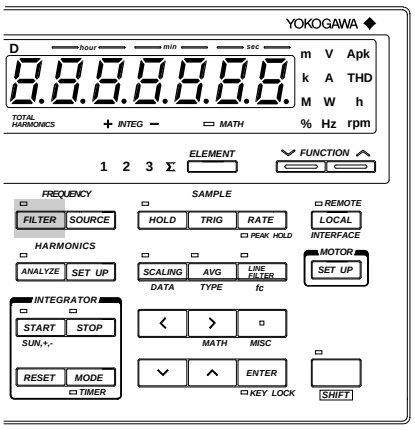
- Setting of the anti-aliasing filter is only possible in harmonic analysis mode. The anti-aliasing filter is not the same as the filter used in the normal measurement mode, and the ON/OFF state of each filter is maintained independently.
- The anti-aliasing filter's cut-off frequency is fixed at 6.5 kHz.
- For details of the sampling frequency, refer to Section 17, "Specifications".

Measuring with Frequency Filter ON

Harmonic analysis may not function properly if the PLL source wave contains harmonics or noise. In this case, it is recommended that the frequency filter be turned ON to eliminate such harmonics or noise during harmonic analysis.

Operating the FILTER Key

Press the FILTER key. The FILTER indicator LED will light up, indicating that the filter is ON.
To turn the filter OFF, press the FILTER key again.



Measuring Using the External Sample Clock

Measurement can be carried out using the external sample clock when the fundamental frequency is between 0.5 Hz and 20 Hz.

CAUTION **Never apply a voltage exceeding the TTL level to the EXT SAMPLE CLK terminal, otherwise damage to the instrument will result.**

1. Select "EXT" as the PLL source.
   For details, refer to Section 9.1, "Operating the Harmonic Analysis Function" (page 9-2).

2. Connect the external sample clock having TTL level (L: 0 to 0.8 V, H: 2 to 5 V), 50% duty and frequency of 2048 times the fundamental frequency between the EXT SAMPLE CLK terminal and GND terminal provided on the rear panel.

9.2 Selecting What to Display on Digital Displays (Optional)

Harmonic analysis results are displayed on displays A, B, C and D.
The information to be displayed on each display can be selected with the FUNCTION key and ELEMENT key below the display.

Operating the FUNCTION Key

This key is used to set the function to be displayed. Some functions (those which are not shown below and on the following pages) cannot be set in harmonic analysis mode. If a function which cannot be set in harmonic analysis mode has been set in the normal measurement mode, V (voltage) will be selected automatically.
V (voltage) will be also selected automatically if the mode is switched from harmonic analysis mode back to normal measurement mode or if a function which cannot be set in the normal measurement mode has been set.

Operating the ELEMENT Key

This key is used to set the element to be displayed.

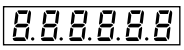
Default Function and Element

When the mode is switched from normal measurement mode to harmonic analysis mode, settings made in normal measurement mode will be retained, except for filter setting. This also applies when the mode is switched from harmonic analysis mode to normal measurement mode.

Information on Each Display

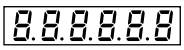
For details, refer to the next pages.

Display A



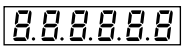
- The harmonic order of the measured/analysis data displayed on display B or C is displayed.

Display B



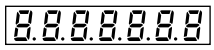
- The fundamental component and each harmonic component of voltage, current and active power are displayed as measured value or relative harmonic content.
- The slip, motor efficiency and total efficiency measured or calculated by the motor evaluation function (available with the WT1030M only) are displayed.

Display C



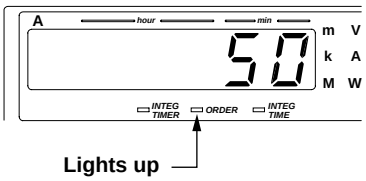
- The fundamental component and each harmonic component of voltage, current and active power are displayed as measured value are displayed.
- The reactive power, apparent powr and power factor of the fundamental (1st harmonic) are displayed.
- The phase angle between the fundamental of voltage and current, and phase angle of each higher harmonic in relation to the fundamental of voltage or current are displayed.
- The torque, synchronous speed and motor output obtained using the motor evaluation function (available with the WT1030M only) are displayed.

Display D



- The voltage, current and active power of fundamental + higher harmonics are displayed.
- The fundamental frequency of the input set as the PLL source is displayed.
- The harmonic distortion (THD) of voltage and current is displayed.
- The rotating speed obtained using the motor evaluation function (available with the WT1030M only) is displayed.

Display A



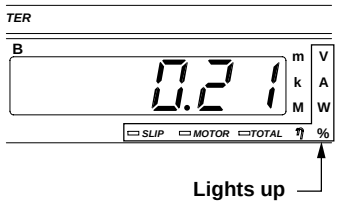
The harmonic order of the data displayed on display B or C is displayed. Orders from the 1st up to the upper limit of the harmonic order (maximum: 50th) can be displayed.

However, due to the fundamental frequency of the PLL source becoming large or from turning the anti-aliasing filter to ON, the Maximum analysis order changes, sometimes resulting in the upper limit of the harmonic order to become larger than the Maximum analysis order. In this case, if the display order is set to a value between the Maximum analysis order and the upper limit of the harmonic order, "- - - - - -" will be displayed on display B or C.

Note

- For the order setting method, refer to Section 9.1 "Operating the Harmonic Analysis Function" (page 9-3.)

Display B

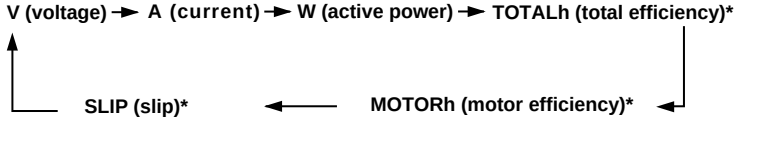


The following are displayed on display B.

- Fundamental component and each harmonic component of voltage corresponding to the harmonic order displayed on display A (as measured value or relative harmonic content)
- Fundamental component and each harmonic component of current corresponding to the harmonic order displayed on display A (as measured value or relative harmonic content)
- Fundamental component and each harmonic component of active power corresponding to the harmonic order displayed on display (as measured value or relative harmonic content)

In addition, the slip, motor efficiency and total efficiency obtained using the motor evaluation function (available with the WT1030M only) are also displayed.

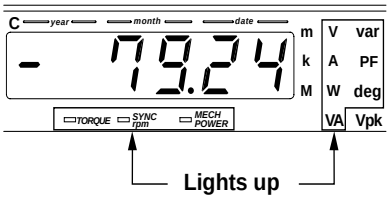
Information displayed on display B changes in the following order.



Note

- For display type setting method, refer to Section 9.1 "Operating the Harmonic Analysis Function" (page 9-3.)
- If MOTOR or TOTAL is selected, the % indicator LED will also light up to indicate that the data is displayed in units of %.

Display C

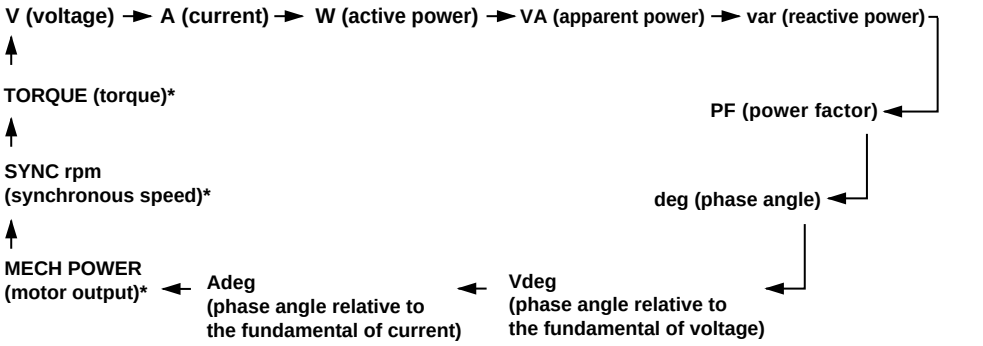


The following are displayed on display C.

- Fundamental component and each harmonic component of voltage corresponding to the harmonic order displayed on display A (as measured value)
- Fundamental component and each harmonic component of current corresponding to the harmonic order displayed on display A (as measured value)
- Fundamental component and each harmonic component of active power corresponding to the harmonic order displayed on display (as measured value)
- Reactive power of the fundamental (1st)
- Apparent power of the fundamental (1st)
- Power factor of the fundamental (1st)
- Phase angle between the fundamental of voltage and current
- Phase angle of each higher harmonic in relation to the fundamental of voltage or current

In addition, the torque, synchronous speed and mechanical power obtained using the motor evaluation function (available with the WT1030M only) are also displayed.

Information displayed on display C changes in the following order.



*** : Available with WT1030M only**

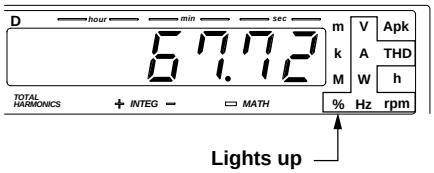
Note

- For a description of how to operate the display for the phase angle, refer to Section 9.6 "Displaying the Phase Angle between the Fundamentals" (page 9-12) or Section 9.7 "Displaying the Phase Angle of Each Higher Harmonic in Relation to the Fundamental of Voltage or Current" (page 9-13.)
- When VA, var, PF or deg is selected, "- - - - - -" will be displayed if an order other than 1st order is selected on display A.
- If MECH POWER is selected, the W indicator LED will also light up to indicate the units of the displayed motor output .

Display D

The following are displayed on display D.

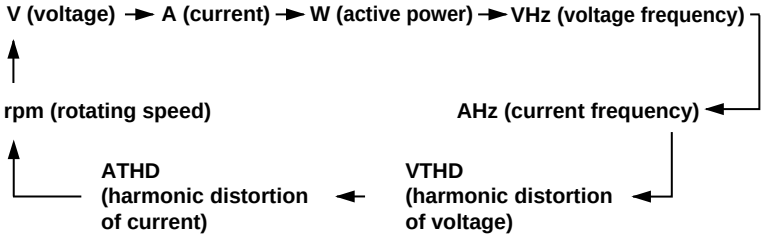
- Total rms value of voltage (regardless of the order displayed on display A)
- Total rms value of current (regardless of the order displayed on display A)



- Total rms value of active power (regardless of the order displayed on display A)
- Fundamental frequency of the input selected as the PLL source
- Harmonic distortion of voltage
- Harmonic distortion of current

In addition, the rotating speed obtained using the motor evaluation function (available with the WT1030M only) is also displayed.

Information displayed on display D changes in the following order.



Note

- For computing equations for voltage, current and active power, refer to Section 9.4 "Displaying Fundamental + Higher Harmonics of Voltage, Current and Active Power" (page 9-10.)
- For computing equation for relative harmonic distortion, refer to Section 9.5 "Displaying the Harmonic Distortion (THD)" (page 9-11.)
- If VTHD or ATHD is selected, the % indicator LED will also light up to indicate that the data is displayed in units of %.

Sample Rate

The sample rate is determined according to the input frequency of the function set as the PLL source.

Example

When input frequency is 50 Hz : 20 ms (50 Hz) x 16 cycles (window width) = 320 ms
When input frequency is 60 Hz : 16.67 ms (60 Hz) 16 cycles (window width) = 266.72 ms
When no input is present : 1 s (when PLL source is not "Line")
10 s (when PLL source is "Line")

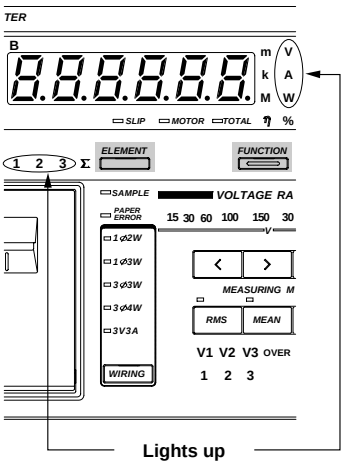
9.3 Displaying Fundamental and Each Harmonic of Voltage, Current, Active Power, Apparent Power, Reactive Power and Power Factor as Measured Value or Relative Harmonic Content (Optional)

The fundamental component and each harmonic component of voltage, current and active power are displayed as measured value or relative harmonic content on display B; they are displayed as measured value on display C. In addition, the fundamental component of reactive power, apparent power and power factor is also displayed.

Function Setting

1. Press the FUNCTION key below display B or C to select **V (voltage)**, **A (current)** or **W (active power)** for display, or press the FUNCTION key below display C to select **VA (apparent power)**, **var (reactive power)** or **PF (power factor)** for display.

For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (pages 9-7 and 9-8).

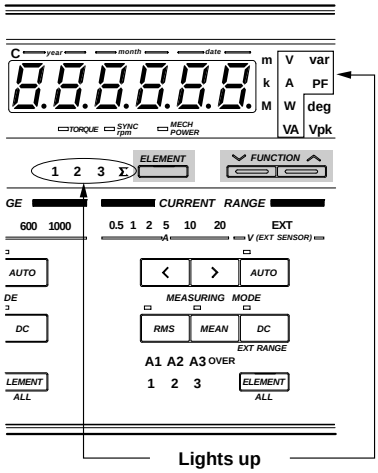


Setting Element to be Displayed

2. Press the ELEMENT key below display B or C

- Display B
  Select element 1, 2 or 3.
  However, Ý is effective only when the fundamental of V, A or W is selected.
- Display C
  Select element 1, 2, 3 or Ý.
  However, Ý is effective only when the fundamental of V, A, W, VA, var or PF is selected.

For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (page 9-6).



Setting the Harmonic Order

3. Set the harmonic order.
For details, refer to "Setting the Harmonic Order" (page 9-3).

Setting the Display Type

4. Use display D to set whether data is to be displayed as measured value or relative harmonic content.
For details, refer to Section 9.1 "Operating the Harmonic Analysis Function" (page 9-3).
This function is applicable only to display B. Data is always displayed as measured values on display C, regardless of the display type set in this step.

Note

- The minus sign will be displayed for var (reactive power) if the voltage is behind the current.
- In case the displayed active power value becomes less than -99999 on display B and C, the minus sign will not be displayed. However, in the printout and regarding the communications output, the minus sign will be present.

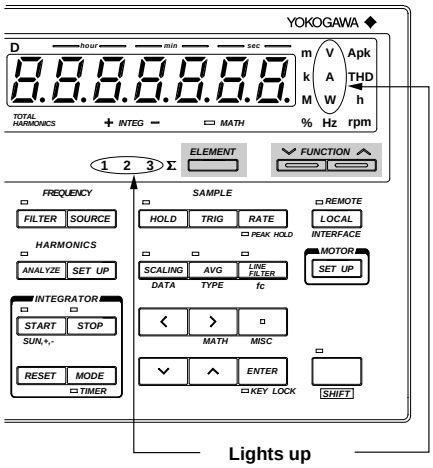
9.4 Displaying the Fundamental + Higher Harmonics of Voltage, Current and Active Power (Optional)

The fundamental and higher harmonics of voltage, current and active power are displayed on display D.

Function Setting

1. Press the FUNCTION key below display D to select **V (voltage)**, **A (current)** or **W (active power)** for display.

   For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (page 9-8.)



Setting the Element to be Displayed

2. Press the ELEMENT key below display D to select the element to be displayed: **1**, **2** or **3**.
   If Ý is selected, "**- - - - - -**" will be displayed on display D.

   For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (page 9-6).

Computing Equation

The fundamental + higher harmonics of voltage, current and active power are calculated using the following equation.

$$\text{V (voltage)} = \sqrt{\sum_{k=1}^{n} (V_k)^2} \qquad \text{A (current)} = \sqrt{\sum_{k=1}^{n} (A_k)^2} \qquad \text{W (active power)} = \sum_{k=1}^{n} W_k$$

V_k, A_k, W_k : Fundamental or harmonic component of voltage, current and active power
k : Analysis order
n : Maximum order. The maximum possible order varies according to the fundamental frequency of the input set as the PLL source and to whether the anti-aliasing filter is ON or OFF. If this maximum order is smaller than the preset order, the preset order will be used as the maximum order.

Note

- Total rms value (fundamental + harmonics) obtained in the harmonic analysis mode differs from that obtained in normal measurement mode. The total rms value in harmonic analysis mode is calculated from the fundamental component and the harmonics up to the maximum order as shown in the above equation.

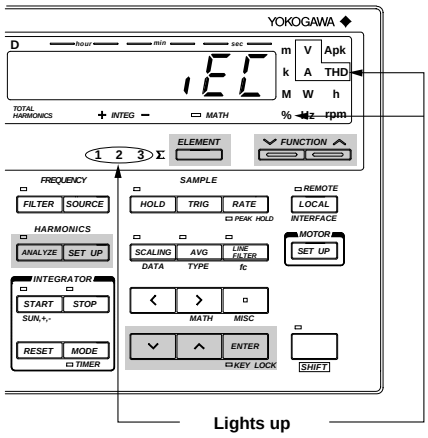
9.5 Displaying the Harmonic Distortion (THD) (Optional)

Harmonic distortion (THD) is displayed on display D.

Function Setting

1. Press the **FUNCTION** key below display D to select **VTHD (harmonic distortion of voltage)** or **ATHD (harmonic distortion of current)**.

For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (page 9-8).



Setting the Element to be Displayed

2. Press the **ELEMENT** key below display D to select the element to be displayed; **1**, **2** or **3**.

For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (page 9-6).

Computing Equation

Harmonic distortion (THD) is calculated using the following equation.

- ,EC : Calculates the ratio of the rms value of each component (from the 2nd to the nth) in relation to the fundamental (1st).
- CSA : Calculates the ratio of the rms value of each component (from the 2nd to the nth) in relation to the rms value of each component (from the 1st to nth).
  (n: Harmonic order set in "Setting the Harmonic Order")

3. Press the **SET UP** key.
Press the ∧ or ∨ key until "tHd" is displayed on display C.

4. Press the **ENTER** key.

5. The currently selected computing equation will be displayed on display D. Press the ∧ or ∨ key to select the desired equation (,EC or CSA).

6. Press the **ENTER** key.

Computation equation

When ,EC is selected:

$$\left[\sqrt{\sum_{k=2}^{n}(C_k)^2}\right] / C_1$$

When CSA is selected:

$$\left[\sqrt{\sum_{k=2}^{n}(C_k)^2}\right] / \left[\sqrt{\sum_{k=1}^{n}(C_k)^2}\right]$$

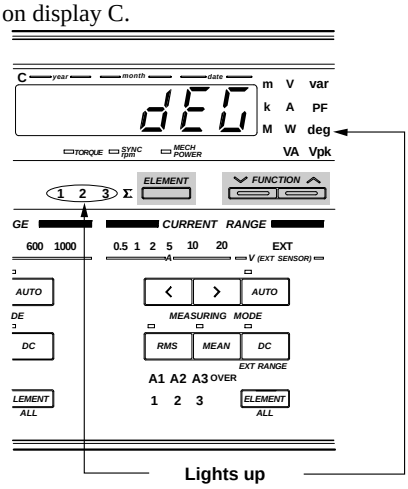
C_1 : Fundamental (1st) of V (voltage) or A (current)
C_k : Fundamental or harmonic component of V (voltage) or A (current)
k : Analysis order
n : Maximum order. The maximum order varies according to the fundamental frequency of the input set as the PLL source and to whether the anti-aliasing filter is ON or OFF. If this maximum order is smaller than the preset order, the preset order will be used as the maximum order.

9.6 Displaying the Phase Angle between the Fundamentals (Optional)

The phase angle between the fundamentals is displayed on display C.

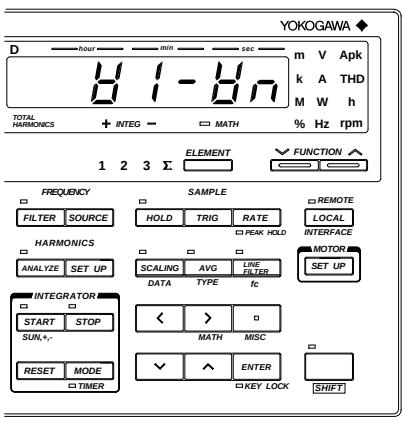
Function Setting

1. Press the **FUNCTION** key below display C to select **deg (phase angle)**.



Setting the Display Type

2. Press the **SET UP** key.
   Press the ∧ or ∨ key until "dEG" is displayed on display C.
3. Press the **ENTER** key.
4. Pressing the ∧ or ∨ key will change the symbol displayed on display D in the following order.



U1-Un	Phase angle of V1, V2*1 and V3 with respect to V1
U1-An	Phase angle of A1, A2*1 and A3 with respect to V1
A1-An	Phase angle of A1, A2*1 and A3 with respect to A1
U2-Un	Phase angle of V1, V2*1 and V3 with respect to V2*1
U2-An	Phase angle of A1, A2*1 and A3 with respect to V2*1
A2-An	Phase angle of A1, A2*1 and A3 with respect to A2*1
U3-Un	Phase angle of V1, V2*1 and V3 with respect to V3
U3-An	Phase angle of A1, A2*1 and A3 with respect to V3
A3-An	Phase angle of A1, A2*1 and A3 with respect to A3
U-U	*2
A-A	*2

- V1, V2 and V3 are fundamental components of the voltages of elements 1, 2 and 3 respectively.
- A1, A2 and A3 are fundamental components of the currents of elements 1, 2 and 3 respectively.
- If the ROM version is before 2.02, three display types, U1-Un → U1-An → A1-An , are available for selection.

*1 V2 and A2 can be applied to 253630 and 253640.

*2 Phase angles as indicated below are displayed depending on the elements selected in step 6.

Display type	Model	Phase angle displayed
U-U	253620	When element 1 is selected, phase angle of V3 with respect to V1
		When element 3 is selected, phase angle of V1 with respect to V3
	253630, 253640	When element 1 is selected, phase angle of V2 with respect to V1
		When element 2 is selected, phase angle of V3 with respect to V2
		When element 3 is selected, phase angle of V1 with respect to V3
A-A	253620	When element 1 is selected, phase angle of A3 with respect to A1
		When element 3 is selected, phase angle of A1 with respect to A3
	253630, 253640	When element 1 is selected, phase angle of A2 with respect to A1
		When element 2 is selected, phase angle of A3 with respect to A2
		When element 3 is selected, phase angle of A1 with respect to A3

5. Press the **ENTER** key.

Setting the Element to be Displayed

6. Select the element for the display method "n" set in step *4*.
   Press the ELEMENT key below display C to select the element to be displayed; **1**, **2** or **3**.

   For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (page 9-6).

Setting the Harmonic Order (to the Fundamental)

7. Set the harmonic order displayed on display A to "1". This causes display C to display the phase angle between the fundamentals.

   For details, refer to Section 9.1 "Operating the Harmonic Analysis Function" (page 9-3).

Setting Phase Angle Display Method

8. The phase angle of the display type selected in step 4 is displayed as phase lag in 360° display method.

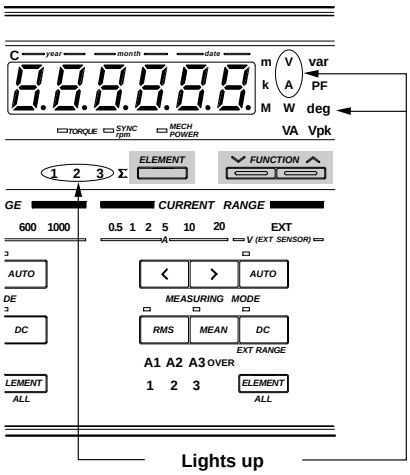
9.7 Displaying the Phase Angle of Each Higher Harmonic in Relation to the Fundamental of Voltage or Current (Optional)

The phase angle of each harmonic in relation to the fundamental of voltage or current is displayed on display C.

Function Setting

1. Press the FUNCTION key below display C to select **Vdeg** or **Adeg (phase angle)**.

For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (page 9-7).



Setting the Element to be Displayed

2. Press the ELEMENT key below display C to select which element is to be measured: **1**, **2** or **3**.

For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (page 9-6).

Setting the Harmonic Order

3. Press the ∧ or ∨ key below display D to set the harmonic order to any value between "2" and the upper limit of the harmonic order.
For details, refer to Section 9.1 "Operating the Harmonic Analysis Function" (page 9-3).
This sets which harmonic the phase angle refers to.
If the harmonic order is set to "1", the phase angle between the fundamentals of the same element will be displayed. In this case, the phase angle will be displayed in the phase angle display method set in "Setting Phase Angle Display Method" (page 5-7).

Display Method

Phase angle is displayed as follows based on the fundamental.

- **When the harmonic is in front of the fundamental:**
  0.00 to 180.00
- **When the harmonic is behind the fundamental:**
  0.00 to -180.00
- **When both phases are the same:**
  0.00

Note

- The ***ELEMENT*** and ***FUNCTION*** keys located below display A can be used to decrease ***(ORDER DOWN)*** and increase ***(ORDER UP)*** the harmonic order respectively. However, it is not possible to change harmonic order fast.

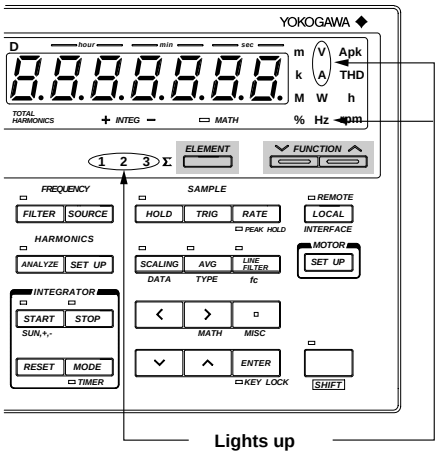
9.8 Displaying the Fundamental Frequency (Optional)

The fundamental frequency of the input selected as the PLL source is displayed on display D.

Function Setting

1. Press the FUNCTION key below display D to select **VHz (voltage frequency)** or **AHz (current frequency)** which has been selected as the PLL source.

For details, refer to Section 9.2 "Selecting What to Display on Digital Displays" (page 9-8).



Setting the Element

2. Select the same element here that has been selected as the PLL source in "Setting the PLL Source" (page 9-2).

"- - - - - -" will be displayed if a function or element which differs from the PLL source is selected.
If "SYNC" has been selected as the PLL source, the frequency of the source selected for measurement of frequency will be measured.

10.1 Using the Waveform Output Functions (Optional)

This function isolates the input voltage and current waveforms from the input signals, to enable observation of the waveforms using an oscilloscope.

WARNING

- **The connectors used in this function have protective covers. When the covers are removed or when using connectors, the voltage ratings across the measuring input and the ground become as follows:**
  Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.
  Voltage across V terminal and ground 600 Vrms max.
  Put the protective cover on the connector when this function is not used.

CAUTION

- **Never short-circuit the waveform output terminals or apply any external voltage to them, otherwise damage to the instrument may result.**

Connecting the Waveform Output Terminals

The waveform output terminals are included in the external input/output connector. Refer to Section 13.1, "External Input/Output Connector Pin Assignment", to connect the oscilloscope's ground to the GND pins (pins 1 and 19), then observe the waveform at the waveform output pins (pins 4, 5, 6, 22, 23 and 24).

Output Voltage

The output voltage is approximately 2 V when the rated input for the range is applied.

Output Method and D/A Conversion Speed

The input voltage/current waveform converted into digital values by the A/D converter in the input circuit is converted to an analog signal by the D/A converter, then output from the waveform output terminals. The conversion speed of the D/A is the same as that of the A/D converter in the input circuit. In normal measurement, it takes approximately 17 µs. For details of the conversion speed during harmonic analysis, refer to "Sampling speed" in "Harmonic Analysis", Section 17, "Specifications".

11.1 Wiring System for Motor Evaluation (WT1030M Only)

The motor evaluation function enables computation of torque, rotating speed, mechanical power, synchronous speed, slip, motor efficiency and total efficiency in addition to active power and frequency measured by this instrument, by inputting a DC voltage proportional to motor's torque or the number of pulses proportional to motor's rotating speed to this instrument via a torque meter or revolution sensor.

The analog input terminals for a torque meter and pulse input terminals for a revolution sensor are provided with the external input/output connector. Refer to Section, "13.1 External Input/Output Connector Pin Assignment" (page 13-1), and connect a torque meter or revolution sensor to the instrument as shown below.

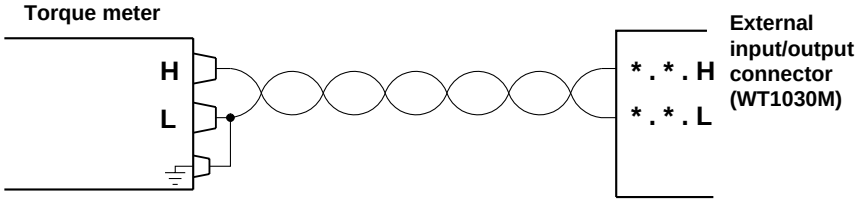
⚠ WARNING

- **The connectors used in this function have protective covers. When the covers are removed or when using connectors, the voltage ratings across the measuring input and the ground become as follows:**
  Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.
  Voltage across V terminal and ground 600 Vrms max.
  Put the protective cover on the connector when this function is not used.

⚠ CAUTION

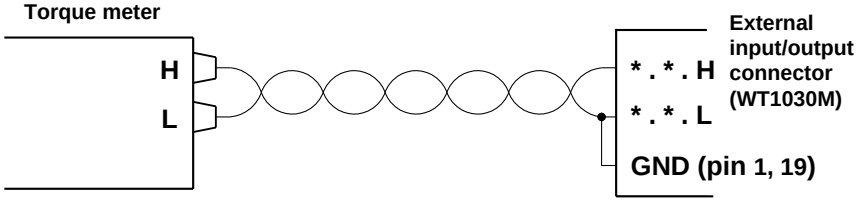
- **Do not apply a voltage exceeding ±14 Vpeak between the case and pin 25 (SPEED. PULSE. H), pin 26 (SPEED. ANALOG. H) or pin 27 (TORQUE. ANALOG. H) of the external input/output connector, otherwise damage to the instrument will result.**
- **Do not apply a voltage between the case and pin 7 (SPEED. PULSE. L), pin 8 (SPEED. ANALOG. L) or pin 9 (TORQUE. ANALOG. L) of the external input/output connector, otherwise damage to the instrument will result.**

- **When terminal L can be grounded at the output side:**



Connect terminal L to the ground at the output side. Make sure that the instrument is also grounded.

- When terminal L can NOT be grounded at the output side:



Connect terminal L to the ground pin (1, 19) of the external input/output connector.

11.2 Displaying Torque (WT1030M only)

To display torque, a DC voltage proportional to motor's torque must be input to the torque analog input terminals (pin 27: TORQUE.A.H, pin 9: TORQUE.A.L) of the external input/output connector of the instrument.
For a description of pin assignment of the connector, refer to Section, "13.1 External Input/Output Connector Pin Assignment" (page 13-1).

Computation equation

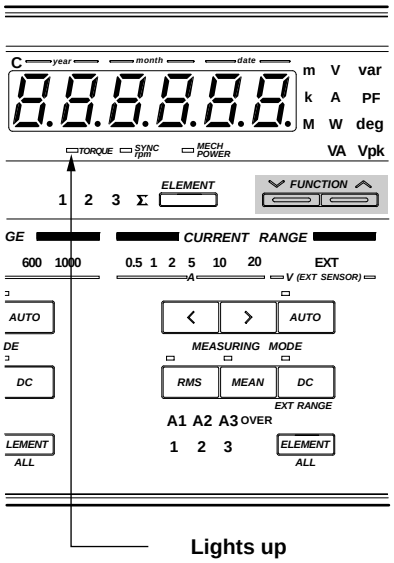
$$\text{Torque} = \text{Scaling value} \times \frac{\text{Input voltage from torque meter (V)}}{\text{10(V)}}$$

Scaling value : Torque indicated by the torque meter when 10 V is input to the torque analog input terminals

Input voltage from torque meter : DC voltage (proportional to the torque) input from the torque meter to the torque analog input terminals

Function Setting

1. Press the **FUNCTION** key below display C to select **TORQUE**.
   For a description, refer to Section 4.3, "Selecting What to Display on Digital Displays" (page 4-10).

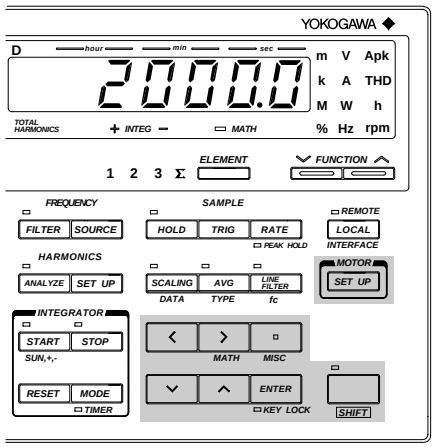


Setting the Scaling Value

Input torque obtained when 10 V is input to the torque analog input terminals.

2. Press the **SET UP** key.
   The symbol displayed on display B changes in the following order each time the ∧ key is pressed.
   trqUE ∅ rPM ∅ PoLE ∅ and back to trqUE
   Pressing the ∨ key causes the symbol to change in the opposite order.

3. When "trqUE" is displayed on display B, press the **ENTER** key.
   Display C displays "SCALE", with the digit on the extreme left on display D blinking.



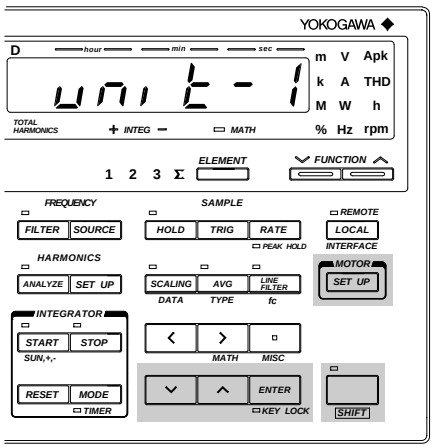
4. Set the desired scaling value.
   You can change the value at the blinking digit by pressing the ∧ or ∨ key. To shift the blinking position, press the < or > key. Set a value at each digit until the desired scaling value is set.
   Etting range : 0.0001 to 10000 (Unit of torque)
   Default :2000.0 (Unit of torque)

5. After the scaling value has been set, press the **ENTER** key.
   The currently selected units of torque will be displayed on display D.

Setting the Unit of Torque

6. Set the units of torque.
Press the ∧ or ∨ key until the desired units of torque is displayed. The units of torque displayed on display D changes as follows each time the ∧ or ∨ key is pressed.

unit-1 → unit-2 → ···
unit-7 → unit-8 →
unit-1 ···



Each symbol indicates certain units of torque as follows.

Symbol	Unit
unit-1	N·m
unit-2	kgf·m
unit-3	kgf·cm
unit-4	mN·m
unit-5	kN·m
unit-6	ftlb
unit-7	ozin
unit-8	lbin

unit-2,3,6,7 and 8 can be selected when /U1 option is used.

7. After the units of torque has been set, press the **ENTER** key.

8. To exit from setting mode in the middle of making settings, press the **SHIFT** key or **SET UP** key.

Note

- Unit of torque will not light up when torque is displayed.

11.3 Displaying the Rotating Speed (WT1030M Only)

To display rotating speed, a DC voltage proportional to motor's rotating speed must be input to the revolution sensor analog input terminals (pin 26: SPEED.A.H, pin 8: SPEED.A.L) of the external input/output connector of the instrument, or the number of pulses proportional to motor's rotating speed must be input to the revolution sensor analog input terminals (pin 25: SPEED.P.H, pin 7: SPEED.P.L) of the external input/output connector. The rotating speed is expressed in units of rpm. For a description of pin assignment of the connector, refer to Section, "13.1 External Input/Output Connector Pin Assignment" (page 13-1).

Computation equation

- When an analog signal (DC voltage) is output from the revolution sensor:

$$\text{Rotating speed} = \text{Scaling value} \times \frac{\text{Input voltage from revolution sensor (V)}}{\text{10 (V)}} \text{ (rpm)}$$

Scaling value : Rotating speed (rpm) indicated by the revolution meter when 10 V is input to the revolution sensor analog input terminals.

Input voltage from revolution sensor : DC voltage (proportional to the rotating speed) input from the revolution sensor to the revolution sensor analog input terminals.

- When pulses are output from the revolution sensor:

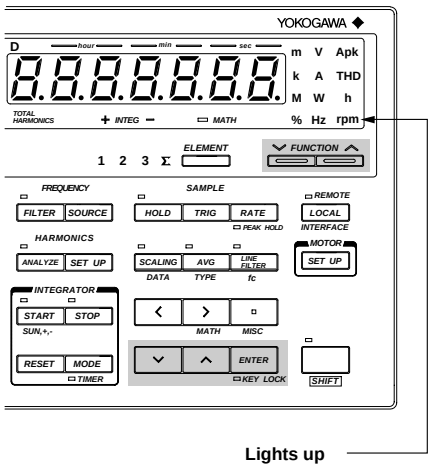
$$\text{Rotating speed} = 60 \times \frac{\text{Revolution sensor frequency}}{\text{Number of pulses}} \text{ (rpm)}$$

Revolution sensor frequency : Pulse frequency input from the revolution meter to the revolution sensor pulse input terminals

Number of pulses : The number of pulses input from the revolution meter to the revolution sensor pulse input terminals when the motor rotates once (For a description of how to set the number of pulses, refer to step *6* on the next page)

Function Setting

1. Press the **FUNCTION** key below display D to select **rpm**.
For a description, refer to Section 4.3, "Selecting What to Display on Digital Displays" (pages 4-10).



Selecting Analog Input or Pulse Input

2. Press the **SET UP** key.
The symbol displayed on display B changes in the following order each time the ∧ key is pressed.
torque ∅ rpm ∅ POLE ∅ and back to torque
Pressing the ∨ key causes the symbol to change in the opposite order.

3. When "rpm" is displayed on display B, press the **ENTER** key.

4. Press the ∧ or ∨ key to select the desired input type.
The input type changes in the order of "ANALOG" (analog input) ∅ "PULSE" (pulse input) and back to "ANALOG".

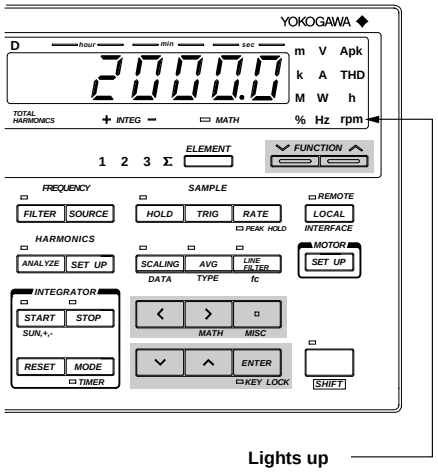
5. After the input type has been selected, press the **ENTER** key.

Setting the Scaling Value/Number of Pulses

If an analog signal is used for the input rotating speed, make sure that the rotating speed (scaling value) obtained when 10 V is applied is input to the revolution sensor analog input terminals. The unit is rpm.

If a pulse signal is used for the input rotating speed, make sure that the number of pulses obtained when the motor rotates once is input to the instrument.

6. Display D displays the scaling value or number of pulses, with the digit on the extreme left blinking. You can change the value at the blinking digit. Pressing the ∧ key changes the value in the order 1, 2, 3 ... 9, 0 and back to 1. Pressing the ∨ key changes the value in the opposite direction. The blinking position can be shifted to the left or right by pressing the < or > key respectively. To shift the decimal point, press the ▫ key.



The scaling value or number of pulses can be set within the following range.

Scaling value

Setting range	: ROM version before 2.01	0.0001 to 10000. (rpm)
	ROM version 2.01 or later	0.0001 to 70000. (rpm)
Default	: 10000. (rpm)	

Number of pulses

Setting range	: ROM version before 2.08	Integer from 1 to 1000
	ROM version 2.08 or later	Integer from 1 to 9999
Default	: 60	

After the scaling value or number of pulses has been set, press the ENTER key.

11.4 Displaying the Synchronous Speed (WT1030M Only)

Set motor's input voltage or current as the input to be used for frequency measurement. The synchronous speed is calculated using the measured frequency and motor's number of poles.

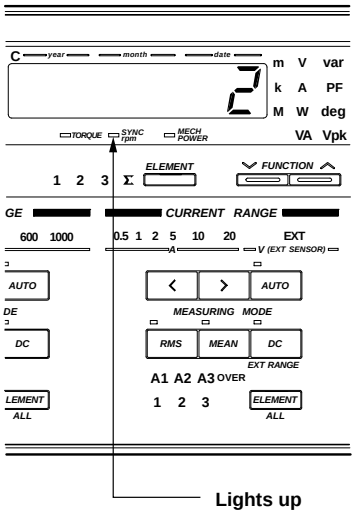
Computation equation

$$\text{Synchronous speed} = \frac{120 \times \text{Measured frequency (Hz)}}{\text{Motor's number of poles}} \text{ (rpm)}$$

Measured frequency : Motor's input voltage or current frequency to be measured by the frequency measurement function of the instrument

Function Setting

1. Press the **FUNCTION** key below display C to select SYNC rpm.
   For a detailed description, refer to Section 4.3, "Selecting What to Display on Digital Displays" (pages 4-10).



Setting the Number of Poles

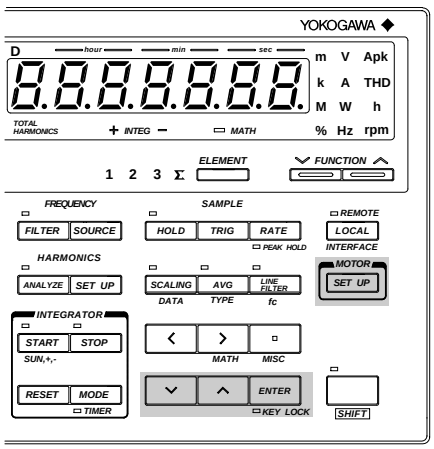
2. Press the **SET UP** key.
   The symbol displayed on display B changes in the following order each time the ∧ key is pressed.
   toruE ∅ rPM ∅ PoLE ∅ and back to toruE
   Pressing the ∨ key causes the symbol to change in the opposite order

3. When "PoLE" is displayed on display B, press the **ENTER** key.

4. The currently set number of poles will blink on display C.
   Press the ∧ or ∨ key to select the desired number of poles. Pressing the ∧ key changes the value in the order 2, 4, 6 ...96, 98 and back to 2. Pressing the ∨ key changes the value in the opposite direction.

   Setting range : Even values from 2 to 98
   Default : 2

   After the number of poles has been set, press the **ENTER** key.



11.5 Displaying the Slip (WT1030M Only)

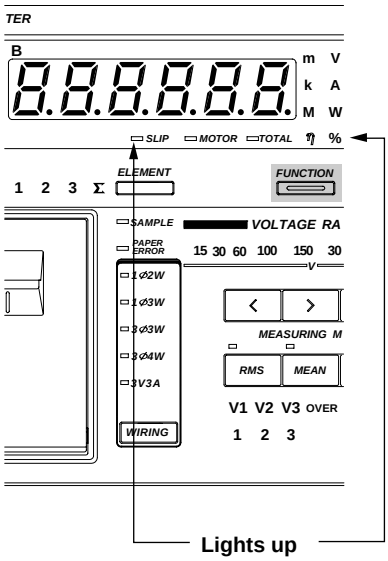
The slip is calculated using the rotating speed and synchronous speed.

Computation equation

$$\text{Slip} = \frac{\text{Synchronous speed (rpm)} - \text{Rotating speed (rpm)}}{\text{Synchronous speed (rpm)}} \times 100 \quad (\%)$$

Function Setting

1. Press the FUNCTION key below display B to select **SLIP**.
   For a description, refer to Section 4.3, "Selecting What to Display on Digital Displays" (page 4-9).



11.6 Displaying the Mechanical Power (WT1030M Only)

The mechanical power is calculated using the torque and rotating speed.

Computation equation

- **When N·m (unit-1) is used as units of torque:**

$$\text{Mechanical power} = \text{TORQUE} \times \frac{2 \times \pi \times \text{rotating speed}}{60} \text{ (W)}$$

- **When kgfm (unit-2) is used as units of torque:**

$$\text{Mechanical power} = \text{TORQUE} \times \frac{2 \times \pi \times \text{rotating speed}}{60} \times 9.80665 \text{ (W)}$$

- **When kgf·cm (unit-3) is used as units of torque:**

$$\text{Mechanical power} = \text{TORQUE} \times \frac{2 \times \pi \times \text{rotating speed}}{60} \times \frac{9.80665}{100} \text{ (W)}$$

- **When mN·m (unit-4) is used as units of torque:**

$$\text{Mechanical power} = \text{TORQUE} \times \frac{2 \times \pi \times \text{rotating speed}}{60} \times \frac{1}{1000} \text{ (W)}$$

- **When kN·m (unit-5) is used as units of torque:**

$$\text{Mechanical power} = \text{TORQUE} \times \frac{2 \times \pi \times \text{rotating speed}}{60} \times 1000 \text{ (W)}$$

- **When ftlb (unit-6) is used as units of torque:**

$$\text{Mechanical power} = \text{TORQUE} \times \frac{2 \times \pi \times \text{rotating speed}}{60} \times 1.35582 \text{ (W)}$$

- **When ozin (unit-7) is used as units of torque:**

$$\text{Mechanical power} = \text{TORQUE} \times \frac{2 \times \pi \times \text{rotating speed}}{60} \times 0.00706155 \text{ (W)}$$

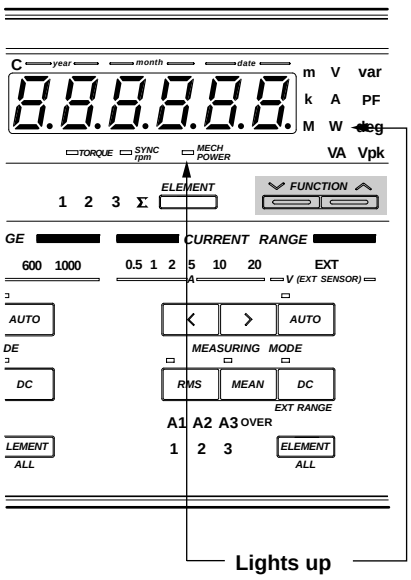
- **When lbin (unit-8) is used as units of torque:**

$$\text{Mechanical power} = \text{TORQUE} \times \frac{2 \times \pi \times \text{rotating speed}}{60} \times 0.112985 \text{ (W)}$$

unit-2,3,6,7 and 8 can be selected when /U1 option is used.

Function Setting

1. Press the FUNCTION key below display C to select **MECH POWER**.
   For a description, refer to Section 4.3, "Selecting What to Display on Digital Displays" (page 4-10).



11.7 Displaying the Motor Efficiency and Total Efficiency (WT1030M Only)

The motor efficiency (motor's input/output efficiency) and total efficiency (converter's input efficiency and motor's output efficiency) are calculated using the motor output (mechanical power) and active power. For a description of converter efficiency (converter's input/output efficiency), refer to Section 7.1, "Measuring Efficiency".

Computation equation

Motor efficiency

- **Wiring system: 1φ2W (Refer to Fig. 1 on page 11-10).**

$$\text{Motor efficiency} = \frac{\text{Mechanicel power}}{W3} \times 100 \quad (\%)$$

- **Wiring system: 1φ3W, 3φ3W (Refer to Fig. 2 on page 11-10. To display total efficiency, connect the instrument as shown in Fig. 5 on page 11-11).**

$$\text{Motor efficiency} = \frac{\text{Mechanicel power}}{\Sigma W} \times 100 \quad (\%)$$

- **Wiring system: 3φ4W, 3V3A (Refer to Fig. 4 on page 11-10).**

$$\text{Motor efficiency} = \frac{\text{Mechanicel power}}{\Sigma W} \times 100 \quad (\%)$$

Total efficiency

- **Wiring system: 1φ2W (Refer to Fig. 1 on page 11-10).**

$$\text{Total efficiency} = \frac{\text{Motor output}}{W1} \times 100 \quad (\%)$$

- **Wiring system: 1φ3W, 3φ3W (Refer to Fig. 2 on page 11-10. To display total efficiency, connect the instrument as shown in Fig. 5 on page 11-11).**

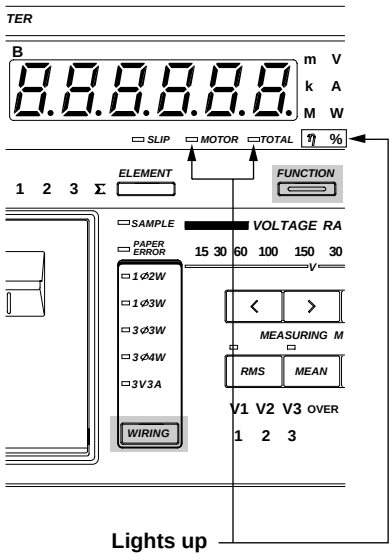
$$\text{Total efficiency} = \frac{\text{Motor output}}{W2} \times 100 \quad (\%)$$

- **Wiring system: 3φ4W, 3V3A (Refer to Fig. 3 on page 11-10).**

$$\text{Total efficiency} = \frac{\text{Motor output}}{\Sigma W} \times 100 \quad (\%)$$

Function Setting

1. Press the FUNCTION key below display B to select **MOTOR η** (**motor efficiency**) or **TOTAL η** (**total efficiency**).
   For a description, refer to Section 4.3, "Selecting What to Display on Digital Displays" (page 4-9).



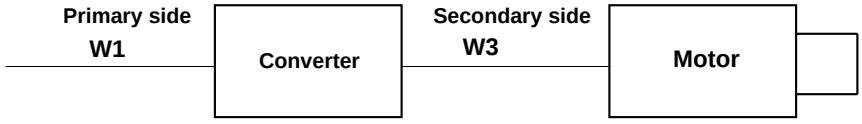
Selecting the Wiring System

When connecting both converter's input and output by 2-wire method:

2. Press the WIRING key to select 1Φ2W.

3. Connect the converter's input to element 1 and output to element 3.

Fig. 1

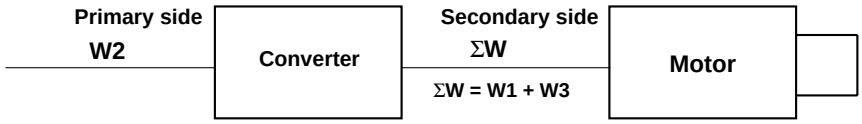


When connecting converter's input by 2-wire method and the output by 3-wire method

2. Press the WIRING key to select 1Φ3W or 3Φ3W.

3. Connect the converter's input to element 2, and the output to elements 1 and 3 by 1Φ3W or 3Φ3W method.

Fig. 2

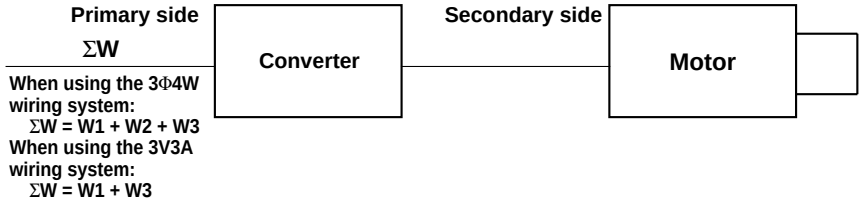


When measuring converter's input by the 3Φ4W or 3V3A method

2. Press the WIRING key to select 3Φ4W or 3V3A.

3. Connect the converter's input by the 3Φ4W or 3V3A wiring method.
   In this case, total efficiency can be measured, but converter efficiency and motor efficiency cannot be measured.

Fig. 3

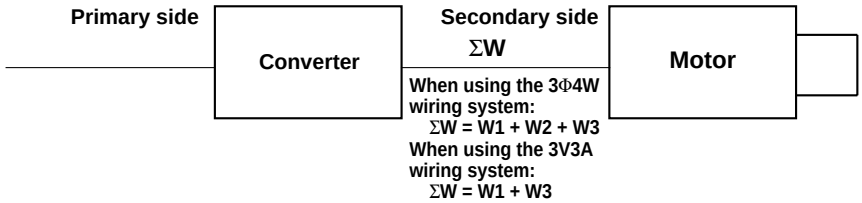


When measuring converter's output by the 3Φ4W or 3V3A wiring method

2. Press the WIRING key to select 3Φ4W or 3V3A.

3. Connect the converter's output by the 3Φ4W or 3V3A wiring method.
   In this case, motor efficiency can be measured, but converter efficiency and total efficiency cannot be measured.

Fig. 4

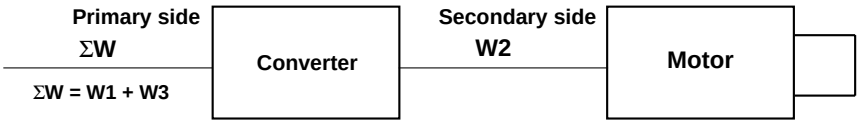


When connecting converter's input by 3-wire method and the output by 2-wire method

2. Press the WIRING key to select 1Φ3W or 3Φ3W.

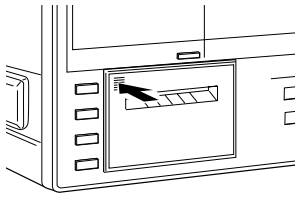
3. Connect the converter's input to elements 1 and 3 by 1Φ3W or 3Φ3W method, and the output to element 2. In this case, total efficiency is displayed instead of motor efficiency, and motor efficiency is displayed instead of total efficiency.

Fig. 5

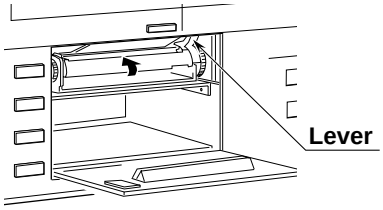


12.1 Loading a Roll Chart (Optional)

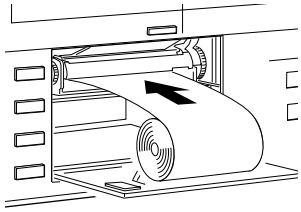
1. Press the left upper corner of the printer cover to open the cover.



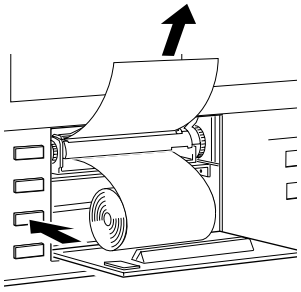
2. Lift the paper feed guide lever in the direction shown by the arrow to release the paper lock.



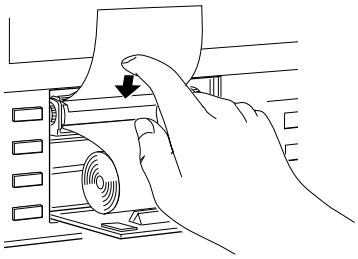
3. Insert the paper underneath the paper feed guide. Make sure that the paper is not skewed. Press the **FEED** key to feed the paper. (Make sure that the paper is fed in the direction as illustrated. If the paper is fed in the opposite direction, printing cannot be performed.)



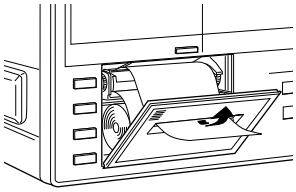
4. Hold down the **FEED** key until approximately 10 cm of the paper comes out of the top of the guide.



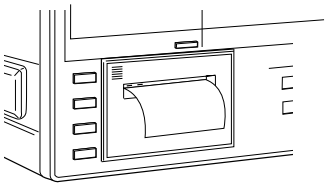
5. Push the middle of the guide in the direction shown by the arrow to secure the paper.



6. Place the paper inside the printer and pass the end of the paper through the slot in the printer cover.



7. Close the printer cover.
   To cut the paper, just pull it upwards. If the printer cover is opened immediately after the paper is cut, press the **FEED** key to feed the paper until the end of the paper comes out through the slot in the printer cover.

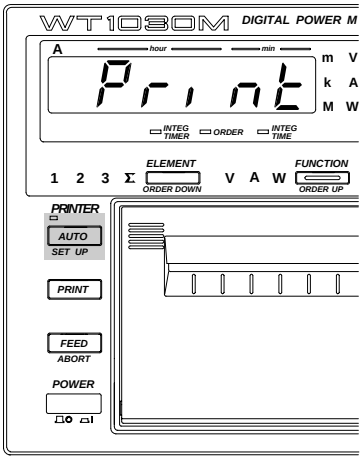


Note

- Never press the **FEED** key if the PAPER ERROR LED is lit, except when loading a roll chart into the printer, otherwise a breakdown may result.

12.2 Setting Printer Output Functions (Optional)

The setting method of the printer output functions differs from that of the communications output functions. For the setting method of the communications output functions, refer to Section 15, "Using the Communications Functions". For print examples, refer to Appendix 3, "Print Examples".



Selecting the Output Function Setting Menu

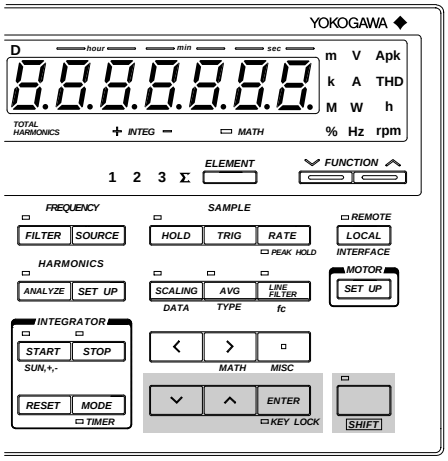
1. Press the **SET UP** key (**SHIFT** + **AUTO**.) "Pr.nt" will be displayed on display A. Press the ∧ or ∨ key until "tEn" is displayed on display B.

2. Press the **ENTER** key.

Selecting Output Function

3. Press the ∧ or ∨ key to select the desired output function.
   - nor : Used to select output items for normal measurement.
   - HAr : Used to select output items for harmonic analysis (optional).

4. Press the **ENTER** key.



Selecting Output Format

5. Press the ∧ or ∨ key to select the desired output format.
   Five output formats are available.
   - dFLt-1 : Default output items are selected. (Refer to this page and next pages.)
   - dFLt-2 : Default output items are selected. (Refer to next pages.)
   - ALL : All the output items which can be set with the instrument are selected.
   - SEL : Desired output items can be selected manually.
   - CLEAr : No output items are selected.

6. Press the **ENTER** key.

Output Items when "nor" is Selected as the Output Function and "dFLt-1" is Selected on Display C:

- The numbers in the table below indicate the element No.

Common to all the models, irrespective of whether the integration function is incorporated or not

V1	V2*2	V3	V4 (Σ)*1	Voltage
A1	A2*2	A3	A4 (Σ)*1	Current
W1	W2*2	W3	W4 (Σ)*1	Active power
Hz				Measured frequency

*1 : If the 1Φ2W (single-phase, two-wire) wiring method has been selected, no data will be output, and "-------" will be displayed.
*2 : No data will be output for the three-phase, three-wire model (253620).

Output Items when "nor" is Selected as the Output Function and "dFLt-2" is Selected on Display C:

- The numbers in the table below indicate the element No.

Common to all the models which are equipped with the integration function

W1	W2*2	W3	W4 (Σ)*1	Active power
Wh1	Wh2*2	Wh3	Wh4 (Σ)*1	Watt-hour
Wh+1	Wh+2*2	Wh+3	Wh+4 (Σ)*1	Positive watt-hour
Wh–1	Wh–2*2	Wh–3	Wh-4 (Σ)*1	Negative watt-hour
Ah1	Ah2	Ah3	Ah4 (Σ)*1	Ampere-hour
Ah+1	Ah+2*2	Ah+3	Ah+4 (Σ)*1	Positive ampere-hour
Ah–1	Ah-2*2	Ah-3	Ah-4 (Σ)*1	Negative ampere-hour
Hz				Measured frequency
HM				Elapsed time of integration

Common to all the models which are not equipped with the integration function

W1	W2*2	W3	W4 (Σ)*1	Active power
VA1	VA2*2	VA3	VA4 (Σ)*1	Apparent power
PF1	PF2*2	PF3	PF4 (Σ)*1	Power factor
DEG1	DEG2*2	DEG3	DEG4 (Σ)*1	Phase angle

*1 : If the 1Φ2W (single-phase, two-wire) wiring method has been selected, no data will be output, and "------" will be displayed.
*2 : No data will be output for the three-phase, three-wire model (253620).

Output Items when "HAr" is Selected as the Output Function and "dFLt-1" is Selected on Display C:

- The numbers in the table below indicate the element No.

Common to all the models, irrespective of whether the integration function is incorporated or not

V1	V2*1	V3	Total rms value of voltage and analysis value of each harmonic from 1st up to n*2th
A1	A2*1	A3	Total rms value of current and analysis value of each harmonic from 1st up to n*2th
W1	W2*1	W3	Total rms value of active power and analysis value of each harmonic from 1st up to n*2th of active power
VTHD1	VTHD2*1	VTHD3	Harmonic distortion of voltage
ATHD1	ATHD2*1	ATHD3	Harmonic distortion of current
VCON1	VCON2*1	VCON3	Content of each harmonic (from 2nd up to n*2th) of voltage
ACON1	ACON2*1	ACON3	Content of each harmonic (from 2nd up to n*2th) of current
WCON1	WCON2*1	WCON3	Content of each harmonic (from 2nd up to n*2th) of active power
Hz			PLL source frequency

*1 : No data will be output for the three-phase, three-wire model (253620).
*2 : "n" is the upper limit of the harmonic order.

Output Items when "HAr" is Selected as the Output Function and "dFLt-2" is Selected on Display C:

- The numbers in the table below indicate the element No.

Common to all the models, irrespective of whether the integration function is incorporated or not

DEG1	DEG2*1	DEG3	Phase angle between fundamentals
VDEG1	VDEG2*1	VDEG3	Phase angle of voltage of each harmonic from 2nd to n*2th in relation to voltage of the 1st harmonic
ADEG1	ADEG2*1	ADEG3	Phase angle of voltage of each harmonic from 2nd to n*2th in relation to current of the 1st harmonic
Hz			PLL source frequency

*1 : No data will be output for the three-phase, three-wire model (253620).
*2 : "n" is the upper limit of the harmonic order.

Output Items when "SEL" is Selected on Display C:

If "SEL" is selected, the output item setting mode is activated. An output item will be displayed on display C, and display D can be used to determined whether the item is to be output or not.

Display B	Display C	Display D
nor	U 1	on

Setting Output Items and Elements

1. Press the ∧ or ∨ key to select the desired output item.

Output Items which can be Selected: When "nor" is Selected as the Output Function

U(V)	A(A)	P(W)
UA(VA)	UAr(var)	PF(PF)
Frq(Frq)	PH(Wh)*1	PHP(WhP)*1
PHM(WhM)*1	AH(Ah)*1	AHP(AhP)*1
AHM(AhM)*1	deg(deg)	UP(V peak)
AP(A peak)	MAEH(Efficiency, computation etc.)	Et(Elapsed time of integration)*1
tor(Torque)*2	rPM(rpm)*2	SrPM(Synchronous speed)*2
SLip(Slip)*2	MECH(Mechanical power)*2	MoEF(Motor efficiency)*2
toEF(Total efficiency)*2		

*1: Available when the instrument is equipped with the computation function

*2: Available with the WT1030M only

Output Items which can be Selected: When "HAr" is Selected as the Output Function

U(V)	A(A)	P(W)
deg(deg)	G-U(Graph of voltage)	G-A(Graph of current)
G-P(Graph of power)	G-Ud(Graph of voltage phase angle)	G-Ad(Graph of current phase angle)
CG-U(Graph of voltage content)		CG-A(Graph of current content)
CG-P(Graph of power content)		tor(Torque)*
rPM(rpm)*	SrPM(Synchronous speed)*	SLip(Slip)*
MECH(Mechanical power)*		MoEF(Motor efficiency)*
toEF(Total efficiency)*		

*: Available with the WT1030M only

To select the desired element, press the < or > key.

Elements Which can be Selected

1 : Element 1
2 : Element 2 (Not available with the three-phase, three-wire model (253620))
3 : Element 3
4 : Element Σ (Not possible to select Vpeak and Apeak. V, A, W, VA, var and PF of fundamental only can be selected if "HAr" has been selected as the output function.)

It is not possible to select any element for efficiency/computation, elapsed time of integration and motor evaluation function (available with the WT1030M only).

Note

- If many output items are selected, it may take some time before the printer begins to print. In this case, reduce the number of output items or hold measurement.

2. Press the ENTER key.
   "on" or "oFF" on display D will begin to blink.

3. Press the ∧ or ∨ key to select "on" or "oFF".

4. Press the ENTER key.
   The digit on the extreme left on display C will begin to blink automatically, so set the desired output item (or element).

5. Repeat steps *1* to *4* until all the desired output items have been selected.

6. To exit in the middle of selection of output items, press the AUTO (SET UP) or SHIFT key.

Note

- The following frequency data will be output.
  During normal measurement : Frequency of the selected source
  During harmonic analysis : Frequency of PLL source

12.3 Printing a Set-up Information List

Set-up Information which can be Printed

Set-up information which can be printed are given below.

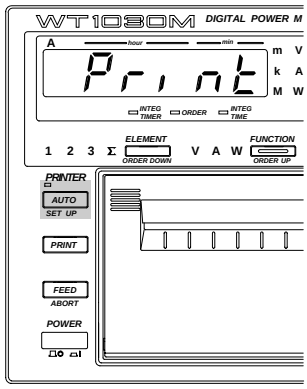
1) Model name
2) Installed options
3) Voltage range and measuring mode selected for each element
4) Current range and measuring mode selected for each element
5) External sensor set-up information
6) Elements to be displayed
7) Wiring system
8) Line filter ON/OFF
9) Peak hold ON/OFF
10) Scaling ON/OFF and set-up information
11) Averaging ON/OFF, averaging type and attenuation constant
12) Hold ON/OFF
13) Sample rate
14) MATH function set-up information
15) Frequency filter ON/OFF, source for measurement of frequency, cut-off frequency
16) Integration mode and timer preset time
17) Rated integration time for D/A outputs
18) Auto print ON/OFF and print interval
19) Harmonic analysis display mode ON/OFF, PLL source, upper limit of the harmonic order, computation method, anti-aliasing filter ON/OFF
20) Torque and units of torque, input type and scaling value or number of pulses for rotating speed, number of poles for cycle speed
21) Command groups

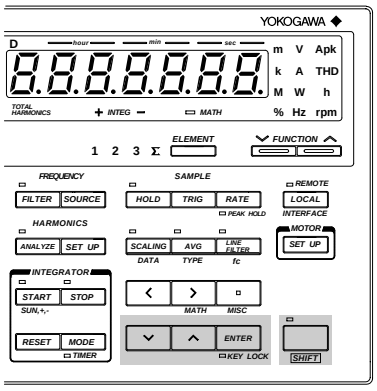
Set-up information items 2) and 16) to 20) can be printed only when the corresponding options are present. The output format is the same as that used by the OS communications command, except that in the case of communications "END" is printed on the last line.

Print Set-up

1. Press the SET UP key (SHIFT + AUTO.)
   Press the ∧ or ∨ key until "PnL" is displayed on display B.

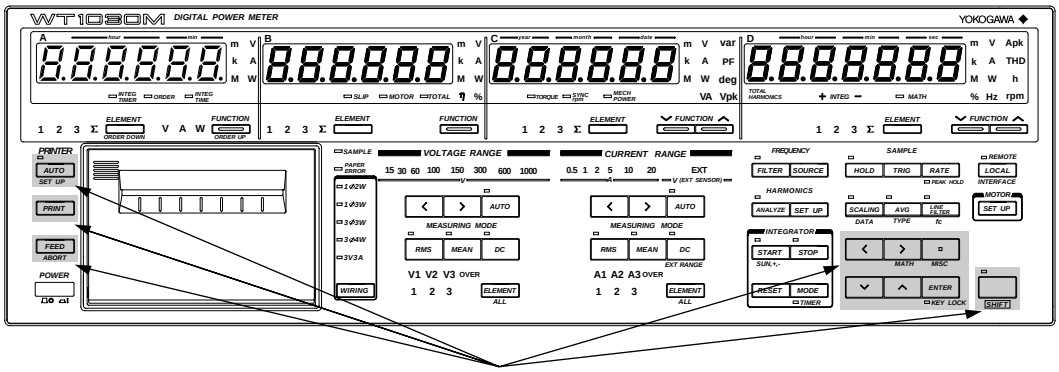
2. Press the ENTER key to start printing.
   When printing is complete.
   Measurement will be resumed.





12.4 Printing Measured Values in Manual or Auto Print Mode (Optional)

Keys used for Printing



These keys are used.

Printing Measured Values in Manual Print Mode

Procedure

1. Press the PRINT key.
   The printer will begin to print out measured values.
   The PRINT key is also valid in auto print mode.

Note

- If many output items are selected, it may take a few seconds before the printer begins to print. In this case, reduce the number of output items or hold measurement.

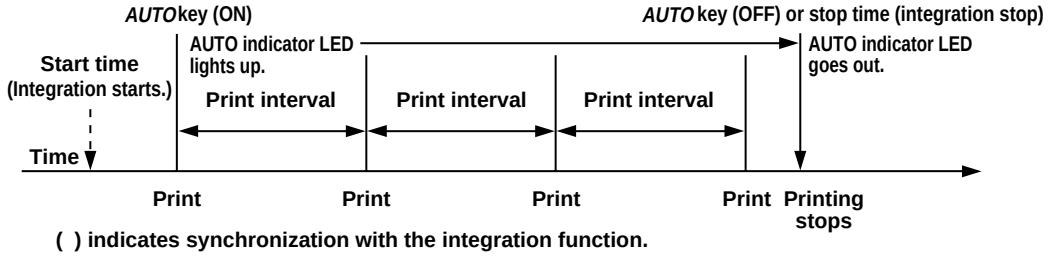
Printing Measured Values in Auto Print Mode

In auto print mode, measured values are printed out automatically at the specified print intervals. In addition, setting the auto print start/stop time enables printing of measured values at the desired time.

If the instrument is equipped with the integration function, measured values are printed in synchronization with integration time.

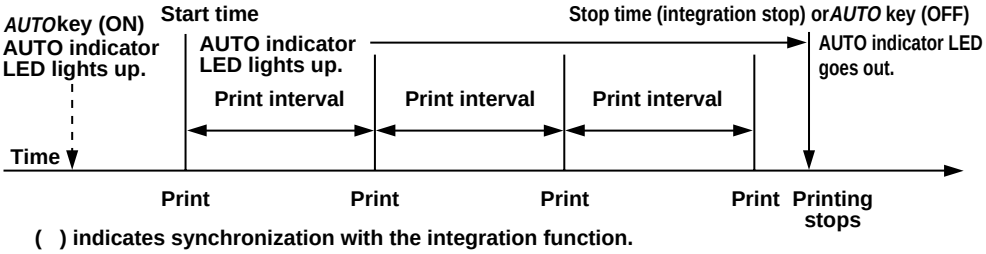
Print timing charts for the AUTO key and for a preset start/stop time are given below.

Print timing when print start time passes before depression of the *AUTO* key



( ) indicates synchronization with the integration function.

Print timing when print start time passes after depression of the *AUTO* key



( ) indicates synchronization with the integration function.

Note

- If the preset stop time has already passed when the AUTO key is turned ON, error code "Err 17" will be displayed.

1. Press the SET UP key (SHIFT + AUTO.)
   "Pr, nt" will be displayed on display A. Press the ∧ or ∨ key until "SYnC" is displayed on display B.

2. Press the ENTER key.

Setting the Auto Print Start/Stop Time

3. Press the ∧ or ∨ key until "t, nEr" is displayed on display C.

4. Press the ENTER key.

5. "StArt" will be displayed on display B, and the currently selected print output start date is displayed on display C, with the digit on the extreme left blinking. You can change the value at the blinking digit. Pressing the ∧ key changes the value in the order 1, 2, 3 ... 9, 0 and back to 1. Pressing the ∨ key changes the value in the opposite direction. The blinking position can be shifted to the left or right by pressing the < or > key respectively.
   After the desired start date has been set, press the ENTER key.

Display A	Display B	Display C	Display D
Pr, nt	StArt	96.01.01	00.00.00
		Y M D	H M S

6. The currently selected print output start time will be displayed on display D, with the digit on the extreme left blinking. Set the start time in the same way as step *5*.
   After the desired start time has been set, press the ENTER key.

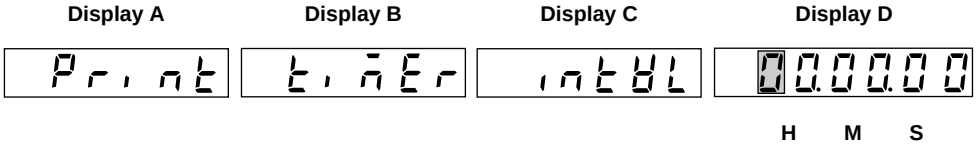
7. "StoP" will be displayed on display B, and the currently selected print output stop date is displayed on display C, with the digit on the extreme left blinking. Set the stop date in the same way as step *5*.
   After the desired stop date has been set, press the ENTER key.

8. The currently selected print output stop time will be displayed on display D, with the digit on the extreme left blinking. Set the stop time in the same way as step *5*.
   After the desired start time has been set, press the ENTER key.

Setting the Print Interval

In auto print mode, measured values are printed out automatically at intervals. Set the print interval as follows.

9. "intVL" is displayed on display C, and the currently selected print interval is displayed on display D, with the digit on the extreme left blinking.



Set the print interval in the same way as step 5.

Allowable minimum interval : 10 s (Error code "Err12" will be displayed if a value below 10 s is set.)
Allowable maximum interval : 99 h 59 min 59 s

After the print interval has been set, press the ENTER key.

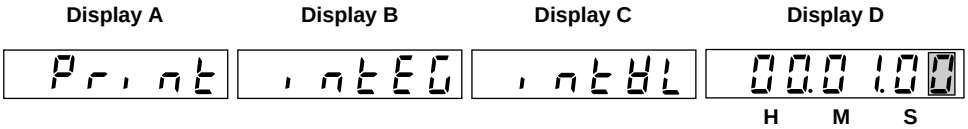
Setting the Print Interval in Synchronization with Integration Time

After steps *1* and *2* on the previous page, carry out the following steps

3. Press the ∧ or ∨ key until "intEG" is displayed on display C.

4. Press the ENTER key.

5. "intVL" will be displayed on display C, and the currently selected print interval is displayed on display D, with the digit on the extreme left blinking.



You can change the value at the blinking digit. Pressing the ∧ key changes the value in the order 1, 2, 3 ... 9, 0 and back to 1. Pressing the ∨ key changes the value in the opposite direction.

Allowable minimum interval : 10 s (Error code "Err12" will be displayed if a value below 10 s is set.)
Allowable maximum interval : 99 h 59 min 59 s

After the print interval has been set, press the ENTER key.
Follow the procedure given on the next page to execute auto print.

Executing Auto Print

After the print interval, auto print start/stop date and time (and print interval for synchronization with the integration function, if necessary) have been set, auto printing can be executed as follows.

1. Press the AUTO key.
   The AUTO indicator LED will light up, indicating that the auto print function is ready. Auto printing will be executed according to the settings made. Pressing the AUTO key will cause the LED to go out.

Note

- If the mode is switched from normal measurement mode to harmonic analysis mode while printing is in progress, the printer will stop and auto print mode is also canceled.

Stopping Print Out

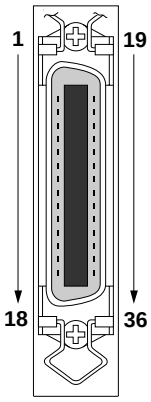
To stop printing while printing is in progress, press the ABORT key (SHIFT + FEED).

13.1 External Input/Output Connector Pin Assignment

The external input/output connector is used for remote control of the instrument as well as output of analog signals from the D/A converter (optional), output of waveforms (optional), input of motor evaluation signals (available with the WT1030M only) and input of the external sample clock for the harmonic analysis function (optional).

Pin Assignment

The table below shows the pin assignment of the external input/output connector.



Pin No.	Signal Name		Pin No.	Signal Name	
1	GND		19	GND	
2	EXT HOLD		20	EXT TRIG	
3	EXT PRINT		21	EXT SAMPLE CLOCK (harmonic analysis)	
4	WAVE V1		22	WAVE A1	
5	WAVE V2 (available with 253630 and 253640 only)		23	WAVE A2 (available with 253630 and 253640 only)	
6	WAVE V3		24	WAVE A3	
7	SPEED. PULSE. L		25	SPEED. PULSE. H	
8	SPEED. ANALOG. L		26	SPEED. ANALOG. H	
9	TORQUE. ANALOG. L		27	TORQUE. ANALOG. H	
10	D/A GND		28	D/A GND	
11	D/A GND		29	D/A GND	
12	D/A CH1	(output)	30	D/A CH2	(output)
13	D/A CH3	(output)	31	D/A CH4	(output)
14	D/A CH5	(output)	32	D/A CH6	(output)
15	D/A CH7	(output)	33	D/A CH8	(output)
16	D/A CH9	(output)	34	D/A CH10	(output)
17	D/A CH11	(output)	35	D/A CH12	(output)
18	D/A CH13	(output)	36	D/A CH14	(output)

Note

- For the location of the connector, refer to Section 1.4 "Part Descriptions and Functions" (page 1-6.)
- The GND pins (pins 1 and 19) and D/A GND pins (pins 10, 11, 28 and 29) are connected internally to the case.
- For remote control, refer to Section 13.2, "Remote Control" (page 13-2.)
- For harmonic analysis, refer to Section 9.1, "Operating the Harmonic Analysis Function (Optional)" (page 9-5.)
- For waveform output, refer to Section 10.1, "Using the Waveform Output Functions (Optional)" (page 10-1.)
- For motor evaluation, refer to Chapter 11, "Using the Motor Evaluation Functions (WT1030M Only)" (page 11-1.).
- For D/A outputs, refer to Section 13.3 "D/A Output (Optional)" (page 13-3.)

WARNING

- **The connectors used in this function have protective covers. When the covers are removed or when using connectors, the voltage ratings across the measuring input and the ground become as follows:**
  Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.
  Voltage across V terminal and ground 600 Vrms max.
  Put the protective cover on the connector when this function is not used.

CAUTION

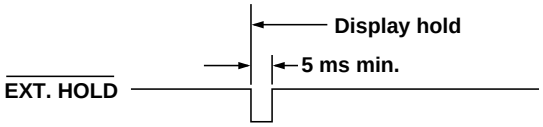
- **Never short-circuit the D/A output terminals or apply any external voltage to them, otherwise damage to the instrument may result.**

13.2 Remote Control

Holding Display Data Update and Updating Display Data

Holding Display Data Update (same function as HOLD key)

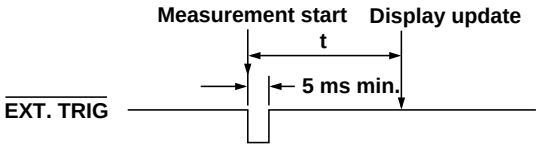
To hold the display data update, apply the EXT HOLD signal according to the timing chart below.



Updating Display Data (same function as TRIG key)

Applying an EXT TRIG signal when the display data is on hold updates the display data.

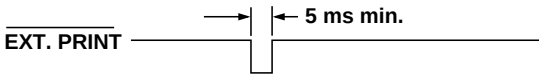
Update timing



Printing Measured Values to the Built-in Printer (Optional)

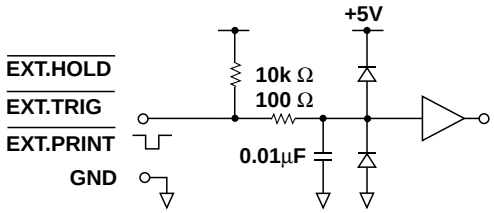
t: Sample rate + 100 ms

To print measured values to the built-in printer, apply the EXT PRINT signal according to the timing chart below.



Remote Control Circuit

Remote control



TTL level
L: 0 to 0.8 V
H: 2.0 to 5 V

CAUTION

- **Never apply a voltage exceeding the TTL level to the EXT.HOLD, EXT.TRIG and EXT.PRINT pins, otherwise damage to the instrument will result.**

Note

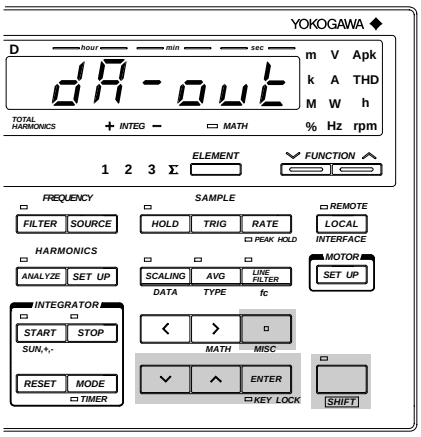
- For the pin assignment, refer to Section 13.1 "External Input/Output Connector Pin Assignment" (page 13-1.)

13.3 D/A Output (Optional)

Setting D/A Output

Measured/computed data or harmonic analysis data (analog signal) can be output from the D/A output terminals of the external input/output connector on the rear panel. Up to 14 items (14 channels) can be output.

Selecting the D/A Output Setting Menu



1. Press the **MISC** key (**SHIFT** + □.)
   Press the ∧ or ∨ key to display "dA-out" on display D.

2. Press the **ENTER** key. The currently selected output function will be displayed on display B.
   Default setting : "nor" (output function for normal measurement)

Selecting Output Function

3. Press the ∧ or ∨ key to select the desired output function.
   nor : Used to select output items for normal measurement.
   HAr : Used to select output items for harmonic analysis (optional).

4. Press the **ENTER** key.

Selecting Output Format

The output format currently selected is displayed on display C.

5. Press the ∧ or ∨ key to select the desired output format.
   The following three output formats are available. For a description of each output item, refer to the following pages.
   dFLt-1 : Default output items are selected. (Refer to next pages.)
   dFLt-2 : Default output items are selected. (Refer to next pages.)
   SEL : Desired output items can be selected manually.

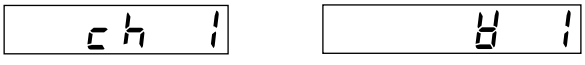
6. Press the **ENTER** key.
   If "SEL" is selected, the D/A output channel setting screen is displayed on display C, and the D/A output item and element setting screen is displayed on display D.
   - When "nor" (normal measurement) is selected as the output function:

     Display C **Display D**

   - When "HAr" (harmonic analysis) is selected as the output function:

     Display C **Display D**

   - If "SEL" has been selected, carry out the steps given on page 13-6.

Output Items when "nor" is Selected as the Output Function and "dFLt-1" is Selected on Display C:

- The numbers indicate the element No.

Common to all the models irrespective of whether the integration function is incorporated or not

Output Channel	Output Item	
ch1	V1	Voltage
ch2*1	V2	Voltage
ch3	V3	Voltage
ch4*2	V4 (Σ)	Voltage
ch5	A1	Current
ch6*1	A2	Current
ch7	A3	Current
ch8*2	A4 (Σ)	Current
ch9	W1	Active power
ch10*1	W2	Active power
ch11	W3	Active power
ch12*2	W4 (Σ)	Active power
ch13	Measured value on display C	
ch14	Measured value on display D	

*1 : No data will be output for the three-phase, three-wire model (253620).
*2 : If the single-phase, two-wire system is selected, "0V" (no data) will be output for W4 (Σ), Wh4 (Σ) and Ah4 (Σ).

Output Items when "nor" is Selected as the Output Function and "dFLt-2" is Selected on Display C:

- The numbers indicate the element No.

Common to all the models which are equipped with the integration function

Output Channel	Output Item	
ch1	W1	Active power
ch2*1	W2	Active power
ch3	W3	Active power
ch4*2	W4 (Σ)	Active power
ch5	Wh1	watt-hour
ch6*1	Wh2	watt-hour
ch7	Wh3	watt-hour
ch8*2	Wh4 (Σ)	watt-hour
ch9	Ah1	ampere-hour
ch10*1	Ah2	ampere-hour
ch11	Ah3	ampere-hour
ch12*2	Ah4 (Σ)	ampere-hour
ch13	Hz	Measured frequency
ch14	HM	Elapsed time of integration

Common to all the models which are not equipped with the integration function

Output Channel	Output Item	
ch1	W1	Active power
ch2*1	W2	Active power
ch3	W3	Active power
ch4	AV1	Apparent power
ch5*1	VA2	Apparent power
ch6	VA3	Apparent power
ch7	PF1	Power factor
ch8*1	PF2	Power factor
ch9	PF3	Power factor
ch10*2	PF4 (Σ)	Power factor
ch11	DEG1	Phase angle
ch12*1	DEG2	Phase angle
ch13	DEG3	Phase angle
ch14*2	DEG4 (Σ)	Phase angle

*1 : No data will be output for the three-phase, three-wire model (253620).
*2 : If the single-phase, two-wire system is selected, "0V" (no data) will be output.

Output Items when "HAr" is Selected as the Output Function and "dFLt - 1" is Selected on Display C:

- The numbers indicate the element No.

Common to all the models, irrespective of whether the integration function is incorporated or not

Output Channel	Output Item	
ch1	A1	1st	1st harmonic component data of current of element 1
ch2	A1	2nd	2nd harmonic component data of current of element 1
ch3	A1	3rd	3rd harmonic component data of current of element 1
ch4	A1	4th	4th harmonic component data of current of element 1
ch5	A1	5th	5th harmonic component data of current of element 1
ch6	A1	6th	6th harmonic component data of current of element 1
ch7	A1	7th	7th harmonic component data of current of element 1
ch8	A1	8th	8th harmonic component data of current of element 1
ch9	A1	9th	9th harmonic component data of current of element 1
ch10	A1	10th	10th harmonic component data of current of element 1
ch11	A1	11th	11th harmonic component data of current of element 1
ch12	A1	12th	12th harmonic component data of current of element 1
ch13	A1	13th	13th harmonic component data of current of element 1
ch14	Hz		PLL source frequency

Note

- If the upper limit of the harmonic order is 12th or below, harmonic component data up to the upper limit of the harmonic order only will be output. "0V" (no data) will be output for the harmonic component data exceeding the upper limit of the harmonic order.

Output Items when "HAr" is Selected as the Output Function and "dFLt - 2" is Selected on Display C:

- The numbers indicate the element No.

Common to all the models, irrespective of whether the integration function is incorporated or not

Output Channel	Output Item	
ch1	A1	1st	1st harmonic component data of current of element 1
ch2	A1	3rd	3rd harmonic component data of current of element 1
ch3	A1	5th	5th harmonic component data of current of element 1
ch4	A1	7th	7th harmonic component data of current of element 1
ch5*	A2	1st	1st harmonic component data of current of element 2
ch6*	A2	3rd	3rd harmonic component data of current of element 2
ch7*	A2	5th	5th harmonic component data of current of element 2
ch8*	A2	7th	7th harmonic component data of current of element 2
ch9	A3	1st	1st harmonic component data of current of element 3
ch10	A3	3rd	3rd harmonic component data of current of element 3
ch11	A3	5th	5th harmonic component data of current of element 3
ch12	A3	7th	7th harmonic component data of current of element 3
ch13	DEG1		Phase angle between fundamentals
ch14	Hz		PLL source frequency

* : No data will be output for the three-phase, three-wire model (253620).

Note

- If the upper limit of the harmonic order is 6th or below, harmonic component data up to the upper limit of the harmonic order only will be output. "0V" (no data) will be output for the harmonic component data exceeding the upper limit of the harmonic order.

Selecting the Output Item and Element when "SEL" is Selected on Display C

Selecting the D/A Output Channel

5. Press the ∧ or ∨ key to select the desired output channel.

6. Press the **ENTER** key.

Selecting the Output Item and Element

7. Press the ∧ or ∨ key to select the desired output item.

Output Items which can be Selected: When "nor" is Selected as the Output Function

U(V)	I(A)	P(W)
S(VA)	Q(var)	λ(PF)
Frq(Frq)	WP(Wh)*2	WP+(WhP)*1
WP-(WhM)*1	q(Ah)*2	q+(AhP)*1
q-(AhM)*1	deg(deg)	Up(V peak)
Ip(A peak)	η(Efficiency, computation etc.)	T(Elapsed time of integration)*1
Tq(Torque)*2	Spd(rpm)*2	Sync(Synchronous speed)*2
Slip(Slip)*2	Pm(Mechanical power)*2	Mtr(Motor efficiency)*2
Eff(Total efficiency)*2		

*1: Available when the instrument is equipped with the computation function
*2: Available with the WT1030M only

Output Items which can be Selected: When "HAr" is Selected as the Output Function

U(V)	I(A)	P(W)
S(VA))	Q(var)	λ(PF)
Frq(Frequency *2)	deg(Phase angle)	Uthd(Distortion of voltage)
Ithd(Distortion of current)	Ucon(Content of voltage)	Icon(Content of current)
Pcon(Content of power)	Udeg(Phase angle of voltage)	Ideg(Phase angle of current)
Tq(Torque)*1	Spd(rpm)*1	Sync(Synchronous speed)*1
Slip(Slip)*1	Pm(Mechanical power)*1	Mtr(Motor efficiency)*1
Eff(Total efficiency)*1		

*1: Available with the WT1030M only
*2: PLL source frequency

8. Press the > key. Now, an element can be selected. Press the ∧ or ∨ key to select the desired element.

Elements Which can be Selected

1 : Element 1
2 : Element 2 (Not available with the three-phase, three-wire model (253620))
3 : Element 3
4 : Element Σ (Not possible to select Vpeak and Apeak. V, A, W, VA, var and PF of fundamental only can be selected if "HAr" has been selected as the output function.)
It is not possible to select any element for efficiency/computation, elapsed time of integration and motor evaluation function (WT1030M only).

9. Press the **ENTER** key.
If "nor" has been selected, carry out from step *11* on the following page.

Setting the Order

10. If "HAr " is selected as the output format, select the desired order on display D.
Press the ∧ or ∨ key to select the order within the following range.
Allowable range: 0 to 50
It is possible to select "0" for V, A and W only. If "0" is selected, the total rms value will be output.
After the desired order has been selected, press the ENTER key.

11. The next D/A output channel no. will begin to blink automatically.

12. Repeat steps *5* to *9* to set the desired output items and element for each channel.

Quitting Setting Mode

13. To exit from setting mode, follow the procedure below.
After all 14 channels have been set, "End" is displayed in the channel setting screen (display B or C). To quit setting mode, press the ENTER key. To continue making settings, press the ∧ or ∨ key to select the desired channel no.
To exit from setting mode in the middle of making settings, press the □ (MISC) or SHIFT key.

Note

- When "EFFH" (efficiency/computation) is selected, 0 V is output from the D/A converter unless EFF is selected as the MATH function.
- If the scaling value has been set for voltage, current and power, a voltage of 5.0 V (full scale) will be output from the D/A converter when the rated value is input.
- If the scaling values set for each element differ from each other in the case of element Σ, the number of display digits will be limited so that Σ value does not exceed 30000 when the rated value is input to each corresponding element. A voltage of 5.0 V (full scale) will be output from the D/A converter as the Σ value obtained when the rated value is input to each corresponding element.
- The following frequency data will be output from the D/A converter.
  During normal measurement : Frequency of the selected source
  During harmonic analysis : Frequency of PLL source

Setting Rated Integration Time when Outputting Integrated Values from the D/A Converter

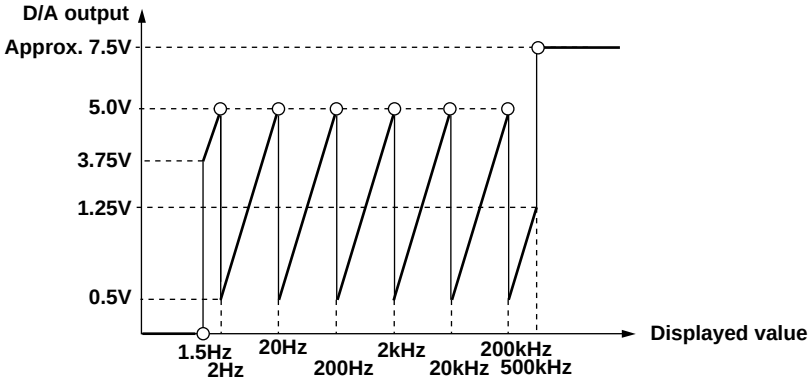
1. Press the MISC key (SHIFT + □).
Press the ∧ or ∨ key to display "tG-t" on display D.

2. Press the ENTER key.
The rated integration time currently set will be displayed on display B. Set the desired time using the ∧, ∨, < and > keys.
Minimum time allowed : 1 min
Maximum time allowed : 999 h 59 min

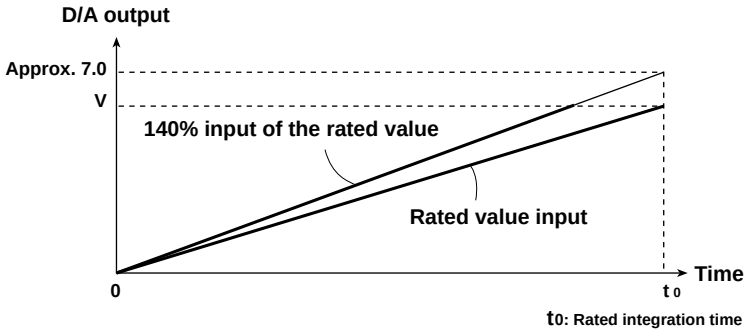
3. When the rated integration time has been set, press the ENTER key.

Output Items and D/A Output Voltage

Frequency

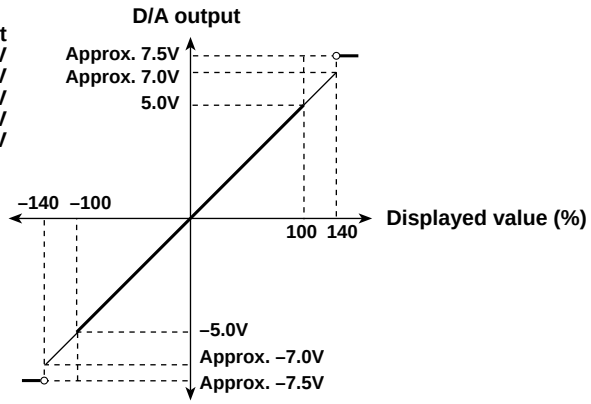


Integrated Value



Other Items

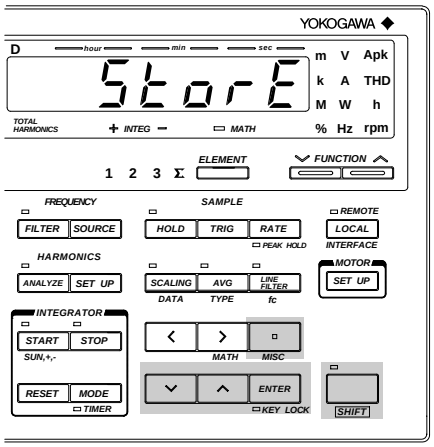
Displayed Value	Output
140%	Approx. 7.0V
100%	5.0V
0%	0V
–100%	–5.0V
–140%	Approx. –7.0V



- The maximum output level is ±5.0 V for power factor (PF) and phase angle (deg). However, the output will be approx. +7.5 V if there is an error.
- If the selected phase angle display method is for 0° to 360°, the output will be between 0 V and +5 V. If the method is for phase lag 180° to phase lead 180°, the output will be between –5.0 V and +5.0 V. The output will be approx. 7.5 V if there is a phase angle error.
- For efficiency computation, THD (optional) and content (optional), slip (WT1030M only), +5 V will be output when they are 100%.
- For torque (WT1030M only), +5 V will be output when the torque set as the scaling value is reached.
- For rotating speed (WT1030M only), +5 V will be output when the rotating speed set as the input analog scaling value is reached, irrespective of whether the input is pulse or analog signal.
- For synchronous speed (WT1030M only), +5 V will be output when the synchronous speed set as the input analog scaling value is reached.
- For mechanical power (WT1030M only), +5 V will be output when the mechanical power which can be obtained from the torque value set as the torque scaling value and the rotating speed set as the rotating speed scaling value is reached.

14.1 Storing, Recalling and Initializing Set-up Information

Storing



1. Press the **MISC** key (**SHIFT** + ▫.)
   Press the ∧ or ∨ key until "StorE" appears on display D.

2. Press the **ENTER** key.
   "FILE1" will be displayed on display B.

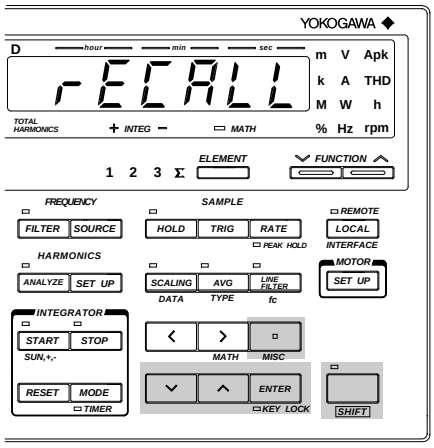
3. Press the ∧ or ∨ key to select the file no. of the built-in memory where the set-up information is to be stored.
   Files from FILE1 to FILE8 are available in the built-in memory.
   The state of the selected file will be displayed on display D.
   If any set-up information already exists in the selected file, the storage date will be displayed. If not, "FrEE" will be displayed.

4. Press the **ENTER** key.
   The current set-up information will be stored into the file selected in step *3*. If any set-up information already exists in the file, the information will be replaced by the current information. Note that the old information will be deleted.

Note

- If the power is turned OFF during storage of the set-up information, not only the file to which the set-up information is being stored will be damaged, but also other files may be initialized.

Recall



1. Press the MISC key (SHIFT + ▫).
   Press the ∧ or ∨ key until "rECALL" appears on display D.

2. Press the ENTER key.
   "FILE 1" will be displayed on display B.

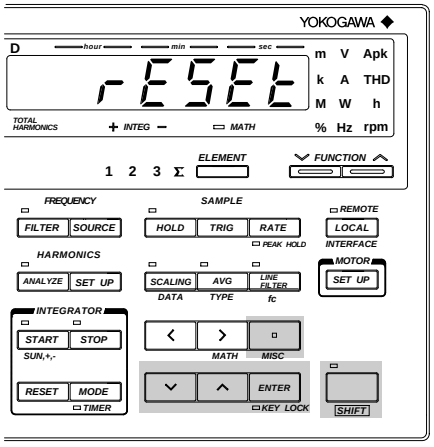
3. Press the ∧ or ∨ key to select the file no. of the built-in memory where the set-up information is to be recalled.
   The state of the selected file will be displayed on display D.
   If any set-up information already exists in the selected file, the storage date will be displayed. If not, "FREE" will be displayed.

4. Press the ENTER key.
   The set-up information currently stored in the file selected in step *3* will be recalled. If there is no set-up information in that file, "Err30" error code will be displayed on display D.

Note

- If the power is turned OFF during recalling of the set-up information, "Err60" will occur when the power is turned ON again, possibly causing the instrument to be initialized.

Initialization



1. Press the MISC key (SHIFT + ▫).
   Press the ∧ or ∨ key until "rESEt" appears on display D.

2. Press the ENTER key.
   "rESEt" will shift to display C, and "no" begins to blink on display D.
   If you do not want to initialize the set-up information, press the ENTER key.

3. To initialize the set-up information, press the ∧ or ∨ key until "YES" appears, then press the ENTER key.

   The set-up information will be initialized. All set-up information will be set as shown on page 2-6.

Note

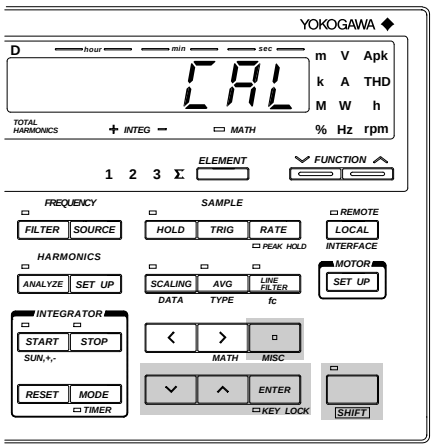
- All measurement data will be lost when initialization is carried out.
- If the power is turned OFF during initialization, "Err60" may occur when the power is turned ON again, possibly causing the instrument to be initialized.

14.2 Carrying Out Zero Level Calibration

To carry out measurements that conform to the specifications (Chapter 17) without changing measuring mode or range after elapse of 30-minute warm-up time following turning ON of the power, it is necessary to carry out zero-level calibration.
Zero-level calibration is carried out so that the output level will be zero when the input level is adjusted to zero using the internal circuit.

1. Press the **MISC** key (**SHIFT** + ▫).
   Press the ∧ or ∨ key until "CAL" appears on display D.

2. Press the **ENTER** key to carry out zero-level calibration.



14.3 Key Lock Function

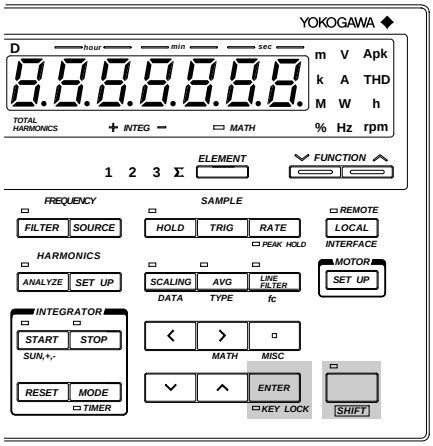
The key lock function is provided to prevent key operations during measurement. Operation of all panel keys except the POWER and SHIFT keys will be disabled.

Enabling Key Lock Function

Press the KEY LOCK key (SHIFT + ENTER). The KEY LOCK indicator LED will light up.

Disabling Key Lock Function

Press the KEY LOCK key (SHIFT + ENTER) when the KEY LOCK indicator LED is lit. The LED will go out.



14.4 Backup Function for Set-up Information

The instrument is equipped with a lithium battery to provide battery backup for the set-up information in case of power failure. The battery lasts for approximately ten years (page 2-5.) The following set-up information can be backed up.

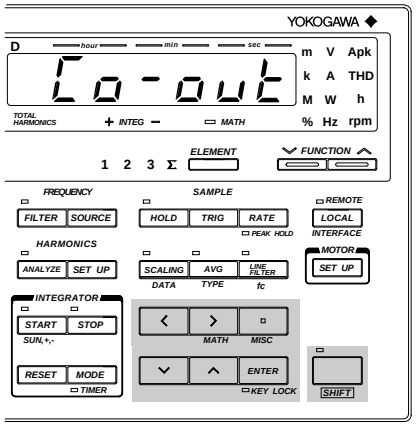
Date
Time
Wiring system
Voltage ranges, auto range ON/OFF
Current ranges, auto range ON/OFF
Measurement voltage and current modes for each element
Sample rate
Data hold
Line filter
Input element
Scaling ON/OFF
Scaling constant
Averaging ON/OFF
Averaging type
Attenuation constant
Function and element selected for each display
Cut-off frequency
Peak hold
Frequency filter
Object for frequency measurement
Phase angle display format
MATH settings
Key lock
Communication output mode
Communication output function ON/OFF
Communication output type
Communications command
Delimiter
Presence/absence of header
Output interval during talk-only
GP-IB address — (When equipped with a GP-IB interface)
Handshake mode
Data format
Baud rate
} (When equipped with a RS-232-C interface)
Harmonic analysis ON/OFF
Object for harmonic analysis
PLL source
Harmonic analysis display format
Harmonic analysis phase angle display format
Harmonic analysis display order
Upper limit of the harmonic order setting
THD computing method
Anti-aliasing filter
} When the harmonic analysis function (optional) is incorporated
Print mode
Print interval
Print start/stop time
Print synchronization
Print output function ON/OFF
} When a built-in printer (optional) is incorporated
Integration mode
Integration timer preset time
Integration start/stop time
Integrated value
Elapsed time of integration
Integration polarity setting
} When the integration function (optional) is incorporated
D/A output function (normal)
D/A output function (harmonic analysis)
} When the D/A output function (optional) is incorporated
Rated integration time for D/A outputs
External sensor range
External sensor output value
} When the external input function (optional) is incorporated
Torque value
Torque unit
rpm input type (analog or pulse)
number of rpm pulses
rpm scaling value
Polarity
} Available with WT1030M only

15.1 Selecting the Output Items

Output items can be selected from the controller (computer) or panel. The communications function is used to output data to a listener-only device such as a printer.

Procedure

Selecting the Output Item Setting Menu



1. Press the **MISC** key (SHIFT + ▫).
   Press the ∧ or ∨ key until "Co-out" is displayed on display D.

2. Press the **ENTER** key. The currently selected output function will be displayed on display B.
   Default setting : "nor" (output function for normal measurement)

Selecting Output Function

3. Press the ∧ or ∨ key to select the desired output function.
   - nor : Used to select output items for normal measurement (normal measurement or integration measurement).
   - HAr : Used to select output items for harmonic analysis (optional).
   - o-tYPE : Used to select the output data format (ASCII or binary).

4. Press the ENTER key.

Selecting Output Format

The output format currently selected is displayed on display C.

5. Press the ∧ or ∨ key to select the desired output format.
   The following output formats are available. For details, refer to the following pages.
   - dFLt-1 : Default items are output.
   - dFLt-2 : Default items are output.
   - ALL : All items are output.
   - SEL : Desired items can be selected manually.
   - CLEAr : No items are output.
   - ASC.. : Items are output in ASCII format (available only when "o-tYPE" is selected in step *3*)
   - b.nAry : Items are output in binary format (available only when "o-tYPE" is selected in step *3*)

6. Press the **ENTER** key.
   If "SEL" is selected in step *5*, the output item and element setting menu will be displayed on display C, and the output ON/OFF state is displayed on display D.

Selecting the Output Item and Element when "SEL" is Selected on Display C

7. The currently set output item and element are displayed on display C. Press the ∧ or ∨ key to select the desired item.

8. Press the > key. Now, an element can be selected. Press the ∧ or ∨ key to select the desired element.
   Elements Which can be Selected:
   1 : Element 1
   2 : Element 2 (Not available with the three-phase, three-wire model (253620))
   3 : Element 3
   4 : Element S (Not possible to select Vpeak and Apeak. V, A, W, VA, var and PF of fundamental only can be selected if "HAr" has been selected as the output function.)
   It is not possible to select any element for efficiency/computation, elapsed time of integration and motor evaluation function.

9. Press the ENTER key.
   The data displayed on display D begins to blink automatically.
   Press the ∧ or ∨ key to select whether or not the selected item is to be output.

10. Repeat steps *7* to *9* until all the desired output items have been selected.

Quitting Setting Mode

11. To exit from setting mode, press the MISC or SHIFT key.

Description of Output Items

Selectable Output Items when "nor" is Selected as the Output Function and "dFLt - 1" is Selected on Display C:

Common to all models, irrespective of whether the integration function is incorporated or not

V1	V2[*1]	V3	V4 (Σ)	Voltage
A1	A2[*1]	A3	A4 (Σ)	Current
W1	W2[*1]	W3	W4 (Σ)	Active power
Hz				Measured frequency

*1 : Not possible with the three-phase, three-wire model (253620).

Selectable Output Items when "nor" is Selected as the Output Function and "dFLt - 2" is Selected on Display C:

Common to all the models which are equipped with the integration function

W1	W2[*1]	W3	W4 (Σ)	Active power
Wh1	Wh2[*1]	Wh3	Wh4 (Σ)	Watt-hour
Wh+1	Wh+2[*1]	Wh+3	Wh+4 (Σ)	Positive watt-hour
Wh–1	Wh–2[*1]	Wh–3	Wh–4 (Σ)	Negative watt-hour
Ah1	Ah2	Ah3	Ah4 (Σ)	Ampere-hour
Ah+1	Ah+2[*1]	Ah+3	Ah+4 (Σ)	Positive ampere-hour
Ah–1	Ah–2[*1]	Ah–3	Ah–4 (Σ)	Negative ampere-hour
Hz				Measured frequency
HM				Elapsed time of integration

*1 : Not possible with the three-phase, three-wire model (253620).

Common to all the models which are not equipped with the integration function

W1	W2[*1]	W3	W4 (Σ)	Active power
VA1	VA2[*1]	VA3	VA4 (Σ)	Apparent power
PF1	PF2[*1]	PF3	PF4 (Σ)	Power factor
DEG1	DEG2[*1]	DEG3	DEG4 (Σ)	Phase angle

*1 : Not possible with the three-phase, three-wire model (253620).

Selectable Output Items when "HAr" is Selected as the Output Function and "dFLt - 1" is Selected on Display C:

Common to all the models, irrespective of whether the integration function is incorporated or not

V1	V2[*1]	V3	Total rms value of voltage and analysis value of each harmonic from 1st up to n[*2]th
A1	A2[*1]	A3	Total rms value of current and analysis value of each harmonic from 1st up to n[*2]th
W1	W2[*1]	W3	Total rms value of active power and analysis value of each harmonic from 1st up to n[*2]th of active power
VTH1	VTH2[*1]	VTH3	Harmonic distortion of voltage
ATH1	ATH2[*1]	ATH3	Harmonic distortion of current
VCN1	VCN2[*1]	VCN3	Content of each harmonic (from 2nd up to n[*2]th) of voltage
ACN1	ACN2[*1]	ACN3	Content of each harmonic (from 2nd up to n[*2]th) of current
WCN1	WCN2[*1]	WCN3	Content of each harmonic (from 2nd up to n[*2]th) of active power
Hz			PLL source frequency

*1 : Not possible with the three-phase, three-wire model (253620).

*2 : "n" is the upper limit of the harmonic order.

Selectable Output Items when "HAr" is Selected as the Output Function and "dFLt-2" is Selected on Display C:

Common to all the models, irrespective of whether the integration function is incorporated or not

DEG1	DEG2[*1]	DEG3	Phase angle between fundamentals
DGV1	DGV2[*1]	DGV3	Phase angle of voltage of each harmonic from 2nd to n[*2]th in relation to voltage of the 1st harmonic
DGA1	DGA2[*1]	DGA3	Phase angle of voltage of each harmonic from 2nd to n[*2]th in relation to current of the 1st harmonic
Hz			PLL source frequency

*1 : Not possible with the three-phase, three-wire model (253620).

*2 : "n" is the upper limit of the harmonic order.

List of Selectable Output Items

When "norm" is Selected as the Output Function:

U(V)	I(A)	P(W)
S(VA)	Q(var)	PF(PF)
Frq(Frequency)	WH(Wh)[*1]	WHP(WhP)[*1]
WHM(WhM)[*1]	AH(Ah)[*1]	AHP(AhP)[*1]
AHM(AhM)[*1]	dEG(deg)	UP(V peak)
IP(A peak)	η(Efficiency, computation etc.)	Time(Elapsed time of integration)[*1]
Tor(Torque)[*2]	rpm(rpm)[*2]	Srpm(Synchronous speed)[*2]
SLIP(Slip)[*2]	Pm(Mechanical power)[*2]	ηmot(Motor efficiency)[*2]
ηtot(Total efficiency)[*2]		

*1 : Available when the instrument is equipped with the integration function

*2 : Available with the WT1030M only

When "HAr" is Selected as the Output Function

U(V)	I(A)	P(W)
S(VA)	Q(var)	PF(PF)
Frq(Frequency [*2])	dEG(Phase angle)	THD(Distortion of voltage)
THD(Distortion of current)	UCON(Content of voltage)	ICON(Content of current)
PCON(Content of power)	UDEG(Phase angle of voltage)	IDEG(Phase angle of current)
Tor(Torque)[*1]	rpm(rpm)[*1]	Srpm(Synchronous speed)[*1]
SLIP(Slip)[*1]	Pm(Mechanical power)[*1]	ηmot(Motor efficiency)[*1]
ηtot(Total efficiency)[*1]		

*1 : Available with the WT1030M only

*2 : PLL source frequency

Note

- If many output items are selected, it may take some time before they are output depending on the state of the instrument (sample rate, harmonic analysis, printing). In this case, reduce the number of output items or hold measurement.
- If you want to output data at high speed, select the binary format.

15.2 Using the GP-IB Interface

The instrument is equipped with a GP-IB interface in accordance with your preference. This interface permits remote control from a controller such as a personal computer, and output of various data.

Overview of the GP-IB Interface

The table below shows functions that are available in each mode.

Mode	Function	
Addressable mode (mode A and mode B)	Listener	• Functions performed by front panel key operations (except for LOCAL key and power ON/OFF) • Measured/computed data output request • Panel set-up information output request • Error code output request
	Talker	• Measured/computed data output • Panel set-up information output • Error code output • Status byte output
Talk-only mode	Talker	Measured/computed data output

Addressable Mode A

Measured data is output when an "OD" (measured data output request command) is received. This mode enables transmission of measured data at a specified time.

Addressable Mode B

This mode does not require a measured data query command. When measured data is requested by the controller (personal computer etc.), the data is output as the display is updated when measurement is completed. Therefore, if an attempt is made to transmit measured data at intervals shorter than the display intervals, the controller is forced to wait until the next display interval.

488.2 Mode

Protocol commands complying to IEEE St'd 488.2-1987 can be used.

Talk-only Mode

This mode does not require a controller. Measured data is output at certain intervals. The interval can be set to any length. This mode is useful when the instrument is connected to a listener-only device such as a printer.

GP-IB Interface Specifications

Electrical and mechanical specifications : Conforms to IEEE Std 488-1978 (JIS C 1901-1987)
Functional specifications : refer to the table blow.
Code : ISO (ASCII) code
Address setting : listener and talker addresses 0 to 31 or talk-only can be selected using the front panel keys.
Remote mode clear : remote mode can be cleared by pressing the LOCAL key on the front panel. However, this is not possible if Local Lockout has been set by the controller.

Function	Subset Name	Description
Source handshaking	SH1	Full source handshake capability
Acceptor handshaking	AH1	Full acceptor handshake capability
Talker	T5	Basic talker capability, serial polling, untalk on MLA (My Listen Address), talk-only capability
Listener	L4	Basic listener capability, unlisten on MTA (My Talk Address), no listen-only capability
Service request	SR1	Full service request capability
Remote local	RL1	Full remote/local capability
Parallel poll	PP0	No parallel polling capability
Device clear	DC1	Full device clear capability
Device trigger	DT1	Full device trigger capability
Controller	C0	No controller function

Response to Interface Messages

IFC (Interface Clear)

Cancels (unaddresses) talker and listener.

REN (Remote Enable)

Transfers the instrument from local control to remote control.

GTL (Go To Local)

Transfers the instrument from remote control to local control.

SDC (Selective Device Clear), DCL (Device Clear)

Clears GP-IB input/output buffer, and resets an error. The set-up information and measurement state are not affected.
DCL is applicable to all devices on the bus, whilst DSC is applicable only to designated devices.

GET (Group Execute Trigger)

Same function as the TRIG key.

LLO (Local Lockout)

Invalidates the LOCAL key on the front panel to inhibit transfer from remote control to local control.

Switching between Remote and Local Mode

When Transferred from Local to Remote Mode

The REMOTE indicator LED will light up. All front panel keys except the LOCAL key cannot be operated any more. Set-up information entered in local mode is retained.

When Transferred from Remote to Local Mode

The REMOTE indicator LED will go out. All front panel keys can be operated. Set-up information entered in remote mode is retained.

Valid Keys for Remote Control

Pressing the LOCAL key in remote control transfers the instrument to local control. However, this is not possible if Local Lockout has been set by the controller.

WARNING

- **The connectors used in this function have protective covers. When the covers are removed or when using connectors, the voltage ratings across the measuring input and the ground become as follows:**
  Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.
  Voltage across V terminal and ground 600 Vrms max.
  Put the protective cover on the connector when this function is not used.

Setting the Address/Addressable Mode

Procedure

Setting the Addressable/Talk-only Mode

Press the LOCAL key to display the mode setting screen on display B. Pressing the ∧ or ∨ key changes the mode in the order of "Addr A" ∅ "Addr b" ∅ "tonLy" ∅ "488.2" and back to "Addr A".

Select the desired mode, then press the ENTER key.

Setting the Address

If addressable mode (AddrA, AddrB or 488.2) is selected, the address setting screen will be displayed on display D.

Press the ∧, ∨, < or > key to select the desired address, then press the ENTER key.

Setting the Output Interval (when talk-only mode is selected)

If talk-only mode (tonly) is selected, the output interval setting screen will be displayed on display D.

Press the ∧, ∨, < or > key to set the desired interval (in units of hour, minute and second), then press the ENTER key.

Setting the Sending Terminator (when mode except for 488.2 is selected)

When the address or output interval is set, the sending terminator setting screen will be displayed on display D.

Pressing the ∧ or ∨ key changes the terminator in the order of CrLF ∅ LF ∅ Eoi and back to CrLF. Select the desired terminator, then press the ENTER key.

Note

- For 488.2 mode (command specified in IEEE488.2-1987), the sending terminator is fixed to LF. Thus, the sending terminator setting screen will not be displayed if 488.2 is selected.

Description

Setting the Mode

For details, refer to page 15-4.

Setting the Address

A particular address is assigned to each device connected to the GP-IB interface so that each device can be recognized by every device. Therefore, an address must be assigned to this instrument when it is connected to a personal computer.

Setting range : 0 to 30

Default setting : 1

Setting the Output Interval

If talk-only mode is selected, it is necessary to set the intervals at which data is to be output.

Setting range : 00.00.00 (0 h 0 min 0 s) to 99.59.59 (99 h 59 min 59 s)

Default setting : 00.00.00

If the output interval is set to 00.00.00, data will be output at every sample rate (at every display update in the case of harmonic analysis).

Terminator

- When this instrument is used as a listener
  Use "CR+LF", "LF" or "EOI" as the receiving terminator.
- When this instrument is used as a talker
  Use "CR+LF+EOI", "LF" or "EOI" as the sending terminator. The default setting is "CR+LF+EOI".

Using an IEEE488.2-1987 Command

Select "488.2" in the mode setting screen. For a description of each command, refer to Appendix 2.

Note

- It is not possible for this instrument to receive data if only the "CR" terminator is sent from the controller. It is also not possible to set "CR" as the terminator which is to be sent from this instrument.

15.3 Using the RS-232-C Interface

The instrument is equipped with an RS-232-C interface in accordance with your preference. This interface permits remote control from a controller such as a personal computer, and output of various data.

Overview of the RS-232-C Interface

The table below shows functions that are available in each mode.

Mode	Function	
Normal mode	Reception	• Functions performed using front panel key operations (except for LOCAL key and power ON/OFF)
		• Measured/computed data output request • Panel set-up information output request • Error code output request
	Transmission	• Measured/computed data output • Panel set-up information output • Error code output • Status byte output
Talk-only mode	Transmission	• Measured/computed data output

Normal Mode

This mode is equivalent to addressable mode A of the GP-IB interface function, and enables reception of commands and transmission of measured data. Measured data is output on reception of the OD command.

488.2 Mode

The command being use at GP-IB complying to the IEEE St'd 488.2-1987 standard can be received.

Talk-only Mode

There is no mode that is equivalent to the addressable mode B of the GP-IB interface function with this instrument.

RS-232-C Interface Specifications

Electrical characteristics	Conforms to EIA RS-232-C.
Connection	Point-to-point
Communications	Full-duplex
Synchronization	Start-stop system
Baud Rate	75, 150, 300, 600, 1200, 2400, 4800 and 9600
Start Bit	1 bit
Data Length (Word Length)	7 or 8 bits
Parity	Even, odd or no parity
Stop Bit	1 or 2 bits
Hardware Handshaking	User can select whether CA and CB signals will always be True, or be used for control.
Software Handshaking	User can select whether to control only transmission or both transmission and reception using X-on and X-off signals. X-on: ASCII 11H X-off: ASCII 13H
Receive Buffer Size	256 bytes

WARNING

- **The connectors used in this function have protective covers. When the covers are removed or when using connectors, the voltage ratings across the measuring input and the ground become as follows:**
  Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.
  Voltage across V terminal and ground 600 Vrms max.

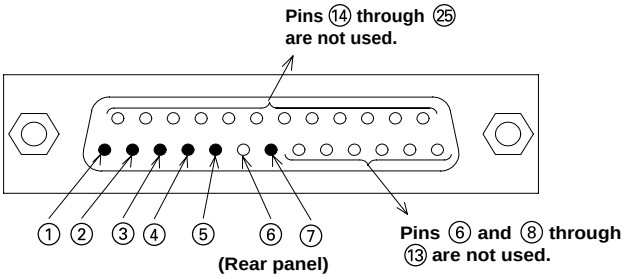
  Put the protective cover on the connector when this function is not used.

Connecting the RS-232-C Interface Cable

When connecting this instrument to a personal computer, make sure that the handshaking method, data transmission rate and data format selected for the instrument match those selected for the computer. Also make sure that the correct interface cable is used.

Connector and Signal Names

Numbers in the figure represent pin nos.



RS-232-C connector: DBSP-JB25S or equivalent

1	AA (GND; Protective Ground)	Grounded to the case of this instrument.
2	BA (TXD; Transmitted Data)	Data transmitted to personal computer Signal direction: Output
3	BB (BXD; Received Data)	Data received from personal computer Signal direction: Input
4	CA (RTS; Request to Send)	Signal used to handshake when receiving data from personal computer Signal direction: Output
5	CB (CTS; Clear to Send)	Signal used to handshake when transmitting data to personal computer Signal direction: Input
7	AB (GND; Signal Ground)	Ground for signals

Note

- Pins 6 and 8 through 25 are not used.

Signal Direction

The figure below shows the direction of the signals used by the RS-232-C interface.

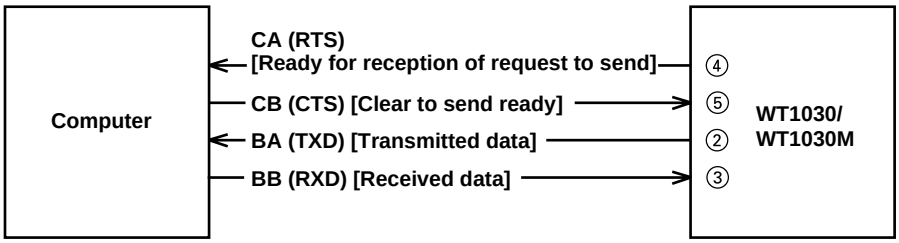


Table of RS-232-C Standard Signals and their JIS and CCITT Abbreviations

Table

Pin No. (25-pin connector)	Abbreviations			Name
	RS-232-C	CCITT	JIS	
①	AA(GND)	101	FG	Protective ground
⑦	AB(GND)	102	SG	Signal ground
②	BA(TXD)	103	SD	Transmitted data
③	BB(RXD)	104	RD	Received data
④	CA(RTS)	105	RS	Request to send
⑤	CB(CTS)	106	CS	Clear to send
6	CC(DSR)	107	DR	Data set ready
20	CD(DTR)	108/2	ER	Data terminal ready
22	CE(RI)	125	CI	Ring indicator
8	CF(DCD)	109	CD	Data channel received carrier detect
21	CG(-)	110	SQD	Data signal quality detect
23	CH/CI(-)	111	SRS	Data signal rate select
24/15	DA/DB(TXC)	113/114	ST_1/ST_2	Transmitter signal element timing
17	DD(RXC)	115	RT	Receiver signal element timing
14	SBA(-)	118	BSD	Secondary transmitted data
16	SBB(-)	119	BRD	Secondary received data
19	SCA(-)	120	BRS	Secondary request to send
13	SCB(-)	121	BCS	Secondary clear to send
12	SCF(-)	122	BCD	Secondary received carrier detect

* Circles indicate pins used for the RS-232-C interface of this instrument.

Setting Communications Mode, Handshake Mode, Data Format and Baud Rate Procedure

Selecting the Item

Press the LOCAL key to display the item setting screen on display B. Pressing the ∧ or ∨ key changes the item in the order of "hAnd" ∅ "For" ∅ "b-rAtE" ∅ "tErn" ∅ "nodE" and back to "hAnd".

Select the desired item, then press the ENTER key to confirm the selection.

Setting the Normal/Talk-Only Mode

If "MODE" is selected and confirmed, the mode setting screen will be displayed on display D. The mode changes in the order of "nor" ∅ "tonLy" ∅ "488.2" and back to "nor".

Select the desired mode using the ∧, ∨, < and > keys, then press the ENTER key.

Setting the Handshake Mode, Data Format, Baud Rate and Sending Terminator

If "HAND" is selected and confirmed, the handshake mode setting screen will be displayed on display D. Press the ∧ or ∨ key to select the desired handshake mode, then press the ENTER key. The format setting screen will be displayed on display D.

Set the data format, baud rate and sending terminator by the same method the handshake mode is selected.

Setting the Output Interval (when talk-only mode is selected)

If talk-only mode is selected in the normal/talk-only mode setting screen, the output interval setting screen will be displayed on display D.

Press the ∧, ∨, < or > key to set the desired interval (in units of hour, minute and second), then press the ENTER key.

Description

Setting the Mode

For details, refer to page 15-7.

Handshaking

To use an RS-232-C interface to transfer data between this instrument and a computer, it is necessary to use certain procedures by mutual agreement to ensure the proper transfer of data. These procedures are called "handshaking." Various handshaking systems are available depending on the computer to be used; the same handshaking system must be used for both computer and this instrument.

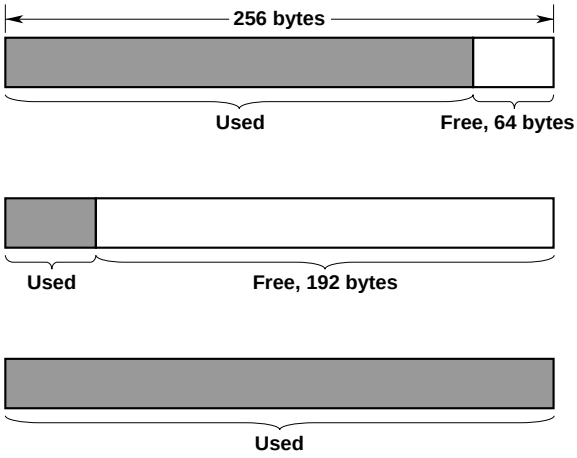
This instrument allows you to choose any handshaking mode from the following four using the panel keys.

Handshaking System Combinations (A circle indicates that the function is available.)

Mode selection no.	Data sending control (Control method when sending data to computer)			Data receiving control (Control method when receiving data from computer)		
	Software handshake	Hardware handshake		Software handshake	Hardware handshake	
	Sending stops when X-off is received, and sending is resumed when X-on is received.	Sending stops when CB (CTS) is False, and sending is resumed when CB is True.	No handshake	X-off is sent when received data buffer becomes 3/4-full, and X-on is sent when received data buffer becomes 1/4-full.	CA (RTS) is set to False when received data buffer becomes 3/4-full, and is set to True when received data buffer becomes 1/4-full.	No handshake
0			○			○
1	○			○		
2	○				○	
3		○			○	

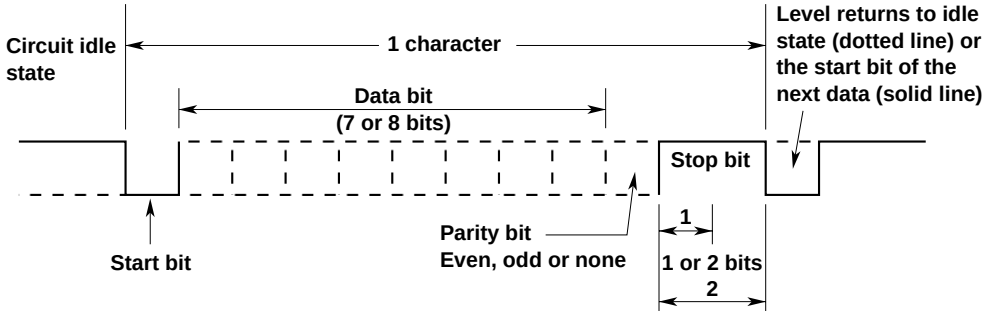
Precautions Regarding Data Receiving Control

When handshaking is used to control received data, data may still be sent from the computer even if the free space in the receive buffer drops below 64 bytes. In this case, after the receive buffer becomes full, the excess data will be lost, whether handshaking is in use or not. Data storage to the buffer will begin again when there is free space in the buffer.



Data Format

The RS-232-C interface of this instrument performs communications using start-stop synchronization. In start-stop synchronization, one character is transmitted at a time. Each character consists of a start bit, data bits, a parity bit, and a stop bit. (Refer to the figure below.)



Data combinations are given below.

Preset value	Start bit	Data length	Parity	Stop bit
0	1	8	No	1
1	1	7	Odd	1
2	1	7	Even	1
3	1	7	No	2

Baud Rate

The baud rate can be selected from 75, 150, 300, 600, 1200, 2400, 4800 or 9600.

Setting the Output Interval

If talk-only mode is selected, it is necessary to set the intervals at which data is to be output.

Setting range : 00.00.00 (0 h 0 min 0 s) to 99.59.59 (99 h 59 min 59 s)

Default setting : 00.00.00

If the output interval is set to 00.00.00, data will be output at every sample rate (at every display update in the case of harmonic analysis).

Terminator

"CR+LF" or "LF" can be used as the terminator.

The receiving terminator can be selected from "CR+LF", "LF" or "CR".

Using an IEEE488.2-1987 Command

Select "488.2" in the mode setting screen. For a description of each command, refer to Appendix 2.

Commands

The interface message function of the GP-IB interface is assigned to the following commands at the RS-232-C interface.

<ESC>S

Equivalent to GP-IB's serial poll function. Status byte is output when the S command is received following reception of the <ESC> code (1BH).

<ESC>R

Equivalent to GP-IB's remote/local control function. The instrument is placed in remote status and panel keys become invalid when the R command is received following reception of the <ESC> code (1BH). Press the LOCAL key to exit from the remote status.

<ESC>L

Equivalent to GP-IB's remote/local control function. When the instrument is in remote status, the instrument will be placed in local status when the L command is received following reception of the <ESC> code (1BH).

<ESC>C

Equivalent to GP-IB's device clear function. The communication devices of this instrument are initialized when the C command is received following reception of the <ESC> code (1BH).

Note

- Error code 390 may be displayed depending on the state of the instrument. In this case, decrease the baud rate.

16.1 Calibration and Corrective Actions in Cases where Hardware Fails

Calibration

To maintain high measurement accuracy, the instrument should be calibrated every three months. We recommend that calibration of the instrument is not carried out by your power meter calibration facility. Calibration should always be carried out by YOKOGAWA. For details, contact YOKOGAWA or your YOKOGAWA sales representative.

Apparent Hardware Failure - Check these Things First!

If the instrument does not operate properly even if the actions given in the table below are performed, contact YOKOGAWA or your YOKOGAWA sales representative. When contacting them, tell them the ROM version no. displayed on display B on power-up.

Symptom	What to Check	Reference Pages
Nothing is displayed when the power is turned ON.	• Is the power cord securely connected to the power connector of the instrument and the AC outlet? • Is the power voltage within the allowed range? • Has the fuse blown?	2-4,2-5
Displayed data is odd.	• Are the ambient temperature and humidity within the allowed range? • Is there noise? • Are measurement leads connected correctly? • Is the line filter off?	2-2,3-1, 3-2,3-4, 4-1
Keys do not function.	• Is the KEY LOCK indicator LED off? • Is the REMOTE indicator LED off?	1-5,14-4, 15-5
Instrument cannot be controlled via GP-IB interface.	• Does the GP-IB address specified in the program match the address set up in the instrument? • Does the interface meet the IEEE Standard 488-1978 electrical and mechanical requirements?	15-4,15-6
Instrument cannot be controlled via RS-232-C interface.	• Are the instrument and controller using the same communications settings?	15-7,15-8

16.2 Error Codes and Corrective Actions

Error Codes for Operation and Measurement

Error Code	Description	Corrective Action	Reference Pages
11	Received command not used by the instrument	Check for error in the command sent.	Appendix
12	Parameter value specified is outside allowed range.	Correct the value.	—
13	Attempt made to execute a key operation or received a communications command, while integration was running or was interrupted, that cannot be executed or received in such a state.	Check whether integration is in progress or is interrupted.	8-13, Appendix
15	Attempt made to execute a command or key operation that was protected.	Check whether the command or key operation is correct.	Appendix
16	Attempt made to execute a key operation or received a communications command, while harmonic analysis was being performed or was interrupted, that can not be executed or received in such state.	Check whether harmonic analysis is in progress or is interrupted.	—
17	Stop time had passed when auto print mode is turned ON.	Correct the stop time. The stop time must be after the current time.	12-8
18	Date/time cannot be set properly.		—
30	No data stored in the selected set-up information file.	Select a file in which set-up information has been stored.	14-1
41	• Attempt made to start integration while there is an overflow condition. • Attempt made to start integration after integration time has reached timer preset value.	Reset integration.	8-11
42	Attempt made to start integration while integration is in progress.		8-10
43	Measurement stopped due to overflow during integration or due to a power failure.		8-11
44	Attempt made to stop integration even though integration was not in progress.		8-11
45	Attempt made to reset integration even though integration was not in progress or integration mode was not selected.		8-11
46	Attempt made to start integration while measurement of peak overflow was in progress or during an overrange condition.		8-10
47	Attempt made to start integration in continuous integration mode when integration timer preset time was set to "0".	Set a correct preset time.	8-8, 8-9
48	Attempt made to start integration in real time counting integration mode when the stop time had already passed.	Set a correct start/stop time.	8-9
51	Measurement data overflow occurred. "- oL -" is displayed.		1-4
52	Voltage peak overflow occurred. PEAK OVER indicator LED lights up.		1-4
53	Current peak overflow occurred. PEAK OVER indicator LED lights up.		1-4
54	Power factor exceeded "2" during measurement of power factor.		—
55	"PFErr" was displayed at the end of power factor computation during measurement of phase angle.		1-4, 5-6
56	Input level was too low or below measurement range during measurement of frequency. "Err-Lo" is displayed.		6-1
57	Measured frequency was above the measurement range. "Err-Hi," is displayed.		6-1
58	Computation overflow occurred. "--oF--" is displayed.		1-4, 7-8
72	Header was not sent to DSP properly.	Initialize the instrument.	14-2
89	Printer's buffer memory was full.	Make sure that the roll chart is set in place.	12-1

Error Codes Regarding Self Diagnosis

Error Code	Description	Corrective Action
60	Set-up information backup data failure (Set-up information is set to factory default.)	
61	EPROM (input element 1) failure	Service required.
62	EPROM (input element 2) failure	Service required
63	EPROM (input element 3) failure	Service required
64	EPROM (D/A board) failure	Service required
65	Sampling clock (input element 1) failure	Service required
66	Sampling clock (input element 2) failure	Service required
67	Sampling clock (input element 3) failure	Service required
68	EEPROM (motor board) failure	Service required
69	Lithium battery voltage drop	Service required
70	Communications interface board not installed.	Service required
71	DSP communications failure	Service required
73	Printer communications failure	Service required
74	Printer communications failure (ROM failure)	Service required
75	DSP program RAM failure	Service required
79	ROM checksum error	Service required
80	RAM read/write check error	Service required
81	DSP data RAM failure	Service required
84	DSP dual port RAM failure	Service required
87	Printer RAM failure	Service required
90	Incorrect board combination	Service required

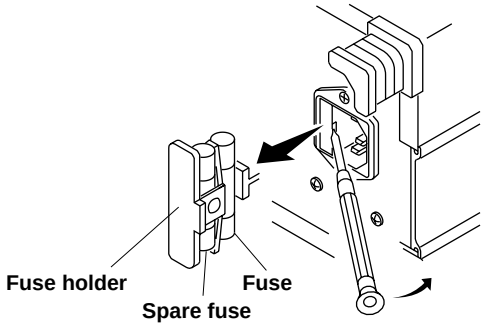
Note

- If the instrument still does not operate properly even if the actions given above are performed, or if a self diagnostic error code is displayed, turn the power ON while holding down the ENTER key. In this case, the set-up information will be set to the default settings (page 2-6.)

16.3 Replacing the Power Supply Fuse

Fuse Position and Replacement Method

The power supply fuse is installed inside the fuse holder located next to the power connector as illustrated below



Fuse Ratings

Max. rated voltage	Max. rated current	Type	Approved standard	Part No.
250 V	5 A	Time lag	UL/VDE	A1353EF

WARNING

- **The fuse used must be of the specified rating in order to prevent a fire hazard. Never use a fuse of any other rating, and never short-circuit the fuse holder to bypass the fuse.**
- **Do not operate the instrument if you have any reason to suspect any defect or problem with the fuse.**

Replacing the Fuse

1. Turn the power switch OFF.
2. Disconnect the power cord from the power connector of the instrument.
3. Place the tip of a flat-blade screwdriver into the slot of the fuse holder, and move the screwdriver in the direction of the arrow to remove the fuse holder.
4. Remove the blown fuse.
5. Insert a new fuse into the holder, then install the holder in place.

16.4 Recommended Parts for Replacement

The 3-year warranty applies only to the main unit of this instrument (starting from the day of delivery) and doesn't cover any other items nor expendable items (items which wear out). In order to use the instrument over a prolonged period of time, we recommend periodic replacement. Contact your nearest Yokogawa sales representative for replacement parts.
Addresses may be found on the back cover of this manual.

Parts mane	Replacement interval
Built-in printer	after printing 200 rolls (parts No. B9293UA) continuously

17.1 Specifications

Input

Item	Voltage V	Current A
Input circuit type	Floating input	
	Resistive voltage divider	Shunt input
Rated inputs (range rms)	15/30/60/100/150/ 300/600/1000V	Direct input: 0.5/1/2/5/10/20 A External input (optional): 250 m/500 m/1/2.5/5/10 V
Input impedance	Approx. 2.4 MΩ, approx. 13 pF	Direct input: Approx. 6 mΩ + approx. 0.07 uH External input: Approx. 100 kΩ
Instantaneous maximum allowable input for 1 cycle, 20 ms	The peak value is 4.0 kV or the RMS value is 2.8 kV, whichever is the lesser.	The peak value is 450 A or the RMS value is 300 A, whichever is the lesser. For the external input , the peak value is 15 times the range or lower.
Instantaneous maximum allowable input for 1 s	The peak value is 2.8 kV or the RMS value is 2.0 kV, whichever is less.	The peak value is 150 A or the RMS value is 40 A, whichever is less. For the external input , the peak value is 10 times the range or lower.
Continuous maximum allowable input	The peak value is 2.0 kV or the RMS value is 1.5 kV, whichever is the lesser.	The peak value is 100 A or the RMS value is 30 A, whichever is the lesser. For the external input , the peak value is 5 times the range or lower.
Continuous max. common mode voltage (at 50/60 Hz)	600 Vrms (when the protective cover for the output connector is used)CAT II, 400 Vrms (when the protective cover for the output connector is removed)CAT II	
Common mode rejection ratio at 600 Vrms between input terminals and case	(Voltage input shorted and current input open) 50/60 Hz ±0.01% of rng or lower Reference value: 100 kHz max. ±((maximum range rating)/(range rating) × 0.001 × f% of rng), 0.01% or higher (f: kHz)	
Input terminals	Binding posts	Large binding posts External input: BNC
A/D conversion	Simultaneous sampling of Voltage and Current inputs, Resolution: 16 bits, Maximum conversion rate: approx. 17 us	
Range switching	Manual, automatic and communications control Range can be selected for each element.	
Auto range switching	Range up: When the peak value exceeds 3.3 times of the rated range or the measured value exceeds 110% of the rated range Range down: When the measured value becomes less than 30% of the rated range	
Measurement mode	The mode can be set for each element, voltage and current circuit separately. RMS: RMS measurement MEAN: Rectified Mean Calibrated to a RMS sine wave measurement DC: Mean value measurement (DC component)	

Measurement Functions

Item	Voltage/Current	Power
Method	Digital Multiplication System	
Crest factor	Selectable to 3	
Temperature: 23±5°C Humidity: 30% to 75% R.H. Supply voltage: 100V±5% Input waveform: Sine wave Common Mode Voltage: 0 V Line filter: OFF Power factor: cosψ=1 Display accuracy within 3 months after calibration The units of f in the above mentioned formulas is kHz.	DC: ±(0.1% of rdg + 0.2% of rng) 0.5Hz≤f<45Hz: ±(0.1% of rdg + 0.3% of rng) 45Hz≤f≤66Hz: ±(0.1% of rdg + 0.1% of rng) 66Hz<f≤1kHz: ±(0.1% of rdg + 0.2% of rng) 1kHz<f≤10kHz: ±(0.08 × f% of rdg + 0.3% of rng) 10kHz<f≤100kHz: ±(0.04 × f% of rdg + 0.7% of rng) 100KHz<f≤300kHz ±(0.12 × (f-100)% of rdg + 5% of rng) The accuracy when the frequency is between 0.5 Hz and 10 Hz and it is 100 kHz or higher is the theoretical value.	DC: ±(0.2% of rdg + 0.3% of rng) 0.5Hz≤f<45Hz: ±(0.2% of rdg + 0.5% of rng) 45Hz≤f≤66Hz: ±(0.1% of rdg + 0.1% of rng) 66Hz<f≤1kHz: ±(0.2% of rdg + 0.2% of rng) 1kHz<f≤10kHz: ±(0.09 × f% of rdg + 0.4% of rng) 10kHz<f≤100kHz: ±(0.06 × f% of rdg + 1.0% of rng) 100kHz<f≤200kHz ±(0.22 × (f-100)% of rdg + 7% of rng) The accuracy when the frequency is between 0.5 Hz and 10 Hz and it is 100 kHz or higher is the theoretical value.
Effect of power factor The ψ is the phase angle between the voltage and current, and the f is frequency.	—	When cosψ=0 : add ±0.15% of rng to 45Hz ≤f ≤ 66Hz. As reference data, add ±(0.15+0.2 ×f kHz)% of rng, up to 200kHz max. When 1> cosψ >0 : add the product of tanψ and the effect on cosψ = 0.
Effective input range	Within 10 to 110% of range rating	
Temperature coefficient	±0.03% of rng/°C at 5 to 18°C and 28 to 40°C	
Accuracy Within 1 Year	1.5 times of rdg error of the accuracy within 3 months	
Detection accuracy of phase lead/lag	±5 deg (20 Hz to 10 kHz), when both voltage and current inputs are sine wave and their amplitude is 50% of the range rating or higher.	
Line filter function	Measurements are possible with a low-pass filter installed in the input circuit. Cut-off frequency (fc): 500 Hz, 1 kHz, 2 kHz or 6.5 kHz	
Accuracy when Line Filter is ON	Voltage/current: Accuracy (when filter is OFF) + 1% of rdg, when fc/5 below Power: Accuracy (when filter is OFF) + 2% of rdg, when fc/5 below	
Measurable minimum frequency	Display update interval / Minimum frequency 100ms / 25Hz 250ms / 10Hz 500ms / 5Hz 2s / 1.5Hz 5s / 0.5Hz	

Note: The accuracy within 3 months and within 1 year is specified after zero-level calibration is carried out or measuring range (or mode) is changed following elapse of warm-up time (approx. 30 min).

Display Functions

Display update interval:
100 ms, 250 ms, 500 ms, 2 s, 5 s selectable

Peak hold function:
Holds the maximum Vpk and Apk.

Response time:
Within two update cycles + 100 ms

Display Scaling Function:
Scaling of PT ratio, CT ratio and power scaling factor

Resolution:
Position of the decimal point and units of measurement are determined so that the resolution of the voltage and current ranges are not exceeded.

Reassign ratio: 0.0001 to 10000

Averaging Function:
During normal measurement
Algorithm: Two algorithms can be selected
- Exponential averaging
- Moving averaging

For exponential averaging the attenuation constant can be selected and for the moving averaging the number of averages can be set to 8, 16, 32, 64, 128, 256.

During harmonic analysis
In the case of exponential averaging, the attenuation constant shall be 5.625 when the frequency of the PLL source is between 55 Hz and 75 Hz. Otherwise, the attenuation constant shall be 4.6875.

Frequency Measurement Functions

Input : Can be selected from V1, V2, V3, A1, A2 or A3.
Operafing principle : Reciprocal counting method
Frequency ranges :

Display update interval	Frequency range
100ms	40Hz-f-500kHz
250ms	20Hz-f-500kHz
500ms	10Hz-f-500kHz
2s	2Hz-f-100kHz
5s	1.5Hz-f-90kHz

Accuracy : ±(0.05% of rdg + 1 digit)
1.5 Hz - f - 300 kHz : Minimum input is 10% of range rating.
300 kHz < f - 500 kHz : Minimum input is 30% of range rating.
Frequency filter must be ON when the input frequency is 100 Hz or below.
When frequency filter is switched ON, the input frequency must be less than 440 Hz (30% of range rating or higher) to obtain the specification accuracy.

Communication Functions

Communication Specifications (GP-IB & RS-232-C)
GP-IB
Electrical and mechanical specifications : IEEE St'd 488-1978
Interface functions : SH1, AH1, T5, L4, SR1, RL1, PR0, DC1, DT1, C0
Protocol : IEEE St'd 488.2-1987
Code : ISO (ASCII) code
Address : Talker/listener address (0 to 30)
RS-232-C
Transmission mode : Start Stop Synchronization
Baud Rate : 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps

Computing Functions

		Active Power	Apparent Power	Reactive Power (var)	Power Factor (PF)	Phase Angle (deg)
Computation	1-phase 2-wire	$\overset{(W)}{W}$	$VA=\overset{(VA)}{V} \times A$	$\sqrt{(VA)^2 - W^2}$	$\frac{W}{VA}$	$\cos^{-1}(\frac{W}{VA})$
	1-phase 3-wire	W_i $i=1, 3$ $\Sigma W = W_1+W_3$	$VA_i=V_i \times A_i$ $i=1, 3$ $\Sigma VA = VA_1+VA_3$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ $i=1, 3$ $\Sigma var = var_1+var_3$	$PF_i = \frac{W_i}{VA_i}$ $i=1, 3$ $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{W_i}{VA_i})$ $i=1, 3$ $\Sigma\varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 3-wire (two power meter method)	W_i $i=1, 3$ $\Sigma W = W_1+W_3$	$VA_i=V_i \times A_i$ $i=1, 3$ $\Sigma VA = \frac{\sqrt{3}}{2}(VA_1+VA_3)$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ $i=1, 3$ $\Sigma var = var_1+var_3$	$PF_i = \frac{W_i}{VA_i}$ $i=1, 3$ $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{W_i}{VA_i})$ $i=1, 3$ $\Sigma\varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 3-wire (three power meter method)	W_i $i=1, 2, 3$ $\Sigma W = W_1+W_3$	$VA_i=V_i \times A_i$ $i=1, 2, 3$ $\Sigma VA = \frac{\sqrt{3}}{3}(VA_1+VA_2+VA_3)$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ $i=1, 2, 3$ $\Sigma var = var_1+var_3$	$PF_i = \frac{W_i}{VA_i}$ $i=1,2,3$ $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{W_i}{VA_i})$ $i=1, 2, 3$ $\Sigma\varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 4-wire	W_i $i=1, 2, 3$ $\Sigma W = W_1+W_2+W_3$	$VA_i=V_i \times A_i$ $i=1, 2, 3$ $\Sigma VA = VA_1+VA_2+VA_3$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ $i=1, 2, 3$ $\Sigma var = var_1+var_2+var_3$	$PF_i = \frac{W_i}{VA_i}$ $i=1,2,3$ $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{W_i}{VA_i})$ $i=1, 2, 3$ $\Sigma\varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
Computing Range		Depending on selected V and A range	Depending on selected V and A range	Depending on selected V and A range (var•0)	–1 to 0 to 1	–180 to 0 to 180 or 0 to 360
Maximum Display or Display Resolution		30000	30000	30000	±1.0000	0.01
Computing Accuracy		—	±0.001% of VA range	±0.001% of VA range	±0.0001	Calculated from the power factor, with an additional error of ±0.005°

Note 1 : The apparent power (VA), reactive power (var), power factor (PF), and phase angle (deg) measurement in this instrument are computed digitally from the voltage, current and active power. If the input is non-sinusoidal, the measured values may differ from those obtained with instruments employing different measurement principles.

Note 2 : When the Current or Voltage value is less than 0.5% of range, the VA and var will be displayed 0, and PF/deg will be displayed as Error.

Note 3 : Regarding the detected accuracy of the Lead and Lag, both voltage and current of the rated input are specified at 50% or more for sinusoidal waveforms. The detected Lead/Lag accuracy is ±5 degree over the frequency range 20 Hr to 10 kHz.

Note 4 : In the case the 360° is set for the phase angle display method, when the phase angle display shows an angle smaller than 5 degree at 0° and 180°, the accuracy is not specified.

Note 5 : If the scaling value set for each element differ from each other in the case of Σ computation, the number of display digits will be limited so that Σ value does not exceed 30000 when the rated value is input to each corresponding element. A voltage of 5 V (full scale) will be output from the D/A converter as the Σ value obtained when the rated value is input to each corresponding element.

Motor Evaluation Functions (WT1030M Only)

Measurement items:
Torque, rotating speed
Computation items:
Torque, rotating speed, mechanical power, synchronous speed, slip, motor efficiency, total efficiency
Analog input for torque computation:

Input impedance	: Approx. 100 kΩ
Accuracy	: ±(0.1% or rdg + 0.1% of F.S.)
Effective input range	: Max. ±11 V
Rated input	: 10 V/F.S.
Temperature coefficient	: ±0.03% of rng/°C

Analog input for rotating speed computation:

Input impedance	: Approx. 100 kΩ
Accuracy	: ±(0.1% or rdg + 0.1% of F.S.)
Effective input range	: Max. ±11 V
Rated input	: 10 V/F.S.
Temperature coefficient	: ±0.03% of rng/°C

Pulse input for rotating speed computation:

Input impedance	: Approx. 200 kΩ
Accuracy	: ±(0.05% or rdg + 2 digits)

Effective frequency range:

100ms	25Hz-f-200kHz
250ms	10Hz-f-200kHz
500ms	5Hz-f-200kHz
2s	1.5Hz-f-50kHz
5s	0.5Hz-f-25kHz

Input amplitude range : Max. ±10 Vpeak
Effective amplitude : Min. 1 Vpp

D/A Output (Optional)

Number of output channels	: Up to 14. (selectable for each channel)
Accuracy	: Display accuracy ±0.2% of F.S.
Output voltage	: ±5 VDC F.S. at rated value or range (maximum, approx. 7.5 V)
Maximum output current	: ±1 mA
Temperature coefficient	: ±0.05% of F.S./°C
Update rate	: Identical to display update interval

Printer (Optional)

Printed parameters	Normal mode	: Selected numerical items
	THD mode	: Numerical print out of V, A, W, VA, var, deg, PF Bar graph print out of A, W, deg
Printing type		: Thermal line dot printing

Integration Functions (Optional)

Maximum display	: 300000 According to the displayed value, the resolution will be changed.
Modes	: Standard integration mode (timer mode) Continuous integration mode (repeat mode) Manual integration mode
Timer	: When the bmer is set, integration will be stopped automatically.
Setting range	: 000 h : 00 min to 999 h: 59 min (000 h : 00 min will be shown when manual integration mode is selected.)
Count overflow	: If integration count overflows the maximum displayable value, integration stops and the elapsed time is held on the display.
Accuracy	: ±(display accuracy + 0.05% of rdg)
Timer accuracy	: ±0.0005%

Harmonic Analysis (Optional)

Method : PLL synchronization or external sampling clock

Frequency range

PLL synchronization : Fundamental frequency 10 Hz to 440 Hz

External sampling clock : Fundamental frequency 0.5 Hz to 20 Hz

Analysis items : Each harmonic level of V, A, W and deg, active voltage, active current, active power, VA, var, PF and deg of fundamental, phase angle between elements, Σ V, Σ A, Σ W, harmonic distortion, harmonic content

Sampling speed, window width, order

PLL synchronization : Determined according to the input fundamental frequency.

Fundamental frequency	Sampling speed	Window width	Max. analysis Order
10-f<20	f x 2048	4 periods	50(50)
20-f<40	f x 1024	8 periods	50(50)
40-f<70	f x 512	16 periods	50(50)
70-f<130	f x 256	32 periods	50(25)
130-f<250	f x 128	64 periods	50(13)
250-f<440	f x 128	64 periods	50(9)

External sampling clock

Fundamental frequency	Sampling speed	Window width	Max. analysis Order
0.5Hz-f<20	f x 2048	4 periods	50(50)

Values in ( ) are applicable when the anti-aliasing filter is ON.

The external sampling clock has a frequency 2048 times the fundamental frequency, and is square wave with TTL level and 50% duty.

FFT data length : 8192 points

FFT word length : 32 bits

Window function : Rectangular

Accuracy	Voltage/Current	Power
When anti-aliasing filter is ON	0.5Hz-f<45Hz: ±(1% of rdg+0.3% of rng) 45Hz-f-66Hz: ±(1% of rdg+0.1% of rng) 66Hz<f-1kHz: ±(1% of rdg+0.2% of rng) 1kHz<f-3.5kHz: ±(2% of rdg+0.3% of rng) In the case where the fundamental frequency is 50 or 60 Hz, the reflecting level up to the 40th order is –50 dB or lower.	0.5Hz-f<45Hz: ±(2% of rdg+0.5% of rng) 45Hz-f-66Hz: ±(2% of rdg+0.1% of rng) 66Hz<f-500Hz: ±(2% of rdg+0.2% of rng)
When anti-aliasing filter is OFF	Same as for normal measurement mode	

Relative deviation between the fundamental frequency and sampling frequency : Within ±0.03%

Data process : No gap between windows or window overlapping (when the fundamental frequency is 50 or 60 Hz)

Maximum input range (peak value) : 3 times the rated value

General Specifications

Ambient temperature range : 5 to 40°C

Storage temperature : –25 to 60°C (no condensation)

Ambient humidity range : 20 to 80% R. H. (no condensation)

Operating altitude : 2000 m or below

Warm up time : Approx. 30 min.

Insulation resistance : 50 MΩ or more at DC 500 V
(Between input terminals and case, between voltage input terminals and current input terminals, between elements of each input terminal, between input terminals and power plug, between case and power plug)

Withstand voltage : 3700 VAC for 1 minute at 50/60 Hz
(Between input terminals and case, between voltage input terminals and current input terminals, between elements of each input terminal, between input terminals and power plug)
1500 VAC for 1 minute at 50/60 Hz
(Between case and power plug)

Rated power supply : 100 to 120 VAC, 200 to 240 VAC

Allowable range : 90 to 132 VAC, 180 to 264 VAC

Rated power supply frequency : 50/60 Hz

Allowable range : 48 to 63 Hz

Power consumption : 130 VA Max.

Internal clock accuracy : ±30 s in a month

Vibration test condition

Sweep test : Frequency 8 to 150 Hz sweep, all 3 directions for 1 minute

Endurance test : Frequency 16.7 Hz, all 3 directions amplitude 4 mm for 2 h

Impact condition

Impact test : Acceleration 490 m/s^2, all 3 directions

Free fall test : Height 100 mm, 1 time for each 4 sides

External dimensions : Approx. 426 (W) x 132 (H) x 400 (D) mm

Weight : Approx. 10 kg

Accessories
Power code: (x1), fuse: (x2, including a spare one)
External input/output connector: A1005JD (x1)
External input/output connector cable (/EX2): B9284LK (one for each element)
Print paper (/B5): B9293UA (x2)
Rubber feet: A9088ZM: (a pair of, for back feet)
User's Manual (this manual): (x1)

Emission*
Complying Standard:EN55011-Group1, ClassA
This is a Class A product for industrial environment. In a domestic environment, this product may cause radio interference in which cause the user may be required to take adequate measures.
Cable Condition:
Measuring Input
To bundle the wires between source and load for each phase and to separate the input signal wires by less than 50mm between each phase and neutral line.
External Input
To use shielded wires

Immunity*
Complying Standard:EN50082-2:1995
Susceptibility Under Immunity Condition
Measuring Input : ±20% of range max
DA Output : ±40% of range max
Motor Evaluation Functions
Analog Input : within 0.5% of F.S
Pulse Input : within 0.1% of rdg
Waveform Output
Noise Increase: <±1V
Testing Condition
Voltage : rage 300V Input, 240V/50Hz
Current : range 500mA Input, 500mA/50Hz
Motor Evaluation Functions
Analog Input : 0V
Pulse Input : Input, 5V/5Hz

Safety standard*
Complying Standard :EN61010
Overvoltage Category II
Pollution degree 2

* Applies to products manufactured after Jan. 1997 having the CE Mark. For all other products, please contact your nearest YOKOGAWA representative as listed on the back cover of this manual.

Waveform Output (Optional)

Method : D/A output

Conversion rate : Same as that of A/D converter located in the input circuit

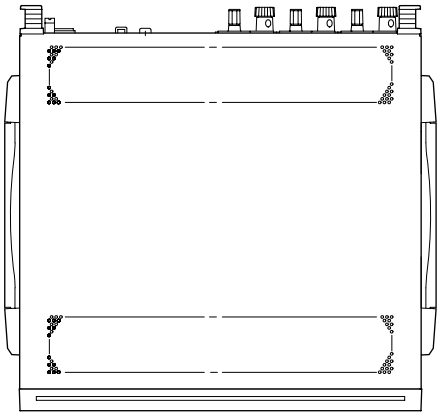
Output voltage : Approx. 2 V for input range

External Control

Signals : EXT-HOLD, EXT-TRIG, EXT-PRINT

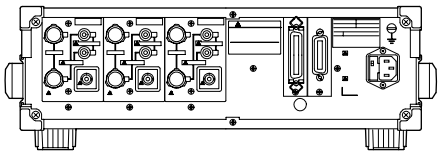
Input level : TTL level (low active)

17.2 External Dimensions

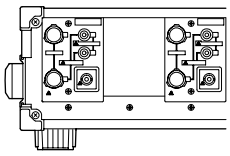


Rear View

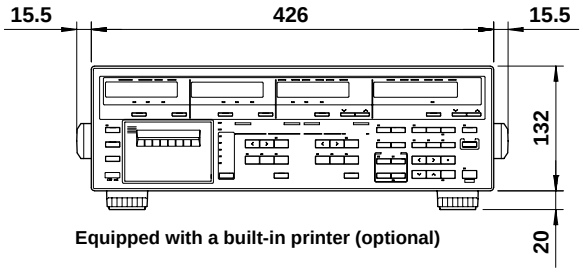
unit: mm



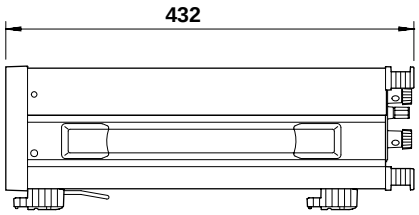
253630 253640



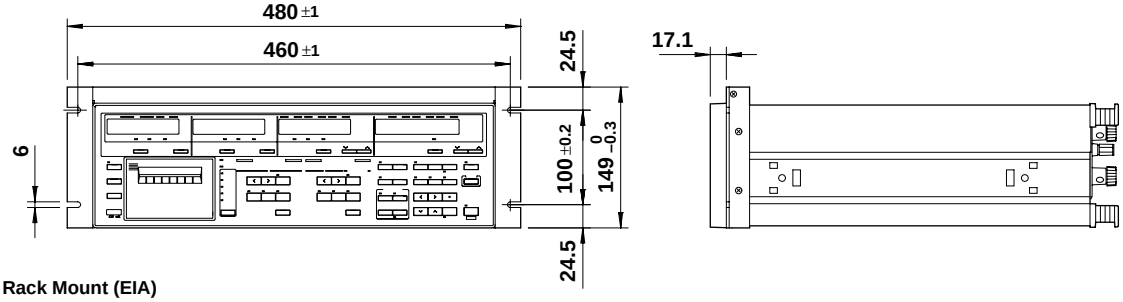
253620



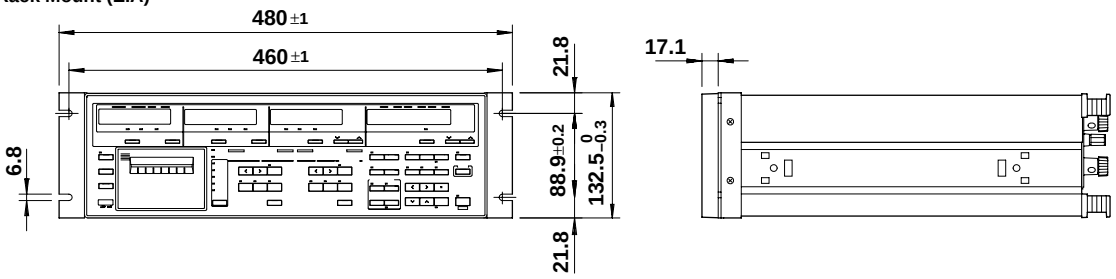
Equipped with a built-in printer (optional)



- **Rack Mount (JIS)**



- **Rack Mount (EIA)**



Unless otherwise specified, tolerance is ±3%. (However, tolerance is ±0.3 mm when below 10 mm.)

Appendix 1.1 List of Communications Commands

For detailed description of each command, refer to the Appendix 1.2.

	Command	Action
Wiring system	WR m (WiRing)	Sets wiring system.
Voltage range	RV m,n (Range Voltage)	Sets voltage range.
	AV m,n (Auto Voltage range)	Sets voltage auto range.
Current range	RA m,n (Range current(A))	Sets current range.
	AA m,n (Auto current(A) range)	Sets current auto range.
	SA m,n (Sensor Ampere)	Sets external sensor current value.
Measurement mode	MV m,n (rms/Mean/dc Voltage)	Sets RMS/MEAN/DC mode for voltage measurement.
	MA m,n (rms/Mean/dc current(A))	Sets RMS/MEAN/DC mode for current measurement.
Peak hold	KH m(peaK Hold)	Sets peak hold ON or OFF.
Frequency measurement	QS m(freQuency Source)	Sets peak hold ON or OFF.
	QF m(freQuency Filter)	Sets source for which frequency measurement is to be performed.
Line filter	FL m (Filter)	Sets line filter ON or OFF.
	FC m (FiLter Cut off frequency)	Sets cut-off frequency.
Display update interval	SI m (Sampling Interval)	Sets sample rate.
Hold	HD m (sampling HolD)	Holds display and output data.
Trigger	E or ST or <GET>	Trigger
Display	DA m (Display A function)	Selects function to be displayed on display A.
	DB m (Display B function)	Selects function to be displayed on display B.
	DC m (Display C function)	Selects function to be displayed on display C.
	DD m (Display D function)	Selects function to be displayed on display D.
	EA m (Element display A)	Selects element to be displayed on display A.
	EB m (Element display B)	Selects element to be displayed on display B.
	EC m (Element display C)	Selects element to be displayed on display C.
	ED m (Element display D)	Selects element to be displayed on display D.
Phase angle display	DG m (DeGree)	Sets phase angle display format.
Scaling	SC m (SCaling)	Sets scaling function ON or OFF.
	KVm,n (K*Voltage)	Sets scaling constant.
	KAm,n (K*Ampere)	Sets scaling constant.
	KWm,n (K*Wattage)	Sets scaling constant.
Averaging	AG m (AveraGing)	Sets averaging function ON or OFF.
	AT m (Averaging Type)	Selects exponential averaging or moving averaging.
	AC m (Averaging Coefficient)	Sets attenuation constant or averaging number.
MATH	MT m (MaThematics)	Sets computing equation.
Zero-level calibration	ZC(Zero Calibration)	Executes zero-level calibration.
Other	DT m1,m2,m3 (DaTe)	Sets date.
	TI m1,m2,m3 (TIme)	Sets time.
Set-up information	SL m (panel Setting Load)	Recall set-up information.
	SS m (panel Setting Save)	Store set-up information.
	RC (Reset Command)	Initializes set-up information.
Communications	CMm (Communication coMmand)	Sets command group to be used.
	OD (Output Data)	Requests output of measured data.
	OF m1,m2 (Output Function)	Sets output items.
	OFD m (Output Function Default)	Sets default output items.
	OS (Output panel Setting)	Requests output of set-up information.
	OE (Output Error code)	Requests output of error code.
	H m (Header)	Sets header for output data.
	TO m (Type of Output data)	Sets type of measured data.
	DL m (DeLimiter)	Selects output data delimiter.
	IM m (Interrupt Mask)	Sets status byte interrupt cause mask.

Note

- If commands relating to options are used on instruments which do not have the options installed, "Error 11" is displayed. Also, there are no responses to inquiries.
- For the ESC commands of the RS-232-C interface, refer to page 15-12.

Optional Commands

	Command	Action
Integration	IS (Integrate Start)	Starts integration.
	IP (Integrate stoP)	Stops integration.
	IR (Integrate Reset)	Resets integrated value.
	IC m (Integrate Continuous)	Sets integration mode.
	TM m1,m2 (integrate TiMer)	Sets integration timer preset time.
	IT m1/m2/m3/m4/m5/m6,m7/m8/m9/m10/m11/m12 (Integrate real Time)	Sets integration start time and stop time.
	IL m (Integrate poLarity)	Sets integration polarity.
Harmonic analysis	HA m (Harmonics Analize)	Sets harmonic analysis ON or OFF.
	HO m (Harmonics Order)	Sets maximum order.
	PS m (Pll Source)	Sets PLL source.
	AF m (Anti-aliasing Filter)	Sets anti-aliasing filter ON or OFF.
	DH m (Display for Harmonics)	Sets display format for harmonic analysis.
	DF m (Distortion Formula)	Sets distortion equation
	HG m (Harmonics deGreee)	Sets phase angle equation for harmonic analysis.
	OR m (harmonics ORder)	Sets order of harmonic to be displayed.
	OH m1,m2 (Output Harmonic function)	Sets output items for harmonic analysis.
	OHD m (Output Harmonics Default)	Sets output items to default settings for harmonic analysis.
Printer	PO (Print Out)	Requests print out.
	FD m (paper FeeD)	Requests paper feed.
	AB (print ABort)	Requests print abort.
	PR m (PRinter)	Sets auto print mode ON or OFF.
	PY m (Print sYnchronous mode)	Sets print synchronous method.
	PI m1,m2,m3 (Print Interval)	Sets print interval for auto print.
	PT m1/m2/m3/m4/m5/m6, m7/m8/m9/m10/m11/m12 (Print real Time)	Sets auto print ON/OFF time.
	PF m1,m2 (Print Function)	Sets print items for normal measurement.
	PFD m (Print Function Default)	Sets print items to default settings for normal measurement.
	PH m1,m2 (Print Harmonics)	Sets print items for harmonic analysis.
	PHD m (Print Harmonics Default)	Sets print items to default settings for harmonic analysis.
	PP (Print Panel setting)	Prints out set-up information.
/DA	OA m1,m2,m3 (Output Analog)	Sets D/A output items manually.
	OAD m (Output Analog Default)	Sets D/A output items to default settings for normal measurement.
	AH m1,m2,m3,m4 (Analog Harmonics)	Sets D/A output items for harmonic analysis.
	AHD m (Analog Harmonics Default)	Sets D/A output items to default settings for harmonic analysis.
	RT m1,m2 (integrate Rated Time)	Sets rated time for integration.
MOTOR	MTF m (Motor Torque Full-scale)	Sets rated torque input value.
	MTU m (Motor Torque Unit)	Sets unit of torque input.
	MRT m (Motor Rpm Type)	Sets rpm input type.
	MRP m (Motor Rpm Pulse)	Sets number of pulses per revolution.
	MRA m (Motor Rpm Analog)	Sets rated rpm analog input value.
	MPL m (Motor PoLe)	Sets number of poles.

Appendix 1.2 Command

AA/AA? **Sets auto or manual range mode for the current ranges/queries the current setting.**

Syntax **AAm1,m2** <terminator>
"m1" indicates input element.
m1= 0 : All elements (setting not possible during query)
1 : Element 1
2 : Element 2 (possible only for the 3-phase 4 wire model)
3 : Element 3
"m2" indicates whether range mode is auto or manual.
m2= 0 : Manual range
1 : Auto range

Query **AAm1?** <terminator>

Response example
AA1,0

Description
- Auto range is not allowed while integration is in progress; execution error 13 will occur.
- If the range is changed during auto range mode, manual range mode will be validated instead of auto range mode.
- If integration is started during auto range mode, auto range mode will be invalidated.
- "m1" of AAm1? indicates the input element selected. If "0" is set, error 12 will occur.

AB **Causes the printer to stop printing.**

Syntax **AB** <terminator>

Description
- This command is not valid unless printing is in progress.

AC/AC? **Sets attenuation constant for normal measurement/queries the current setting. The constant set is used as the attenuation constant for exponential averaging, or as the number of data for moving averaging.**

Syntax **ACm** <terminator>
"m" indicates attenuation constant.
m= 1 : 8
2 : 16
3 : 32
4 : 64
5 : 128
6 : 256

Query **AC?** <terminator>

Response example
AC1

Description
- For the attenuation constant for harmonic analysis, refer to Section 7.5, "Using Averaging Functions".

AF/AF? **Determines whether or not the anti-aliasing filter is used for harmonic analysis/queries the current setting.**

Syntax **AFm** <terminator>
"m" indicates whether anti-aliasing filter is ON or OFF.
m= 0 : OFF
1 : ON

Query **AF?** <terminator>

Response example
AF1

AG/AG? **Determines whether or not averaging should be performed/queries the current setting.**

Syntax **AGm** <terminator>
"m" indicates whether averaging is ON or OFF.
m= 0 : OFF
1 : ON

Query **AG?** <terminator>

Response example
AG0

Description
- Averaging is not allowed while integration is in progress; execution error 13 will occur.

AH/AH? **Sets D/A output items for harmonic analysis/ queries the current setting. Up to 14 items can be selected and output.**

Syntax **AH m1,m2,m3,m4** <terminator>
"m1" indicates the D/A output channel. 1 - m1 - 14
"m2" indicates the output item no.
m2= 0 : No output (None)
1 : Total rms value of 1st up to n*th harmonic of voltage, analysis value of each harmonic from 1st up to n*th
2 : Total rms value of 1st up to n*th harmonic of current, analysis value of each harmonic from 1st up to n*th
3 : Total rms value of 1st up to n*th harmonic of active power, analysis value of each harmonic from 1st up to n*th
4 : Reactive power (var)
5 : Apparent power (VA)
6 : Power factor (PF)
7 : PLL source frequency (Sync)
11 : Phase angle (deg) between fundamentals
16 : Harmonic distortion of voltage (VTHD)
17 : Harmonic distortion of current (ATHD)
19 : Content of each harmonic (from 2nd to n*th) of voltage (V%)
20 : Content of each harmonic (from 2nd to n*th) of current (A%)
21 : Content of each harmonic (from 2nd up to n*th) of active power (W%)
22 : Phase angle of current of 1st and voltage of each harmonic from 2nd to n*th in relation to voltage of the 1st harmonic (Vdeg)
23 : Phase angle of voltage of 1st and current of each harmonic from 2nd to n*th in relation to current of the 1st harmonic (Adeg)
29 : TORQUE (possible only for the WT1030M)
30 : rpm (possible only for the WT1030M)
31 : SYNC-rpm (possible only for the WT1030M)
32 : SLIP (possible only for the WT1030M)
33 : MECH-POWER (possible only for the WT1030M)
34 : MOTOR η (possible only for the WT1030M)
35 : TOTAL η (possible only for the WT1030M)
"m3" indicates element.
m3= 1 : Element 1
2 : Element 2 (possible with the 3-phase 4-wire model only)
3 : Element 3
4 : Σ (V, A, W, var, VA, PF only)
"m4" indicates the order. 0 - m4 - 50
m4= 0 : When total rms value of 1st to n*th of voltage, current or active power or an item except the order is selected
1-n* : When analysis value of each harmonic from 1st to n*th of voltage, current or active power or phase angle (Vdeg, Adeg) is selected
2-n* : When content (V%, A%, W%) is selected
* "n" is the upper limit of the harmonic order.

Query **AHm1?** <terminator>

Response example
AH1,1,1,1

Description
- If m2 is set to "0" (None), make sure that m3 and m4 are set to "1" and "0" respectively, since selection of element and order has no effect. Even if m2 is set to a value except for "0" (None), make sure that m3 and m4 are set to "1" and "0" respectively if the selected item does not relate to element or orde.
- "m1" of AHm1? indicates the D/A output channel.

AHD/AHD? **output items for harmonic analysis to the default settings/queries the current setting. Two sets of default settings are available.**

Syntax **AHDm** <terminator>
m= 1 : Default 1 (DFLT-1)
2 : Default 2 (DFLT-2)
3 : Manual setting (SEL)

Query **AHD?** <terminator>

Response example
AHD1

Description
- Executing the AH command when the setting mode is not manual will activate manual setting mode (AHD3).

AT/AT? Sets averaging type (exponential or moving) for normal measurement/queries the current setting.

Syntax **AMm** <terminator>
"m" indicates averaging type.
m= 0 : Exponential averaging
1 : Moving averaging

Query **AT?** <terminator>

Response example
AT0

Description
- Exponential averaging is always used as averaging method for harmonic analysis.

AV/AV? Sets auto or manual range mode/queries the current setting.

Syntax **AVm1,m2** <terminator>
"m1" indicates input element.
m1= 0 : All elements (setting not possible during query)
1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
"m2" indicates whether range mode is auto or manual.
m2= 0 : Manual range
1 : Auto range

Query **AVm1?** <terminator>

Response example
AV1,0

Description
- Auto range is not allowed while integration is in progress; execution error 13 will occur.
- If the range is changed during auto range mode, manual range mode will be validated instead of auto range mode.
- If integration is started during auto range mode, auto range mode will be invalidated.
- "m1" of AVm1? indicates the input element selected. If "0" is set for m1, error 12 will occur.

CM/CM? Selects command/output format group/queries the current setting.

Syntax **CMn** <terminator>
"m" indicates command/output format group used.
m= 0 : WT1030
1 : 2531 command/output format group
2 : 2533E command/output format group

Query **CM?** <terminator>

Response example
CM0

Description
- For the command/output format which differs from that used for this instrument in case CM1 or CM2 is selected, refer to Appendix 1.5 and 1.6.

DA/DA? Sets the function for display A/queries the current setting.

Syntax **DAm** <terminator>
"m" indicates one of the following functions.
m= 1 : Voltage
2 : Current
3 : Power
15 : Elapsed time of integration (INTEG-TIME) (possible only for the /INTG model)

Query **DA?** <terminator>

Response example
DA1

Description
- Since the order of harmonic is displayed on display A during harmonic analysis, the displayed content will remain unchanged even if a function is selected. This setting becomes effective when normal measurement mode is activated.

DB/DB? Sets the function for display B/queries the current setting.

Syntax **DBm** <terminator>
"m" indicates one of the following functions.
- During normal measurement
  m= 1 : Voltage (V)
  2 : Current (A)
  3 : Power (W)
  32 : SLIP (possible only for the WT1030M)
  34 : MOTOR η (possible only for the WT1030M)
  35 : TOTAL η (possible only for the WT1030M)
- During harmonic analysis
  m= 1 : Analysis value (V) or content (V%) of each harmonic of voltage
  2 : Analysis value (A) or content (A%) of each harmonic of current
  3 : Analysis value (W) or content (W%) of each harmonic of active power
  32 : SLIP (possible only for the WT1030M)
  34 : MOTOR η (possible only for the WT1030M)
  35 : TOTAL η (possible only for the WT1030M)

Query **DB?** <terminator>

Response example
DB2

Description
- It is determined by the display format for harmonic analysis (selected by DH command) whether analysis value or content of each harmonic of voltage/current/power is displayed during harmonic analysis.

DC/DC? Sets the function for display C/queries the current setting.

Syntax **DCm** <terminator>
"m" indicates one of the following functions.
- During normal measurement
  m= 1 : Voltage (V)
  2 : Current (A)
  3 : Power (W)
  4 : Reactive power (var)
  5 : Apparent power (VA)
  6 : Power factor (PF)
  11 : Phase angle (deg)
  12 : Voltage peak (V peak)
  29 : TORQUE (possible only for the WT1030M)
  31 : SYNC-rpm (possible only for the WT1030M)
  33 : MECH-POWER (possible only for the WT1030M)
- During harmonic analysis
  m= 1 : Analysis value (V) of each harmonic of voltage
  2 : Analysis value (A) of each harmonic of current
  3 : Analysis value (W) of each harmonic of active power
  4 : Reactive power (var)
  5 : Apparent power (VA)
  6 : Power factor (PF)
  11 : Phase angle (deg) between fundamentals
  22 : Phase angle of current of 1st and voltage of each harmonic from 2nd to n*th in relation to voltage of the 1st harmonic (Vdeg)
  23 : Phase angle of voltage of 1st and current of each harmonic from 2nd to n*th in relation to current of the 1st harmonic (Adeg)
  29 : TORQUE (possible only for the WT1030M)
  31 : SYNC-rpm (possible only for the WT1030M)
  33 : MECH-POWER (possible only for the WT1030M)
  * "n" is the upper limit of the harmonic order.

Query **DC?** <terminator>

Response example
DC3

Description
- What is displayed when phase angle (deg) is selected for harmonic analysis is determined by the phase angle formula for harmonic analysis (selected by HG command).

DD/DD? Sets the function for display D/queries the current setting.

Syntax **DDm** <terminator>
"m" indicates one of the following functions.
- During normal measurement
  m= 1 : Voltage (V)
  2 : Current (A)
  3 : Power (W)
  7 : Input voltage frequency (VHz)

8 : Input current frequency (AHz)
9 : Watt-hour (Wh) (possible only for the /INTG model)
10 : Ampere-hour (Ah) (possible only for the /INTG model)
13 : Current peak (A peak)
14 : Efficiency and computed result
24 : Positive watt-hour (possible only for the /INTG model)
25 : Negative watt-hour (possible only for the /INTG model)
26 : Positive ampere-hour (Ah) (possible only for the /INTG model)
27 : Negative ampere-hour (Ah) (possible only for the /INTG model)
30 : rpm (possible only for the WT1030M)

- During harmonic analysis

m= 1 : Total rms value of 1st to n*th harmonic of voltage (V)
2 : Total rms value of 1st to n*th harmonic of current (A)
3 : Total rms value of 1st to n*th harmonic of active power (W)
7 : Input voltage frequency (VHz)
8 : Input current frequency (AHz)
16 : Harmonic distortion of voltage (VTHD)
17 : Harmonic distortion of current (ATHD)
30 : rpm (possible only for the WT1030M)
* "n" is the upper limit of the harmonic order.

Query **DD?** <terminator>
Response example
DD3

Description
- If watt-hour/ampere-hour (Wh, Wh+, Wh-, Ah, Ah+, Ah-) is selected during normal measurement, the integration polarity will also change (IL command) accordingly.

DF/DF? Sets equation for harmonic distortion (THD) for harmonic analysis/queries the current setting.

Syntax **DFm** <terminator>
"m" indicates the equation for harmonic distortion (THD).
m= 0 : IEC
1 : CSA

Query **DF?** <terminator>
Response example
DF0

Description
- For details of equation for harmonic distortion, refer to page 9-11.

DG/DG? Sets the phase angle display method/queries the current setting.

Syntax **DGm** <terminator>
"m" indicates the display method.
m= 0 : 180°
1 : 360°

Query **DG?** <terminator>
Response example
DG0

DH/DH? Determines whether data (V, A, W) is to be displayed as measured value or relative harmonic content on display B during harmonic analysis/queries the current setting.

Syntax **DHm** <terminator>
"m" indicates display type.
m= 0 : Measured value (Value)
1 : Relative harmonic content (Cont)

Query **DH?** <terminator>
Response example
DH0

Description
- When relative harmonic content is chosen, "------" will be displayed on display B if "1" (fundamental) has been selected for the harmonic order for display A.
- Measured value (harmonic) is always displayed on display C.

DL/DL? Sets the terminator for communication output data/queries the current setting.

Syntax **DLm** <terminator>
"m" indicates terminator.

		GP-IB	RS-232-C
m=	0 :	CR LF EOI	CR LF
	1 :	LF	LF
	2 :	EOI	CR

Query **DL?** <terminator>
Response example
DL0

Description
- If measured data to be output via communication is in binary format (TO1), EOI will be used as terminator, but the settings made by the DL command remain unchanged.

DT/DT? Sets the date for the internal clock of the instrument/queries the current setting.

Syntax **DDTm1,m2,m3** <terminator>
"m1" indicates year, and must be set within the following range.
1996 - m1 - 2095
"m2" indicates month, and must be set within the following range.
1 - m2 - 12
"m3" indicates day, and must be set within the following range.
1 - m3 - 30 or 31 or 28 or 29

Query **DT?** <terminator>
Response example
DT1996,4,1

EA/EA? Sets the element for display A/queries the current setting.

Syntax **EAm** <terminator>
"m" indicates element.
m= 1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
4 : Σ

Query **EA?** <terminator>
Response example
EA1

Description
- If elapsed time of integration (INTEG-TIME) is displayed on display A or harmonic analysis is in progress (i.e. the order is displayed on display A), changing the element displayed on display A is not allowed; error 15 will occur.

EB/EB? Sets the element for display B/queries the current setting.

Syntax **EBm** <terminator>
"m" indicates element.
m= 1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
4 : Σ

Query **EB?** <terminator>
Response example
EB1

Description
- If a motor relating function (TORQUE, rpm, SYNC-rpm, SLIP, MECH-POWER, MOTOR η, TOTAL η) is selected on display B, setting an element is not allowed; execution error 15 will occur.

EC/EC? Sets the element for display C/queries the current setting.

Syntax **ECm** <terminator>
"m" indicates element.
m= 1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
4 : Σ

Query **EC?** <terminator>
Response example
EC1

Description • If a motor relating function (TORQUE, rpm, SYNC-rpm, SLIP, MECH-POWER, MOTOR η, TOTAL η) is selected on display C, setting an element is not allowed; execution error 15 will occur.

ED/ED? Sets the element for display D/queries the current setting.

Syntax **EDm** <terminator>
"m" indicates element.
m= 1 :Element 1
2 :Element 2 (possible only for the 3-phase 4-wire model)
3 :Element 3
4 :Σ

Query **ED?** <terminator>

Response example
ED1

Description • If efficiency or computed result (MATH) is displayed on display D, changing the element for display D is not allowed; execution error 15 will occur.
• If a motor relating function (TORQUE, rpm, SYNC-rpm, SLIP, MECH-POWER, MOTOR η, TOTAL η) is selected on display D, setting an element is not allowed; execution error 15 will occur.

E,ST, <interface message GET>

Generates a trigger.

Syntax **E** <terminator>
ST <terminator>
<interface message GET>

Description • This command is valid only during sample hold mode.

FC/FC? Sets the line filter cut-off frequency/queries the current setting.

Syntax **FCm** <terminator>
"m" indicates the line filter cut-off frequency (Fc).
m= 0 :0.500 kHz
1 :1.000 kHz
2 :2.000 kHz
3 :6.500 kHz

Query **FC?** <terminator>

Response example
FC0

Description • It is not possible to change the cut-off frequency during integration if the line filter (FL1) is ON; execution error 13 will occur.

FD Feeds print paper.

Syntax **FDm** <terminator>
"m" indicates number of lines to be feed, and must be within the following range. 1 - m - 20

Response example
FD1

Description • When paper feed is carried out by pressing the FEED key, one line is fed each time the key is pressed.

FL/FL? Determines whether or not line filter is used/ queries the current setting.

Syntax **FLm** <terminator>
"m" indicates whether filter is ON or OFF.
m= 0 :ON
1 :OFF

Query **FL?** <terminator>

Response example
FL0

Description • Filter cannot be switched ON or OFF while integration is in progress; error 13 will occur.
• Filter cannot be switched ON or OFF while harmonic analysis is in progress; error 16 will occur.

H/H? Determines whether or not to add a head to measured data output via communication/ queries the current setting.

Syntax **Hm** <terminator>
"m" indicates whether a header is added or not.
m= 0 :No header added
1 :Header added

Query **H?** <terminal>

Response example
H0

Description • If measured data to be output via communication is in binary format (TO1), no header will be added, but the settings made by the H command remain unchanged.

HA/HA? Determines whether to set the harmonic analysis mode or return to the normal measurement mode/queries the current setting.

Syntax **HAm** <terminator>
"m" indicates whether the mode is harmonic analysis mode or normal measurement mode.
m= 0 :Normal measurement mode
1 :Harmonic analysis mode

Query **HA?** <terminator>

Response example
HA1

Description • It is not possible to activate the harmonic analysis mode while integration is in progress or integration is being interrupted; execution error 13 will occur.
• The integration function cannot be used when the harmonic analysis mode is active. If an attempt is made to start integration using the IS command, execution error 16 will occur.

HD/HD? Determines whether or not output data should be updated/queries the current setting.

Syntax **HDm** <terminator>
"m" indicates whether measured data (display and output) is not updated or updated at every display update interval.
m= 0 :Updates the data at each sampling rate.
1 :Hold

Query **HD?** <terminator>

Response example
HD0

HG/HG? Sets the object for which the phase angle (deg) of fundamentals is to be computed during harmonic analysis/queries the current setting.

Syntax **HGm** <terminator>
"m" indicates the equation for phase angle (deg).
m= 0 :(V1-VN), the phase angle of V1, V2(only 253630 & 253640) and V3 with respect to V1
1 :(V1-AN), the phase angle of A1, A2(only 253630 & 253640) and A3 with respect to V1
2 :(A1-AN), the phase angle of A1, A2(only 253630 & 253640) and A3 with respect to A1
3 :(V2-VN), the phase angle of V1, V2 and V3 with respect to V2, only 253630 & 253640
4 :(V2-AN), the phase angle of A1, A2 and A3 with respect to V2, only 253630 & 253640
5 :(A2-AN), the phase angle of A1, A2 and A3 with respect to A2, only 253630 & 253640
6 :(V3-VN), the phase angle of V1, V2(only 253630 & 253640) and V3 with respect to V3
7 :(V3-AN), the phase angle of A1, A2(only 253630 & 253640) and A3 with respect to V3
8 :(A3-AN), the phase angle of A1, A2(only 253630 & 253640) and A3 with respect to A3
9 :"V-V",
if 253620, V1-V3 and V3-V1
if 253630, V1-V2, V2-V3 and V3-V1
10 :"A-A",
if 253620, A1-A3 and A3-A1
if 253630, A1-A2, A2-A3 and A3-A1
V1 :Fundamental component of the voltage of element 1
V2 :Fundamental component of the voltage of element 2
V3 :Fundamental component of the voltage of element 3
A1 :Fundamental component of the current of element 1
A2 :Fundamental component of the current of element 2
A3 :Fundamental component of the current of element 3

Query **HG?** <terminator>

Response example
HG0

HO/HO? Sets the maximum order for harmonic analysis/ queries the current setting.

Syntax **HOm** <terminator>
"m" indicates the maximum order, and must be set within the following range.
1 - m - 50

Query **HO?** <terminator>

Response example
HO50

Description
- If the set maximum order is smaller than that displayed on display A (set by the OR command for harmonic analysis), the same order as the maximum order will be displayed.

IC/IC? Sets the integration mode/queries the current setting.

Syntax **ICm** <terminator>
"m" indicates one of the following integration modes.
m= 0 : Normal integration mode
1 : Continuous integration mode
2 : Real time counting standard integration mode
3 : Real time counting continuous integration mode

Query **IC?** <terminator>

Response example
IC0

Description
- Changing of the integration mode is not allowed while integration is in progress; execution error 13 will occur.
- If real time counting integration mode (normal or continuous) is used, set both the start time and stop time to times after the current time. Executing the IS command after both the start time and stop time have been set will place the instrument in standby state.
- f continuous integration mode is selected, make sure that the timer preset time is set to a value larger than "0".
- If timer integration is to be carried out in normal integration mode, set the timer preset time to any desired value.

IL/IL? Sets the polarity for integrated result displayed when watt-hour or ampere-hour is selected on display D/queries the current setting.

Syntax **ILm** <terminator>
"m" indicates the polarity.
m= 0 : SUM (Wh or Ah is displayed)
1 : + (Wh+ or Ah+ is displayed)
2 : - (Wh- or Ah- is displayed)

Query **IL?** <terminator>

Response example
IL0

IM/IM? Specifies which causes will be allowed to generate a status byte/queries the current setting.

Syntax **IMm** <terminator>
"m" indicates the cause, and must be set within the following range. 0 - m - 15
m= 1 : Computation end
2 : Integration end
4 : Syntax error
8 : OVER

Query **IM?** <terminator>

Response example
IM15

Description
- If more than one of these causes is to be allowed, set "m" to the sum of their individual "m" values. For instance, if all causes are to be allowed, set "m" to 15 (=1+2+4+8).

IP Stops integration.

Syntax **IP** <terminator>

Description
- If an attempt is made to stop integration when integration has already been interrupted (stopped), execution error 44 will occur.

IR Resets integrated result.

Syntax **IR** <terminator>

Description
- If an attempt is made to reset the integrated result while integration is in progress, execution error 45 will occur.

IS Starts integration.

Syntax **IS** <terminator>

Description
- If an attempt is made to start integration when integration is already in progress, execution error 42 will occur.
- If a voltage or current peak overflow, or overrange takes place when an attempt is made to start integration, execution error 46 will occur, and integration will not be started.

IT/IT? Sets the integration start time and stop time/ queries the current settings.

Syntax **ITm1/m2/m3/m4/m5/m6,m7/m8/m9/m10/m11/ m12** <terminator>
"m1" indicates start year
1996 - m1 - 2095
"m2" indicates start month
1 - m2 - 12
"m3" indicates start day
1 - m3 - 30 or 31 or 28 or 29
"m4" indicates start hour
0 - m4 - 23
"m5" indicates start minute
0 - m5 - 59
"m6" indicates start second
0 - m6 - 59
"m7" indicates stop year
1996 - m7 - 2095
"m8" indicates stop month
1 - m8 - 12
"m9" indicates stop day
1 - m9 - 30 or 31 or 28 or 29
"m10" indicates stop hour
0 - m10 - 23
"m11" indicates stop minute
0 - m11 - 59
"m12" indicates stop second
0 - m12 - 59

Query **IT?** <terminator>

Response example
IT1996,4,1,17,35,0,1996,4,3,19,35,0

Description
- If the stop time is before the start time, parameter error 12 will occur.
- Parameters can be separated from each other by a comma (,).

KH/KH? Determines whether or not peak hold is used/ queries the current setting.

Syntax **KHm** <terminator>
"m" indicates whether peak hold is ON or OFF.
m= 0 : OFF
1 : ON

Query **KH?** <terminator>

Response example
KH0

Description
- Peak hold cannot be switched ON or OFF while harmonic analysis is in progress; error 16 will occur.

KV/KV?,KA/KA?,KW/KW? Sets the scaling constant/queries the current setting. KV is used for voltage measurement, KA for current measurement, and KW for power measurement.

Syntax **KV m1,m2** <terminator>
KA m1,m2 <terminator>
KW m1,m2 <terminator>
"m1" indicates element.
m1= 0 : All elements (setting not possible during query)
1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
"m2" indicates scaling constant, and must be set within the following range.
0.0001 - m2 - 10000.

Query **KVm1?** <terminator> **KAm1?** <terminator>
KWm1? <terminator>

Response example
KV1,1.0000 **KA1,1.0000** **KW1,1.0000**

Description
- If KV0?, KA0? or KW0? is set for query, parameter error 12 will occur.

MA/MA? **Sets the measurement mode for current/queries the current setting.**

Syntax **MAm1,m2** <terminator>
"m1" indicates input element.
m1= 0 : All elements (setting not possible during query)
1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
"m2" indicates measurement mode.
m2= 0 :RMS
1 :MEAN
2 :DC

Query **MAm1?** <terminator>

Response example
MA1,0

Description
- Changing of the measurement mode is not allowed while integration is in progress; execution error 13 will occur.
- RMS is always selected as measurement mode during harmonic analysis. If an attempt is made to change it, error 16 will occur.
- "m1" of MAm1? indicates the input element selected. If "0" is set, error 12 will occur.

MPL/MPL? **Sets the number of poles to be used to obtain synchronous speed (SYNC-rpm) from the measured frequency/queries the current setting.**

Syntax **MPLm** <terminator>
"m" indicates the number of poles, and must be even number and set within the following range.
2 - m - 98

Query **MPL?** <terminator>

Response example
MPL2

Description
- If an odd number is set for the number of poles, "1" will be subtracted from the number to make it an even number.

MRA/MRA? **Sets the full-scale value for rpm analog input/ queries the current setting.**

Syntax **MRAm** <terminator>
"m" indicates the full-scale value for rpm analog input, and must be set within the following range.
ROM version before 2.01 0.0001 - m - 10000.
ROM version 2.01 or later 0.0001 - m - 70000.

Query **MRA?** <terminator>

Response example
MRA10000

MRP/MRP? **Sets the number of pulses per revolution/ queries the current setting.**

Syntax **MRPm** <terminator>
"m" indicates the number of pulses per revolution, and must be set within the following range.
ROM version before 2.08 1- m - 1000
ROM version 2.08 or later 1- m - 9999

Query **MRP?** <terminator>

Response example
MRP60

MRT/MRT? **Sets the rpm input type/queries the current setting.**

Syntax **MRTm** <terminator>
"m" indicates the rpm input type.
m= 0 : Pulse
1 : Analog

Query **MRT?** <terminator>

Response example
MRT0

MT/MT? **Sets the MATH equation/queries the current setting.**

Syntax **MTm** <terminator>
"m" indicates one of the following equations.
m= 0 :Efficiency
1 :Crest factor of voltage input waveform applied to input element 1
2 :Crest factor of voltage input waveform applied to input element 2
3 :Crest factor of voltage input waveform applied to input element 3
4 :Crest factor of current input waveform applied to input element 1
5 :Crest factor of current input waveform applied to input element 2
6 :Crest factor of current input waveform applied to input element 3
7 :Display A + Display B
8 :Display A – Display B
9 :Display A x Display B
10 :Display A / Display B

Query **MT?** <terminator>

Response example
MT0

MTF/MTF? **Sets the full scale value for torque input/queries the current setting.**

Syntax **MTFm** <terminator>
"m" indicates the torque input full scale value, and must be set within the following range.
0.0001 - m - 10000.

Query **MTF?** <terminator>

Response example
MTF2000.0

MTU/MTU? **Sets the unit of torque input/queries the current setting.**

Syntax **MTUm** <terminator>
"m" indicates one of the following units.
m= 1 : UNIT-1 (N·m)
2 : UNIT-2 (kgf·m)
3 : UNIT-3 (kgf·cm)
4 : UNIT-4 (mN·m)
5 : UNIT-5 (kN·m)
6 : UNIT-6 (ftlb)
7 : UNIT-7 (ozin)
8 : UNIT-8 (lbin)
2, 3, 6, 7 and 8 can be selected when /U1 option is used.

Query **MTU?** <terminator>

Response example
MTU1

MV/MV? **Sets the measurement mode for voltage/queries the current setting.**

Syntax **MVm1,m2** <terminator>
"m1" indicates input element.
m1= 0 : All elements (setting not possible during query)
1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
"m2" indicates measurement mode.
m2= 0 : RMS
1 : MEAN
2 : DC

Query **MVm1?** <terminator>

Response example
MV1,0

Description
- "m1" of MVm1? indicates the input element selected. If "0" is set, error 12 will occur.
- Changing of the measurement mode is not allowed while integration is in progress; error 13 will occur.
- RMS is always selected as measurement mode during harmonic analysis. If an attempt is made to change it, error 16 will occur.

OA/OA? **Sets D/A output items/queries the current settings. Up to 14 measured data can be selected and output as analog signal from the D/A converter.**

Syntax **OAm1,m2,m3** <terminator>
"m1" indicates D/A output channel, and must be set within the following range.
1 - m1 - 14
"m2" indicates output item no.
m2=0 :No output (None)
1 :Voltage (V)
2 :Current (A)
3 :Power (W)
4 :Reactive power (var)
5 :Apparent power (VA)
6 :Power factor (PF)
7 :Frequency (Frq)
9 :Watt-hour (possible only for the /INTG model)
10 :Ampere-hour (Ah) (possible only for the /INTG model)
11 :Phase angle (deg)
12 :Voltage peak (Vpk)
13 :Current peak (Apk)
14 :Efficiency and computed result (MATH)
15 :Elapsed time of integration (INTEG-TIME) (possible only for the /INTG model)

24 : Positive watt-hour (Wh+) (possible only for the /INTG model)
25 : Negative watt-hour (Wh–) (possible only for the /INTG model)
26 : Positive ampere-hour (Ah+) (possible only for the /INTG model)
27 : Negative ampere-hour (Ah–) (possible only for the /INTG model)
29 : TORQUE (possible only for the WT1030M)
30 : rpm (possible only for the WT1030M)
31 : SYNC-rpm (possible only for the WT1030M)
32 : 32: SLIP (possible only for the WT1030M)
33 : MECH-POWER (possible only for the WT1030M)
34 : MOTOR η (possible only for the WT1030M)
35 : TOTAL η (possible only for the WT1030M)
"m3" indicates element.
m3= 1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
4 : Σ (except for Vpk and Apk)

Query **OAm1?** <terminator>

Response example

OA1,1,1

Description
- It is possible to select non output (m2=0), frequency (m2=7), efficiency and computed result (m2=14), elapsed time of integration (m2=15) and motor related items TORQUE through TOTAL η (m2=29 through 35), whichever element is selected.
  However, it is best to set m3 to 1 if the OA command is used to select any of those items.
- When "14" (efficiency and computed result) is selected for "m2", the D/A output will be 0 V if the equation for MATH selected by MT command is not for efficiency (m=0).

OAD/OAD? Initializes D/A output items/queries the current s ettings. Two sets of default settings are available. The same initialization can also be performed using a key operation.

Syntax **OADm** <terminator>
"m" indicates default no.
m= 1 : Default 1 (DFLT-1)
2 : Default 2 (DFLT-2)
3 : Manual setting (SEL)

Query **OAD?** <terminator>

Response example

OAD1

Description
- Manual setting mode (OAD3) is validated automatically when the OA command is executed if "m" has been set to "1" (default 1) or "2" (default 2).
- If default 1 is selected, items displayed on displays C and D are the same as those output on channels 13 and 14. Therefore, these output items (for channels 13 and 14) will be changed if items on displays C and D are changed.

OD Requests output of measured data.

Syntax **OD** <terminator>

Description
- In the case of GP-IB interface, the OD command should be used only in addressable mode A. If the OD command is used in addressable mode B, execution error 11 will occur. Setting the addressable mode should be done using a key operation.

OE Requests output of error codes via communications.

Syntax **OE** <terminator>

Response example

ERR011 <terminator>

Error code	Description
011	Command error
012	Parameter error
013	Attempted to change settings which cannot be change while integration was in progress.
015	Attempted to execute a command that was protected.
016	Attempted to execute a command that was protected while harmonic analysis was being performed.
017	Stop time had passed when auto print mode was activated.
018	Date/time cannot be set properly.
030	File data failure
041	ttempted to start integration when integration had been stopped due to an irregularity.
042	Attempt made to start integration during integration.
043	Measurement stopped due to overflow during integration or due to a power failure.
044	Attempt made to stop integration while integration was interrupted.
045	Attempt made to reset integration while integration was in progress.
046	Attempt made to start integration when peak overflow was detected.
047	Attempt made to start integration when integration timer preset time was set to "0".
048	Attempt made to start integration, after the stop time had already passed.
051	Measurement data overflow occurred. "-oL" is displayed
052	Voltage peak overflow occurred
053	Current peak overflow occurred
054	Power factor exceeded "2". "PFErr" is displayed.
055	"degErr" was displayed.
056	Frequency input level was too low or below measurement range. "ErrLo" is displayed.
057	Frequency was above the measurement range. "ErrHi," is displayed.
058	Computation overflow occurred. "--oF--" is displayed.
059	Computation overflow occurred. "FrqEr" is displayed.

OF/OF? Sets communication output items for normal measurement/inquiries about the current settings. To set whether or not the selected item is output for each element is possible, and the item for the selected element will be output. (Applicable when CM0 is set)

Syntax **OFm1,m2** <terminator>
"m1" indicates output item no.
m1= 1 : Voltage (V)
2 : Current (A)
3 : Power (W)
4 : Reactive power (var)
5 : Apparent power (VA)
6 : Power factor (PF)
7 : Frequency (Frq)
9 : Watt-hour (possible only for the /INTG model)
10 : Ampere-hour (Ah) (possible only for the /INTG model)
11 : Phase angle (deg)
12 : Voltage peak (Vpk)
13 : Current peak (Apk)
14 : Efficiency and computed result (MATH)
15 : Elapsed time of integration (INTEG-TIME) (possible only for the /INTG model)
24 : Positive watt-hour (Wh+) (possible only for the /INTG model)
25 : Negative watt-hour (Wh-) (possible only for the /INTG model)
26 : Positive ampere-hour (Ah+) (possible only for the /INTG model)
27 : Negative ampere-hour (Ah-) (possible only for the /INTG model)
29 : TORQUE (possible only for the WT1030M)
30 : rpm (possible only for the WT1030M)
31 : SYNC-rpm (possible only for the WT1030M)

32 : SLIP (possible only for the WT1030M)
33 : MECH-POWER (possible only for the WT1030M)
34 : MOTOR η (possible only for the WT1030M)
35 : TOTAL η (possible only for the WT1030M)

"m2" indicates whether each element is ON or OFF, and must be set within the following range.

0 - m2 - 15

m2= 1 : Element 1 is ON
2 : Element 2 is ON. (possible only for the 3-phase 4-wire model)
4 : Element 3 is ON.
8 : Σ is ON. (except for Vpk and Apk)

Query **OFm1?** <terminator>

Response example

OF1,15

Description
- Set "m2" to the sum of their individual "m2" values.

(Examples) m2= 0 : All elements are OFF.
5 : Elements 1 and 3 are ON.
7 : Elements 1, 2 and 3 are ON.
13 : Elements 1, 3 and Σ are ON.
15 : Elements 1, 2, 3 and Σ are ON.

- It is possible to select frequency (m2=7), efficiency and computed result (m2=14), elapsed time of integration (m2=15) and motor related items TORQUE through TOTAL η (m2=29 through 35), whichever element is selected. However, it is best to set m2 to 1 if the OF command is used to select any of those items.
- If an element which is not effective is selected (ON), such selection will be ignored. For instance, if "OF1,15" is set for the 3-phase 3-wire model, element 2 will be ignored, thus "OF1,13" will be responded when a query (OF1?) is made.

OFD/OFD? Initializes communication output items for normal measurement/queries the current settings. Four sets of default setting are available. (Applicable when CM0 is set)

Syntax **OFDm** <terminator>

"m" indicates default no.

m= 0 : All items are OFF. (CLEAR)
1 : Default 1 (DFLT-1)
2 : Default 2 (DFLT-2)
3 : All items are ON. (ALL)
4 : Manual setting (SEL) (Response only when a query is made)

Query **OFD?** <terminator>

Response example

OFD1

Description
- Manual setting mode (OFD4) is validated automatically when the OF command is executed if "m" is set to a value except for "4" (manual setting). Thus, m=4 (manual setting) is effective only for response to a query, and setting OFD4 will not cause an error, but has no effect.

OH/OH? Sets communication output items for harmonic analysis/queries the current settings. It is possible to set whether or not the selected item is output for each element, and the item for the selected element will be output. (Applicable when CM0 is set)

Syntax **OHm1,m2** <terminator>

"m1" indicates output item no.

m2= 0 : No output (None)
m1= 1 : Total rms value of 1st up to n*th harmonic of voltage, analysis value of each harmonic from 1st up to n*th
2 : Total rms value of 1st up to n*th harmonic of current, analysis value of each harmonic from 1st up to n*th
3 : Total rms value of 1st up to n*th harmonic of active power, analysis value of each harmonic from 1st up to n*th
4 : Reactive power (var)
5 : Apparent power (VA)
6 : Power factor (PF)
7 : PLL source frequency (Sync)
11 : Phase angle (deg) between f undamentals
16 : Harmonic distortion of voltage (VTHD)
17 : Harmonic distortion of current (ATHD)
19 : Content of each harmonic (from 2nd to n*th) of voltage (V%)
20 : Content of each harmonic (from 2nd to n*th) of current (A%)
21 : Content of each harmonic (from 2nd up to n*th) of active power (W%)
22 : Phase angle of current of 1st and voltage of each harmonic from 2nd to n*th in relation to voltage of the 1st harmonic (Vdeg)
23 : Phase angle of voltage of 1st and current of each harmonic from 2nd to n*th in relation to current of the 1st harmonic (Adeg)
29 : TORQUE (possible only for the WT1030M)
30 : rpm (possible only for the WT1030M)
31 : SYNC-rpm (possible only for the WT1030M)
32 : SLIP (possible only for the WT1030M)
33 : MECH-POWER (possible only for the WT1030M)
34 : MOTOR η (possible only for theWT1030M)
35 : TOTAL η (possible only for the WT1030M)

"m2" indicates whether each element is ON or OFF, and must be within the following range.

0 - m2 - 15

m2= 1 : Element 1 is ON.
2 : Element 2 is ON. (Possible only for the 3-phase 4-wire model)
4 : Element 3 is ON.
8 : Σ is ON. (V, A, W, var, VA, PF only)
* "n" is the upper limit of the harmonic order.

Query **OHm1?** <terminator>

Response example

OH1,7

Description
- Set "m2" to the sum of their individual "m2" values.

(Examples) m2= 0 : All elements are OFF.
5 : Elements 1 and 3 are ON.
7 : Elements 1, 2 and 3 are ON.

- It is possible to select motor related items TORQUE through TOTAL η (m2=29 through 35), whichever element is selected. However, it is best to set m2 to 1 if the OH command is used to select any of those items.
- If an element which is not effective is selected (ON), such selection will be ignored. For instance, if "OH1,7" is set for the 3-phase 3-wire model, element 2 will be ignored, thus "OH1,5" will be the response when a query (OH1?) is made.

OHD/OHD? Initializes communication output items for harmonic analysis/queries the current settings. Four sets of default setting are available. (Applicable when CM0 is set)

Syntax **OHDm** <terminator>

"m" indicates default no.

m= 0 : All items are OFF. (CLEAR)
1 : Default 1 (DFLT-1)
2 : Default 2 (DFLT-2)
3 : All items are ON. (ALL)
4 : Manual setting (SEL) (Response only when a query is made)

Query **OHD?** <terminator>

Response example

OHD1

Description
- Manual setting mode (OHD4) is validated automatically when the OH command is executed if "m" is set to a value except for "4" (manual setting)Thus, m=4 (manual setting) is effective only for response to a query, and setting OHD4 will not cause an error, but has no effect.

OR/OR? Sets harmonic order to be displayed on display A/ queries the current setting.

Syntax **ORm** <terminator>

"m" indicates harmonic order, and must be set within the following range.

1 - m - 50 (The harmonic order must be smaller than the maximum order.)

Query **OR?** <terminator>

Response example
OR1

Description • If the selected order exceeds the maximum order set by HO command or if it exceeds the maximum limit determined by the fundamental frequency of the input set by PS command, parameter error 12 will occur.

OS

Requests output of panel set-up information via communications.

Syntax **OS** <terminator>

Response example

Line 1: Model name
MODEL253630 <terminator>
Line 2: Voltage range
RV1,9;AV1,0;RV2,9;AV2,0;RV3,9;AV3,0 <terminator>
Line 3: Current range
RA1,4;AA1,0;SA1,1.0000;RA2,4;AA2,0;SA2,1.0000;
RA3,4;AA3,0;SA3,1.0000 <terminator>
Line 4: Display function
DA1;DB2;DC3;DD3; <terminator>
Line 5: Display element
EA1;EB1;EC1;ED1 <terminator>
Line 6: Measurement condition
WR1;FL0;FC0;KH0;QS0;SC0;AG0;HD0;SI0;MT0;
DG0 <terminator>
Line 7: Measurement mode
MV1,0;MV2,0;MV3,0;MA1,0;MA2,0;MA3,0
<terminator>
Line 8: Scaling constant
KV1,1.0000;KA1,1.0000;KW1,1.0000;KV2,10000;
KA2,10000;KW2,10000;KV3,1.0000;KA3,10000;
KW3,1.0000 <terminator>
Line 9: Averaging setting
AT0;AC1 <terminator>
Line 10: Integration setting (possible only for the /INTG model)
IC0;TM0,0;IL0 <terminator>
Line 11: Harmonic analysis setting (possible only for the /HRM model)
DH1;PS1;AF0;DF0;HG0;HO50;HA0;OR1<terminator>
Line 12: Printer setting (possible only for the /B5 model)
PR0;PY0;PI0,0,10 <terminator>
Line 13: D/A output setting (possible only for the /DA model)
RT1,0 <terminator>
Line 14: Motor evaluation setting (possible only for the WT1030M)
MTF2000.0;MTU1;MRT0;MRP60;MRA10000;
MPL2 <terminator>
Line 15: Command/format group
CM0 <terminator>
Line 16: Output end
END <terminator>

Description • The number of lines varies depending on the options used and model type.
• For lines containing items which are set for each element, output items vary depending on the model type.

PF/PF?

Sets print output items for normal measurement/ queries the current settings. To set whether or not the selected item is output for each element is possible, and the item for the selected element will be output.

Syntax **PFm1,m2** <terminator>
"m1" indicates print output item no.
m1= 1 : Voltage (V)
2 : Current (A)
3 : Power (W)
4 : Reactive power (var)
5 : Apparent power (VA)
6 : Power factor (PF)
7 : Frequency (Frq)
9 : Watt-hour (possible only for the /INTG model)
10 : Ampere-hour (Ah) (possible only for the /INTG model)
11 : Phase angle (deg)
12 : Voltage peak (Vpk)
13 : Current peak (Apk)
14 : Efficiency and computed result (MATH)
15 : Elapsed time of integration (INTEG-TIME) (possible only for the /INTG model)
24 : Positive watt-hour (Wh+) (possible only for the /INTG model)
25 : Negative watt-hour (Wh-) (possible only for the /INTG model)
26 : Positive ampere-hour (Ah+) (possible only for the /INTG model)
27 : Negative ampere-hour (Ah-) (possible only for the /INTG model)
29 : TORQUE (possible only for the WT1030M)
30 : rpm (possible only for the WT1030M)
31 : SYNC-rpm (possible only for the WT1030M)
32 : SLIP (possible only for the WT1030M)
33 : MECH-POWER (possible only for the WT1030M)
34 : MOTOR η (possible only for the WT1030M)
35 : TOTAL η (possible only for the WT1030M)
"m2" indicates whether each element is ON or OFF, and must be set within the following range.
0 - m2 - 15
m2= 0 : No output (None)
m2= 1 : Element 1 is ON
2 : Element 2 is ON. (Possible only for the 3-phase 4-wire model)
4 : Element 3 is ON.
8 : Σ is ON.(except for Vpk and Apk)

Query **PFm1?** <terminator>

Response example
PF1,15

Description • Set "m2" to the sum of their individual "m2" values.
(Examples) m2= 0 : All elements are OFF.
5 : Elements 1 and 3 are ON.
7 : Elements 1, 2 and 3 are ON.
13 : Elements 1, 3 and Σ are ON.
15 : Elements 1, 2, 3 and Σ are ON.
• It is possible to select frequency (m2=7), efficiency and computed result (m2=14), elapsed time of integration (m2=15) and motor related items TORQUE through TOTAL η (m2=29 through 35), whichever element is selected. However, it is best to set m2 to 1 if the PF command is used to select any of those items.
• If an element which is not effective is selected (ON), such selection will be ignored. For instance, if "PF1,15" is set for the 3-phase 3-wire model, element 2 will be ignored, thus "PF1,13" will be the response when a query (PF1?) is made.

PFD/PFD?

Initializes print output items for normal measurement/queries the current settings. Four sets of default setting are available.

Syntax **PFDm** <terminator>
"m" indicates default no.
m= 0 : All items are OFF. (CLEAR)
1 : Default 1 (DFLT-1)
2 : Default 2 (DFLT-2)
3 : All items are ON. (ALL)
4 : Manual setting (SEL) (Response only when an inquiry is made)

Query **PFD?** <terminator>

Response example
PFD1

Description • Manual setting mode (PFD4) is validated automatically when the PF command is executed if "m" is set to a value except for "4" (manual setting). Thus, m=4 (manual setting) is effective only for response to a query, and setting PFD4 will not cause an error, but has no effect.

PH/PH? **Sets print output items for harmonic analysis/ queries the current settings. To set whether or not the selected item is output for each element is possible, and the item for the selected element will be output.**

Syntax **PHm1,m2** <terminator>

"m1" indicates print output item no.

m1= 1 : Analysis voltage value and relative harmonic content are printed in numeric. (V)
2 : Analysis current value and relative harmonic content are printed in numeric. (A)
3 : Analysis active power value and relative harmonic content are printed in numeric. (W)
4 : Phase angle of voltage of each harmonic from 2nd to n*th in relation to voltage of the 1st and phase angle of voltage of each harmonic from 2nd to n*th in relation to current of the 1st are printed in numeric. (deg)
5 : Analysis voltage value is printed in graph. (GV)
6 : Analysis current value is printed in graph. (GA)
7 : Analysis active power value is printed in graph. (GW)
8 : Phase angle of voltage of each harmonic from 2nd to n*th in relation to voltage of the 1st is printed in graph. (GVD)
9 : Phase angle of current of each harmonic from 2nd to n*th in relation to current of the 1st is printed in graph. (GAD)
10 : Relative harmonic content of voltage is printed in graph. (CGV)
11 : Relative harmonic content of current is printed in graph. (CGA)
12 : Relative harmonic content of active power is printed in graph. (CGW)
29 : TORQUE (possible only for the WT1030M)
30 : rpm (possible only for the WT1030M)
31 : SYNC-rpm (possible only for the WT1030M)
32 : SLIP (possible only for the WT1030M)
33 : MECH-POWER (possible only for the WT1030M)
34 : MOTOR η (possible only for the WT1030M)
35 : TOTAL η (possible only for the WT1030M)

"m2" indicates whether each element is ON or OFF, and must be within the following range.

0 - m2 - 7

m2= 1 : Element 1 is ON.
2 : Element 2 is ON. (Possible only for the 3-phase 4-wire model)
4 : Element 3 is ON.
* "n" is the upper limit of the harmonic order.

Query **PHm1?** <terminator>

Response example

PH1,7

Description
- Set "m2" to the sum of their individual "m2" values.

(Examples) m2= 0 : All elements are OFF.
5 : Elements 1 and 3 are ON.
7 : Elements 1, 2 and 3 are ON.

- It is possible to select motor related items TORQUE through TOTALη (m2=29 through 35), whichever element is selected. However, it is best to set m2 to 1 if the PH command is used to select any of those items.
- If an element which is not effective is selected (ON), such selection will be ignored. For instance, if "PH1,7" is set for the 3-phase 3-wire model, element 2 will be ignored, thus "PH1,5" will be the response when a query (PH1?) is made.

PHD/PHD? **Initializes print output items for harmonic analysis/queries the current settings. Four sets of default setting are available.**

Syntax **PHDm** <terminator>

"m" indicates default no.

m= 0 : All items are OFF. (CLEAR)
1 : Default 1 (DFLT-1)
2 : Default 2 (DFLT-2)
3 : All items are ON. (ALL)
4 : Manual setting (SEL) (Response only when a query is made)

Query **PHD?** <terminator>

Response example

PHD1

Description
- Manual setting mode (PHD4) is validated automatically when the PH command is executed if "m" is set to a value except for "4" (manual setting). Thus, m=4 (manual setting) is effective only for response to a query, and setting PHD4 will not cause an error, but has no effect.

PI/PI? **Sets print interval in auto print mode/queries the current setting.**

Syntax **PIm1,m2,m3** <terminator>

"m1" indicates hour
0 - m1 - 99
"m2" indicates minute
0 - m2 - 59
"m3" indicates second
10 - m3 - 59

Query **PI?** <terminator>

Response example

PI0,1,0

Description
- The minimum settable print interval is 10 seconds. If the interval is set below 10 seconds, parameter error 12 will occur.

PO **Prints out measured data.**

Syntax **PO** <terminator>

Description
- This command is valid whether print mode is auto or manual.

PP **Prints out panel set-up information.**

Syntax **PP** <terminator>

PR/PR? **Sets print mode /queries the current setting.**

Syntax **PRm** <terminator>

"m" indicates print mode.

m= 0 : Manual
1 : Auto

Query **PR?** <terminator>

Response example

PR0

Description
- In the case of start/stop time synchronous print method (PY0), error 17 will occur if the stop time has already passed when auto print mode is activated.

PS/PS? **Sets the input to be used as the fundamental frequency (PLL source) for PLL synchronization/ queries the current setting.**

Syntax **PSm** <terminator>

"m" indicates the input to be used as the PLL source.

m= 1 : V1
2 : A1
3 : V2 (possible only for the 3-phase 3-wire model)
4 : A2 (possible only for the 3-phase 3-wire model)
5 : V3
6 : A3
7 : EXT (external input)

Query **PS?** <terminator>

Response example

PS1

Description
- If an input other than external input (EXT) is selected, the QS command (used to set the input to be used for frequency measurement) will have be same setting as the PS setting.

PT/PT? **Sets the integration start time and stop time/ queries the current settings.**

Syntax **PT m1/m2/m3/m4/m5/m6,m7/m8/m9/m10/m11/ m12** <terminator>

"m1" indicates start year
1996 - m1 - 2095
"m2" indicates start month
1 - m2 - 12
"m3" indicates start day
1 - m3 - 30 or 31 or 28 or 29
"m4" indicates start hour
0 - m4 - 23

"m5" indicates start minute
0 - m5 - 59
"m6" indicates start second
0 - m6 - 59
"m7" indicates stop year
1996 - m7 - 2095
"m8" indicates stop month
1 - m8 - 12
"m9" indicates stop day
1 - m9 - 30 or 31 or 28 or 29
"m10" indicates stop hour
0 - m10 - 23
"m11" indicates stop minute
0 - m11 - 59
"m12" indicates stop second
0 - m12 - 59

Query **PT?** <terminator>

Response example

PT1996,4,1,17,35,0,1996,4,3,19,35,0

Description
- If the stop time is before the start time, parameter error 12 will occur.
- Parameters can be separated from each other by a comma (,).

PY/PY? Sets the print synchronous method for auto print mode/queries the current setting.

Syntax **PYm** <terminator>

"m" indicates synchronous print method.
m= 0 : Start/stop time synchronous print method
1 : Integration time synchronous print method (possible only for the /INTG model)

Query **PY?** <terminator>

Response example

PY0

Description
- In the case of auto print mode (PR1), error 17 will occur if the stop time has already passed when the start/stop time synchronous print method is selected

QF/QF? Sets the frequency filter ON or OFF/queries the current setting.

Syntax **QFm** <terminator>

"m" indicates whether the frequency filter is ON or OFF.
m= 0 : OFF
1 : ON

Query **QF?** <terminator>

Response example

QF0

QS/QS? Sets the input to be used for frequency measurement/queries the current setting.

Syntax **QSm** <terminator>

"m" indicates the input to be used for frequency measurement.
m= 1 : V1
2 : A1
3 : V2 (possible only for the 3-phase 3-wire model)
4 : A2 (possible only for the 3-phase 3-wire model)
5 : V3
6 : A3

Query **QS?** <terminator>

Response example

QS1

Description
- If this setting is changed, the PLL source (set by the PS command) will also be changed.

RA/RA? Sets current range/queries the current setting.

Syntax **RAm1,m2** <terminator>

"m1" indicates input element.
m1= 0 : All elements
1 : Element 1
2 : Element 2 (possible only for the 3-phase 3-wire model)
3 : Element 3
"m2" indicates current range.
m2= 4 : 0.5 A range
5 : 1 A range
6 : 2 A range
7 : 5 A range
8 : 10 A range
9 : 20 A range
18 : 250 mV range (possible only for the /EX2 model)
19 : 500 mV range (possible only for the /EX2 model)
20 : 1 V range (possible only for the /EX2 model)
21 : 2.5 V range (possible only for the /EX2 model)
22 : 5 V range (possible only for the /EX2 model)
23 : 10 V range (possible only for the /EX2 model)

Query **RAm1?** <terminator>

Response example

RA1,9

Description
- Changing of the current range is not allowed while integration is in progress; execution error 13 will occur.
- The ranges from 250 mV through to 10 V are for the external sensor. When using any of these ranges, be sure to set a correct external sensor scaling value using the SA command.
- If an inquiry is made using RA0?, error 12 will occur.

RC Initializes panel set-up information.

Syntax **RC** <terminator>

Description
- It is not possible to initialize the following communications-related set-up information using this command.
Communication mode
GP-IB address (if the GP-IB interface is used)
Handshake, format and baud rate (if the RS-232-C is used)

RT/RT? Sets the rated integration time when integrated values are to be output as an analog signal/queries the current setting.

Syntax **RTm1,m2** <terminator>

"m1" indicates hour
0 - m1 - 999
"m2" indicates minute
0 - m2 - 59

Query **RT?** <terminator>

Response example

RT1,0

Description
- The settable minimum time is 1 (minute).

RV/RV? Sets voltage range/queries the current setting.

Syntax **RVm1,m2** <terminator>

"m1" indicates input element.
m1= 0 : All elements
1 : Element 1
2 : Element 2 (possible only for the 3-phase 3-wire model)
3 : Element 3
"m2" indicates voltage range.
m2= 3 : 15 V range
4 : 30 V range
5 : 60 V range
6 : 100 V range
7 : 150 V range
8 : 300 V range
9 : 600 V range
10 : 1000 V range

Query **RVm1?** <terminator>

Response example

RV1,9

Description
- Changing of the voltage range is not allowed while integration is in progress; execution error 13 will occur.
- "m1" entered by RVm1? indicates the input element selected. If "0" is set, error 12 will occur.

SA/SA? **Sets the external sensor scaling constant/queries the current setting.**

Syntax **Sam1,m2** <terminator>
"m1" indicates element.
m1= 0 : All elements (setting not possible during inquiry)
1 : Element 1
2 : Element 2 (possible only for the 3-phase 3-wire model)
3 : Element 3
"m2" indicates the external sensor scaling constant, and must be set within the following range.
ROM version before 2.01 0.9000 - m2 - 10000.
ROM version 2.01 or later 0.1000 - m2 - 10000.

Query **SAm1?** <terminator>

Response example
SA1,10.000

Description • If a query is made using SA0?, parameter error 12 will occur.

SC/SC? **Determines whether or not to use the scaling function/queries the current setting.**

Syntax **SCm** <terminator>
"m" indicates whether scaling is ON or OFF.
m= 0 : OFF
1 : ON

Query **SC?** <terminator>

Response example
SC0

SI/SI? **Sets the sample rate for normal measurement/queries the current setting.**

Syntax **SIm** <terminator>
"m" indicates sample rate.
m= 0 : 0.100 s
1 : 0.250 s
2 : 0.500 s
3 : 2.000 s
4 : 5.000 s

Query **SI?** <terminator>

Response example
SI0

Description • Changing of the sample rate is not allowed while integration is in progress; execution error 13 will occur.
• For the sample rate for harmonic analysis, refer to page 9-8.

SL **Recalls panel set-up information from a selected file.**

Syntax **SLm** <terminator>
"m" indicates file no., and must be set within the following range., 1 - m - 8

Description • It is not possible to recall the following communications-related set-up information using this command.
Communication mode
GP-IB address (if the GP-IB interface is used)
Handshake, format and baud rate (if the RS-232-C is used)

SS **Stores panel set-up information into a selected file.**

Syntax **SSm** <terminator>
"m" indicates file no., and must be set within the following range.
1 - m - 8

TI/TI? **Sets the time on the instrument's internal clock/ queries the current setting.**

Syntax **TIm1,m2,m3** <terminator>
"m1" indicates hour
0 - m1 - 23
"m2" indicates minute
0 - m2 - 59
"m3" indicates second
0 - m3 - 59

Query **TI?** <terminator>

Response example
TI17,15,0

TM/TM? **Sets integration timer preset time/queries the current setting.**

Syntax **TMm1,m2** <terminator>
"m1" indicates hour
0 - m1 - 999
"m2" indicates minute
0 - m2 - 59

Query **TM?** <terminator>

Response example
TM1,0

TO/TO? **Sets the data format for measured data to be output via communication/queries the current setting.**

Syntax **TOm** <terminator>
"m" indicates data format.
m= 0 : ASCII
1 : Binary

Query **TO?** <terminator>

Response example
TO0

Description • If binary format (m=1) is selected, measured data will be output without header and with terminator EOI. However, the settings made by the H and DL command will remain unchanged.

WR/WR? **Sets the wiring system/queries the current setting.**

Syntax **WRm** <terminator>
m= 1 : 1Φ2W
2 : 1Φ3W
3 : 3Φ3W
4 : 3Φ4W (possible only for the 3-phase 4-wire model)
5 : 3V3A (possible only for the 3-phase 4-wire model)

Query **WR?** <terminator>

Response example
WR1

ZC **Calibrates zero level.**

Syntax **ZC** <terminator>

Description • Execution of calibration is not allowed while integration is in progress; execution error 13 will occur.
• This command is not effective during harmonic analysis. It is not possible to carry out zero-level calibration.

Appendix 1.3 Status Byte Format

DI08	DI07	DI06	DI05	DI04	DI03	DI02	DI01
Integration BUSY	SRQ	ERROR	Printer BUSY	OVER	Syntax ERROR	Integration END	Computation END

Integration BUSY (DIO 8)

This bit is set to "1" when integration is in progress. This bit cannot be disabled by the IM command since it is a status bit. Even if this bit is set to "1", SRQ will not be affected.

SRQ(DIO 7)

This bit is set to "1" when computation END (DIO 1), integration END (DIO 2), OVER (DIO 4) or syntax ERROR (DIO 3) occurs. When RQS is set to "1", SRQ is set to TRUE, issuing a service request to the controller. This bit is reset to "0" when a response is sent to the serial poll. To prevent the SRQ and status byte being affected by computation END, integration END, OVER or syntax ERROR, this bit must be disabled by the IM command.
After an "IM15", SRQ is affected by a computation END, integration END, syntax ERROR or OVER.
After an "IM1", SRQ is affected only by a computation END.
In the case of "IM4", the SRQ is affected only by a syntax ERROR.

ERROR(DIO 6)

When a syntax ERROR or OVER occurs, this bit is set to "1" and the SRQ is set to TRUE.

Printer BUSY (DIO 5)

This bit is set to "1" when printing of data is in progress. This bit cannot be disabled by the IM command since it is a status bit. Even if this bit is set to "1", SRQ will not be affected.

OVER(DIO 4)

This bit is set to "1" and the SRQ is set to TRUE when an overrange occurs in the measured data. However, this is not valid if the bit has been disabled by the IM command. This bit is reset after a response is made to the serial poll. The nature of OVER can be identified by the OE command.

Syntax ERROR (DIO 3)

This bit is set to "1" when a command error, parameter error or execution error occurs. The error no. can be identified by the OE command. This bit is reset after a response is made to the serial poll. However, this is not valid if the bit has been disabled by the IM command.

Integration END (DIO 2)

This bit is set to "1" when integration has been completed. The bit is reset when a response is made to the serial poll. However, this is not valid if the bit has been disabled by the IM command.

Computation END (DIO 1)

This bit is set to "1" when computation has been completed and the display is updated. The bit is reset when a response is made to the serial poll. However, this is not valid if the bit has been disabled by the IM command.

Appendix 1.4 Data Output Format

Output Format for Measured/Computed Data

Data Format

Measured data normally consists of 6 bytes of header and 11 bytes of data.

Header	Data

Header Section

The header section consists of 6 bytes (h1 to h6.)

h1	h2	h3	h4	h5	h6

h1 to h3: Data type

V_ _ : Voltage A_ _ : Current W_ _ : Power
VA_ : Apparent power Var : Reactive power PF_ : Power factor
HzV : Voltage frequency HzA : Current frequency Wh_ : Watt-hour
Ah_ : Ampere-hour DEG : Phase angle Wh+ : Positive watt-hour
Wh– : Negative watt-hour Ah+ : Positive ampere-hour Ah– : Negative ampere-hour
Vpk : Peak voltage Apk : Peak current
Eff : Efficiency HM_ : Elapsed time of integration
CV1 : Crest factor of V1 CA1 : Crest factor of A1
CV2 : Crest factor of V2 CA2 : Crest factor of A2
CV3 : Crest factor of V3 CA3 : Crest factor of A3
A+B : Value on display A + Value on display B
A-B : Value on display A – Value on display B
A*B : Value on display A ∗ Value on display B
A/B : Value on display A / Value on display B
Tor : Torque rpm : Rotating speed Srp : Synchronous speed
Slp : Slip MPw : Mechanical power
MEf : Motor efficiency TEf : Total efficiency

h4: Element

1 : Element 1 2 : Element 2 3 : Element 3 4 : Σ
_ : No element (for Eff, HM_, CV1 to A/B, Tor to TEf)

h5 : Data state

N : Normal I : Overrange O : Computation overflow P : Peak overflow
E : No data

h6 : Indicates phase lead or lag when the data type is DEG (phase angle).
"_" (space) is selected if the data type is not DEG.

G : Lag D : Lead _ : Not detectable

Data Section

The data section consists of 11 bytes (d1 to d11.)

d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11

d1 : Polarity ; _ (space) or - (minus)
d2 to d8 : Mantissa, floating-point number of the maximum 6 digits
d9 to d11 : Exponent E-3==> m, E+0, E+3==> k, E+6 ==> M
If the data type is Eff, MEf or TEf
d9 : % d10 to d11 : _(space)

• Data state in the case of an overrange (oL, ----- is displayed.)

h1	h2	h3	h4	I	_	_	9	9	9	9	9	9	.	E	+	3

• Data state in the case of a computation overflow

(oF, PFErr, dEGEr, ErrLo, ErrHi, is displayed.)

h1	h2	h3	h4	O	_	_	8	8	8	8	8	8	.	E	+	0

• Data state in the case of no data

"I" of data causing an overrange becomes "E".

• Elapsed time of integration

H	M	_	_	_	_	d1	d2	d3	d4	d5	d6	d7	d8	d9

d1 to d3 : Elapsed time of integration Hour
d4 : " : "
d5 to d6 : Elapsed time of integration Minute
d7 : " : "
d8 to d9 : Elapsed time of integration Second

Output Format when "SEL" (manual setting) is Selected

Measured/computed data can be output simultaneously, and the user is allowed to choose any output items. Each output block is of the following format.

Line 1	V_ _1 , A_ _1 , W_ _1 , VA_1 , Var1 , PF_1 , DEG1 , Vpk1 , Apk1	Terminator
Line 2	HM_ _ , Wh_1 , Wh+1 , Wh-1 , Ah_1 , Ah+1 , Ah-1	Terminator
Line 3	V_ _2 , A_ _2 , W_ _2 , VA_2 , Var2 , PF_2 , DEG2 , Vpk2 , Apk2	Terminator
Line 4	HM_ _ , Wh_2 , Wh+2 , Wh-2 , Ah_2 , Ah+2 , Ah-2	Terminator
Line 5	V_ _3 , A_ _3 , W_ _3 , VA_3 , Var3 , PF_3 , DEG3 , Vpk3 , Apk3	Terminator
Line 6	HM_ _ , Wh_3 , Wh+3 , Wh-3 , Ah_3 , Ah+3 , Ah-3	Terminator
Line 7	V_ _4 , A_ _4 , W_ _4 , VA_4 , Var4 , PF_4 , DEG4	Terminator
Line 8	HM_ _ , Wh_4 , Wh+4 , Wh-4 , Ah_4 , Ah+4 , Ah-4	Terminator
Line 9	Hz** , Eff_	Terminator
Line 10	Tor_ , rpm_ , Srp_ , Slp_ , MPw_ , MEf_ , TEf_	Terminator
Line 11	END	Terminator

Hz : Input to be used for frequency measurement (one of HzV1 to HzA3)**
Eff_ : Efficiency (Eff_) or computed result (CV1 to A/B_)

END: Block end line ("END")

Each output block normally consists of 11 lines including the block end line ("END"). However, if all output items on a line are set to "no output", this line will be omitted, reducing the number of output lines to 10. For instance, if all output items (V_ _2 to Apk2) are set to "no output", line 3 will be omitted.

Furthermore, if any output item on a line is set to "no output", all data following this item on the line will be shifted forward. For instance, if A_ _3 on line 5 is set to "no output", V_ _3 will be followed immediately by the data for W_ _3.

Note

- Lines 3 and 4 are not output with the 3-phase 3-wire model.
- Lines 2, 4, 6 and 8 are output only with the instrument equipped with the integration function (/INTG).
- Line 10 is output only with the WT1030M.

Output Format when "DFLT-1" is Selected

Line 1	V_ _1	,	A_ _1	,	W_ _1	Terminator				
Line 2	V_ _2	,	A_ _2	,	W_ _2	Terminator				
Line 3	V_ _3	,	A_ _3	,	W_ _3	Terminator				
Line 4	V_ _4	,	A_ _4	,	W_ _4	Terminator				
Line 5	Hz**	Terminator								
Line 6	END	Terminator								

Hz**: Input to be used for frequency measurement (one of HzV1 to HzA3)

END: Block end line ("END")

Note

- Line 2 is not output with the 3-phase 3-wire model.

Output Format when "DFLT-2" is Selected (equipped with the integration function)

Line 1	W_ _1	Terminator										
Line 2	HM_ _	,	Wh_1	,	Wh+1	,	Wh-1	,	Ah_1	,	Ah+1	,	Ah-1	Terminator
Line 3	W_ _2	Terminator										
Line 4	HM_ _	,	Wh_2	,	Wh+2	,	Wh-2	,	Ah_2	,	Ah+2	,	Ah-2	Terminator
Line 5	W_ _3	Terminator										
Line 6	HM_ _	,	Wh_3	,	Wh+3	,	Wh-3	,	Ah_3	,	Ah+3	,	Ah-3	Terminator
Line 7	W_ _4	Terminator										
Line 8	HM_ _	,	Wh_4	,	Wh+4	,	Wh-4	,	Ah_4	,	Ah+4	,	Ah-4	Terminator
Line 9	Hz**	Terminator										
Line 10	END	Terminator										

Hz**: Input to be used for frequency measurement (one of HzV1 to HzA3)

END: Block end line ("END")

Note

- Lines 3 and 4 are not output with the 3-phase 3-wire model.

Output Format when "DFLT-2" is Selected (not equipped with the integration function)

Line 1	PF_1	,	DEG1	,	Vpk1	,	Apk1	Terminator		
Line 2	PF_2	,	DEG2	,	Vpk2	,	Apk2	Terminator		
Line 3	PF_3	,	DEG3	,	Vpk3	,	Apk3	Terminator		
Line 4	PF_4	,	DEG4	Terminator						
Line 5	Hz**	Terminator								
Line 6	END	Terminator								

Hz**: Input to be used for frequency measurement (one of HzV1 to HzA3)

END: Block end line ("END")

Note

- Line 2 is not output with the 3-phase 3-wire model.

Output Format for Harmonic Analysis Data

Data Format

Output data consists of 8 bytes of header and 11 bytes of data.

Header	Data

Header Section

The header section consists of 8 bytes (h1 to h8.)

h1	h2	h3	h4	h5	h6	h7	h8

h1 to h3 : Data type

- V_ _ : Total rms value of 1st to n*th of voltage, analysis value of each harmonic from 1st to n*th of voltage
- A_ _ : Total rms value of 1st to n*th of current, analysis value of each harmonic from 1st to n*th of current
- W_ _ : Total rms value of 1st to n*th of active power, analysis value of each harmonic from 1st to n*th of active power
- VA_ : Apparent power
- Var : Reactive power
- PF_ : Power factor of 1st
- HzV : Fundamental frequency of PLL source voltage
- HzA : Fundamental frequency of PLL source current
- DEG : Phase angle between fundamentals
- VTH : Harmonic distortion of voltage
- ATH : Harmonic distortion of current
- VCN : Content of each harmonic from 2nd to n*th of voltage
- ACN : Content of each harmonic from 2nd to n*th of current
- WCN : Content of each harmonic from 2nd to n*th of active power
- DGV : Phase angle of current of 1st and voltage of each harmonic from 2nd to n*th in relation to voltage of the 1st
- DGA : Phase angle of voltage of 1st and current of each harmonic from 2nd to n*th in relation to current of the 1st

Tor : Torque rpm : Rotating speed Srp : Synchronous speed
Slp : Slip MPw : Mechanical power
MEf : Motor efficiency TEf : Total efficiency

h4 : Element

1 : Element 1 2 : Element 2 3 : Element 3
4 : Σ (total rms value of harmonic from 1st to n*th of V_ _, A_ _ and W_ _, VA_, Var and PF)
_ : No element (for Tor to TEf)

h5 : Data state

N : Normal I : Overrange O : Computation overflow P : Peak overflow
E : No data

h6, h7 : Order

01 to 50 : Order of the fundamental or harmonic (must be smaller than the maximum order)
_ : No order (total rms value of harmonic from 1st to n*th of V_ _, A_ _ and W_ _, VA_, Var, PF_, HzV, HzA, DEG, VTH, ATH, Tor to TEf)

h8 : Indicates phase lead or lag when the data type is DGV or DGA, and order is 01.
"_" (space) is selected if the data type is not DGV or DGA.
G : Lag D : Lead _ : Not detectable

* "n" is the upper limit of the harmonic order.

Data Section

The data section consists of 11 bytes (d1 to d11.)

d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11

d1 : Polarity ; _ (space) or - (minus)
d2 to d8 : Mantissa, floating-point number of the maximum 6 digits
d9 to d11 : Exponent E-3==> m, E+0, E+3==> k, E+6 ==> M
If the data type is VTH, ATH, CVN, ACN, WCN, MEf or TEf
d9 : % d10 to d11 : _(space)

Output Format when "SEL" (manual setting) is Selected

Harmonic analysis data can be output simultaneously, and the user is allowed to choose any output items. Each output block is of the following format.
"##" indicates the maximum order. Data for orders exceeding the maximum order will not be output.

Line 1 V_ _1N_ _ , V_ _1N01 , V_ _1N02 , · · · · · · · · · · · · V_ _1N## Terminator

Line 2 A_ _1N_ _ , A_ _1N01 , A_ _1N02 , · · · · · · · · · · · · A_ _1N## Terminator

Line 3 W_ _1N_ _ , W_ _1N01 , W_ _1N02 , · · · · · · · · · · · · W_ _1N## Terminator

Line 4 VA_1N_ _ , Var1N_ _ , PF_1N_ _ , DEG1N_ _ , VTH1N_ _ , ATH1N_ _ Terminator

Line 5 VCN1N02 , VCN1N03 , · · · · · · · · · · · · VCN1N## Terminator

Line 6 ACN1N02 , ACN1N03 , · · · · · · · · · · · · ACN1N## Terminator

Line 7 WCN1N02 , WCN1N03 , · · · · · · · · · · · · WCN1N## Terminator

Line 8 DGV1N01 , DGV1N02 , DGV1N03 , · · · · · · · · · · · · DGV1N## Terminator

Line 9 DGA1N01 , DGA1N02 , DGA1N03 , · · · · · · · · · · · · DGA1N## Terminator

Line 10 to 18 Data for element 2 (data format is the same as line 1 to 9)

Line 19 to 27 Data for element 3 (data format is the same as line 1 to 9)

Line 28 V_ _4N_ _ , A_ _4N_ _ , W_ _4N_ _ , VA_4N_ _ , Var4N_ _ , PF_4N_ _ Terminator

Line 29 Hz**N_ _ Terminator **Hz**: PLL source frequency (one of HzV1 to HzA3)**

Line 30 Tor_N_ _ , rpm_N_ _ , Srp_N_ _ , Slp_N_ _ , MPw_N_ _ , MEf_N_ _
MEf_N_ _ , TEf_N_ _ Terminator

Line 31 END Terminator **END: Block end line ("END")**

Each output block normally consists of 31 lines including the block end line ("END"). However, if all output items on a line are set to "no output", this line will be omitted, reducing the number of output lines to 30. For instance, if all output items (VA_1N_ _ to ATH1N_ _) are set to "no output", line 4 will be omitted. However, lines 1 to 3 and 5 to 9 will not be output if they are set to "no output", since only one output item is contained in those lines.
Furthermore, if any output item on a line is set to "no output", all data following this item on the line will be shifted forward. For instance, if VarIN_ _ on line 4 is set to "no output", VA_1N_ _ will be followed immediately by the data for PF_1N_ _.

Note

- Lines 10 to 18 are not output with the 3-phase 3-wire model.
- Line 30 is output only with the WT1030M.

Output Format when "DFLT-1" is Selected

"##" indicates the maximum order. Data for orders exceeding the maximum order will not be output.

Line 1	V_ _1N_ _	,	V_ _1N01	,	V_ _1N02	,	· · · · · · · · · · · ·	V_ _1N##	Terminator
Line 2	A_ _1N_ _	,	A_ _1N01	,	A_ _1N02	,	· · · · · · · · · · · ·	A_ _1N##	Terminator
Line 3	W_ _1N_ _	,	W_ _1N01	,	W_ _1N02	,	· · · · · · · · · · · ·	W_ _1N##	Terminator
Line 4	VTH1N_ _	,	ATH1N_ _	Terminator					
Line 5	VCN1N02	,	VCN1N03	,	· · · · · · · · · · · ·	VCN1N##	Terminator		
Line 6	ACN1N02	,	ACN1N03	,	· · · · · · · · · · · ·	ACN1N##	Terminator		
Line 7	WCN1N02	,	WCN1N03	,	· · · · · · · · · · · ·	WCN1N##	Terminator		

Line 8 to 14 Data for element 2 (data format is the same as lines 1 to 7)

Line 15 to 21 Data for element 3 (data format is the same as lines 1 to 7)

Line 22	Hz**N_ _	Terminator	**Hz**: PLL source frequency (one of HzV1 to HzA3)**
Line 23	END	Terminator	**END: Block end line ("END")**

Note

- Lines 8 to 14 are not output with the 3-phase 3-wire model.

Output Format when "DFLT-2" is Selected

"##" indicates the maximum order. Data for orders exceeding the maximum order will not be output.

Line 1	DEG1N_ _	Terminator							
Line 2	DGV1N01		DGV1N02	,	DGV1N03	,	· · · · · · · · · · · ·	DGV1N##	Terminator
Line 3	DGA1N01		DGA1N02	,	DGA1N03	,	· · · · · · · · · · · ·	DGA1N##	Terminator

Line 4 to 6 Data for element 2 (data format is the same as lines 1 to 3)

Line 7 to 9 Data for element 3 (data format is the same as lines 1 to 3)

Line 10	Hz**N_ _	Terminator	**Hz**: PLL source frequency (one of HzV1 to HzA3)**
Line 11	END	Terminator	**END: Block end line ("END")**

Note

- Lines 4 to 6 are not output with the 3-phase 3-wire model.

Output Format for Set-up Information/Error Codes

Refer to the application examples of the OS and OE commands given in the Appendix 1.2. To see the contents of the displays in these examples, refer also to the description of the commands given in the Appendix 1.2.

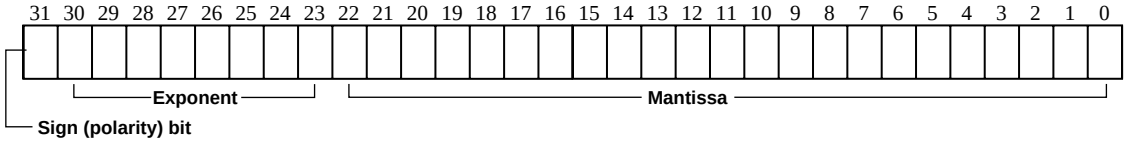
Output Format for Binary Data

Data Section

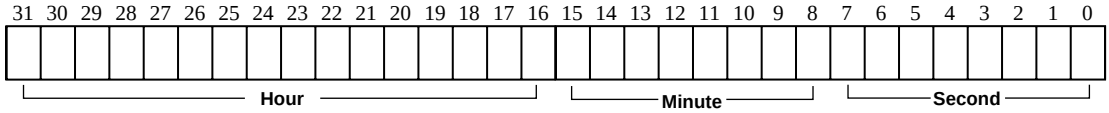
The data section consists of 4 bytes of IEEE SINGLE REAL data. The data can be converted to physical value using the following formula. (MSB of the data is output first.)

$$D = (-1)^S \times 2^{(E-127)} \times \left(1 + \frac{M}{2^{23}}\right)$$

D : Physical value
S : Sign (polarity) bit (0 or 1)
E : Exponent (0 to 254)
M : Mantissa (23 bits of binary value)



- **Data state in the case of an overrange or computation overflow**
  (oL, oF, PFErr, dEGEr, ErrLo, ErrHi is displayed.)
  [9.9E+37] (+×) is output.
- **Elapsed time of integration (------ is displayed.)**
  [9.91E+37] (NAN) is output.
- **Elapsed time of integration**
  Hour: 16-bit binary value
  Minute: 8-bit binary value
  Second: 8-bit binary value



Header is always omitted, irrespective of whether or not addition of header is set by the communication command H.

Output Format

All data selected as described in Section 15.1, "Selecting the Output Items" is output at one time as one block data (4 bytes x number of data sets).

- Data of each items is output in the same order as ASCII format.
- No comma is inserted between data of each item to separate them.
- A terminator, which is normally added at the end of each line, is not added.
- "END", which is output as the block end line, is not output. However, "EOI" will become TRUE when the final data byte is output.

Appendix1.5 For Users Using Communication Commands of Digital Power Meter 2533E

This instrument differs from the 2533E in communications command and data format. This instrument has a function which enables the user to use communications programs created for the 2533E. This function is described below in detail.

Communications Commands

To use 2533E command group with this instrument, setting command CM2 is required. (For a detail description of the CM command, refer to Appendix 1.2, "Commands".
Description is given below for those commands which differ from this instrument when the 2533E command group is selected.

Note

- For a description of how to set the addressable mode, refer to page 15-6.
- The error codes and status byte format are the same as those used with this instrument. For a detailed description, refer to page App 1-15. They differ from those used with the 2533E.
- To receive harmonic analysis data via RS-232-C interface, set handshake mode to a value other than "0", since harmonic analysis data contains a large number of output bytes.

AA/AA? **Sets auto or manual range mode for the current ranges/queries the current setting.**

Syntax **AAm** <terminator>
"m" indicates whether range mode is auto or manual.
m= 0 :Manual range
1 : Auto range

Query **AA?** <terminator>

Response example
AA0

Description
- All elements are switched ON or OFF.
- Error 12 will occur when a query is made if the range modes set for each element differs from each other.

AV/AV? **Sets auto or manual range mode for the voltage ranges/queries the current setting.**

Syntax **AVm** <terminator>
"m" indicates whether range mode is auto or manual.
m= 0 :Manual range
1 :Auto range

Query **AV?**<terminator>

Response example
AV0

Description
- All elements are switched ON or OFF.
- Error 12 will occur when a query is made if the range modes set for each element differs from each other.

DS **Sets the delimiter E0I output timing. This command is used with the 2533E, but cannot be used with this instrument even if 2533E command group is selected by the CM command.**

KV/KV?,KA/KA?,KW/KW?
Sets the scaling constant/queries the current setting. KV is used for voltage measurement, KA for current measurement, and KW for power measurement.

Syntax **KVm** <terminator>
KAm <terminator>
KWm <terminator>
"m" indicates scaling constant, and must be set within the following range.
0.0001 - m - 10000.

Query **KV?** <terminator>
KA? <terminator>
KW? <terminator>

Response example
KV1.0000
KA1.0000
KW1.0000

Description
- Voltage, current and power scaling constant for all elements are set to the same value.

MN/MN/? **Sets the measurement mode/queries the current setting.**

Syntax **MNm** <terminator>
"m" indicates measurement mode.
m = 0 :RMS
1 :MEAN
2 :DC

Query **MN?** <terminator>

Response example
MN0

Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- The same measurement mode is selected for both voltage and current for all elements.
- Error 12 will occur when a query is made if the measurement modes set for each element differs from each other.

OF/OF? **Sets communication output items for normal measurement/queries the current settings. Up to 14 measured data can be selected and output.**

Syntax **OF m1,m2,m3** <terminator>
"m1" indicates output channel no., and must be within the following range.
1 - m1 - 14
"m2" indicates output item no.
m2=0 :No output (None)
1 :Voltage (V)
2 :Current (A)
3 :Power (W)
4 :Reactive power (var)
5 :Apparent power (VA)
6 :Power factor (PF)
7 :Frequency (Frq)
9 :Watt-hour (possible only for the /INTG model)
10 :Ampere-hour (Ah) (possible only for the /INTG model)

m= 0 : Manual range
11 : Phase angle (deg)
12 : Voltage peak (Vpk)
13 : Current peak (Apk)
14 : Efficiency and computed result (MATH)
15 : Elapsed time of integration (INTEG-TIME) (possible only for the /INTG model)
24 : Positive watt-hour (Wh+) (possible only for the /INTG model)
25 : Negative watt-hour (Wh-) (possible only for the /INTG model)
26 : Positive ampere-hour (Ah+) (possible only for the /INTG model)
27 : Negative ampere-hour (Ah-) (possible only for the /INTG model)
29 : TORQUE (possible only for the WT1030M)
30 : rpm (possible only for the WT1030M)
31 : SYNC-rpm (possible only for the WT1030M)
32 : SLIP (possible only for the WT1030M)
33 : MECH-POWER (possible only for the WT1030M)
34 : MOTOR η (possible only for the WT1030M)
35 : TOTAL η (possible only for the WT1030M)

"m3" indicates element.
m3=1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
4 : Σ (except for Vpk and Apk)

Query **OFm1?** <terminator>

Response example

OF1,3,2

Description
- It is possible to select no output (m=0), frequency (m2=7), efficiency and computed result (m2=14), elapsed time of integration (m2=15) and motor related items TORQUE through TOTAL η (m2=29 through 35), whichever element is selected. However, it is best to set m3 to 1 if the OF command is used to select any of those items.

OL

Function: Requests output of setup information. Output format differs from that of the 2533E.

Syntax **OL** <terminator>

Response example

The following lines differ from the response example for OS command given on page App 1-10.

Line 2 : Voltage range
RV10;AV0 <terminator>
Line 3 : Current range
RA9;AA0;SA1.0000 <terminator>
Line 7 : Measurement mode
MN0 <terminator>
Line 8 : Scaling constant
KV,1.0000;KA,1.0000;KW,1.0000 <terminator>
Line 15: Command/format group
CM2 <terminator>

Description
- The data set for element 1 will be output if the range, auto range ON/OFF state, measurement mode, scaling constant for external sensor input and scaling constant for voltage, current and power set for each element differ from each other.

OS

Requests output of setup information. This command cannot be used if 2533E command group is selected by the CM command. However, in this case OL command can be used instead.

RA/RA?

Sets current range/queries the current setting.

Syntax **RAm** <terminator>

"m" indicates current range.
m = 4 : 0.5A range
5 : 1A range
6 : 2A range
7 : 5A range
8 : 10A range
9 : 20A range
18 : 250mVrange (possible only for the /EX2 model)
19 : 500mVrange (possible only for the /EX2 model)
20 : 1V range (possible only for the /EX2 model)
21 : 2.5V range(possible only for the /EX2 model)
22 : 5V range (possible only for the /EX2 model)
23 : 10V range(possible only for the /EX2 model)

Query **RA?** <terminator>

Response example

RA9

Description
- The same current range is selected for all elements.
- Error 12 will occur when a query is made if the current range set for each element differs from each other.

RV/RV?

Sets voltage range/queries the current setting.

Syntax **RVm** <terminator>

"m" indicates voltage range.
m2= 3 : 15V range
4 : 30V range
5 : 60V range
6 : 100V range
7 : 150V range
8 : 300V range
9 : 600V range
10 : 1000V range

Query **RV?** <terminator>

Response example

RV10

Description
- The same voltage range is selected for all elements.
- Error 12 will occur when a query is made if the current range set for each element differs from each other.

SA/SA?

Sets the external sensor input scaling constant/ queries the current setting.

Syntax **SAm** <terminator>

"m" indicates external sensor input scaling constant, and must be set within the following range.
ROM version before 2.01 0.9000 - m - 10000.
ROM version 2.01 or later 0.1000 - m - 10000.

Query **SA?** <terminator>

Response example

SA10.000

Description
- External sensor input scaling constant for all elements is set to the same value.

WR/WR?

Sets the wiring system/queries the current setting.

Syntax **WRm** <terminator>

"m" indicates wiring system.
m= 0 : 3Φ3W
1 : 3Φ4W (possible only for the 3-phase 3-wire model)
2 : 1Φ2W
3 : 1Φ3W
4 : 3V3A (possible only for the 3-phase 3-wire model)

Query **WR?** <terminator>

Response example

WR0

Output Items

To read measured data using 2533E communication program, this instrument's addressable mode B must be set. Output items do not match those displayed on each display as in the 2533E, but match those set for ch.1 to ch.3 by the OF command of the 2533E command group. Select output items according to the 2533E communications program.

Note

- For the 2533E and 2531 command group, output items can be set only by using the OF command. It is not possible to set output items using the panel keys.

Data Output Format

Data consists of 12 bytes of header and 12 bytes of data. The entire data output format is shown below.

ch.1 header	ch.1 data	,	ch.2 header	ch.2 data	,	ch.3 header	ch.3 data

Header Section

h1	h2	h3	h4	h5	h6	h7	h8	h9	h10	h11	h12

h1 to h2 : Output channel

DA : ch.1 DB : ch.2 DC : ch.3

h1 to h4 : Data typ

0 : No output	7 : HzV (Voltage frequency)	14 : MATH (Efficiency and computed result)
1 : V (Voltage)	8 : HzA (Current frequency)	15 : HM (Elapsed time of integration)
2 : A (Current)	9 : Wh (Watt-hour)	24 : Wh+ (Positive watt-hour)
3 : W (Power)	10 : Ah (Ampere-hour)	25 : Wh– (Negative watt-hour)
4 : Var (Reactive power)	11 : DEG (Phase angle)	26 : Ah+ (Positive ampere-hour)
5 : VA(Apparent power)	12 : Vpk (Peak voltage)	27 : Ah– (Negative ampere-hour)
6 : PF(Power factor)	13 : Apk (Peak current)	

Note

- If "15" is set to h3 and h4 when "DB" is set to h1 and h2, "DB4_" is output to h1 through h4. This is done to conform to 2533E format.

h5 to h6: Output channel

EA : ch.1 EB : ch.2 EC : ch.3

h7: Element

1 : Element 1 2 : Element 2 3 : Element 3 4 : Σ

h8: Data state

N : Normal I : Overrange/no data O : Computation overflow

h9 to h11: Unit

V_ _ : V	VA_ : VA	DEG : DEG	Wh- : Wh-
A_ _ : A	HZ_ : Hz	Vpk : Vpk	Ah+ : Ah+
W_ _ : W	Wh_ : Wh	Apk : Apk	Ah- : Ah-
VAR : var	Ah_ : Ah	Wh+ : Wh+	_ _ _ : other

Efficiency(Eff) or MATH(CV1,CV2,CV3,CA1,CA2,CA3,A+B,A-B,A*B,A/B)

h12: Fixed to ",".

Data Section

d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12

d1 : Polarity ; _ (space) or - (minus)

d2 - d9 : Mantissa, floating-point number of the maximum 7 digits

d10-d12 : Exponent

E-3 m

E+0

E+3 k

E+6 M

Appendix1.6 For Users Using Communication Commands of Digital Power Meter 2531

This instrument differs from the 2531 in communications command and data format. This instrument has a function which enables the user to use communications programs created for the 2531. This function is described below in detail.

Communications Commands

To use 2531 command group with this instrument, setting command CM1 is required. (For a detailed description of the CM command, refer to Appendix 1.2, "Commands".
Description is given below for those commands which differ from this instrument when the 2531 command group is selected.

OF/OF? Sets communication output items for normal measurement/queries the current settings. Up to 14 measured data can be selected and output.

Syntax OF m1,m2,m3 <terminator>

"m1" indicates output channel no., and must be within the following range.
1 - m1 - 14
"m2" indicates output item no.
m2=0 : No output (None)
1 : Voltage (V)
2 : Current (A)
3 : Power (W)
4 : Reactive power (var)
5 : Apparent power (VA)
6 : Power factor (PF)
7 : Frequency (Frq)
9 : Watt-hour (possible only for the /INTG model)
10 : Ampere-hour (Ah) (possible only for the /INTG model)
11 : Phase angle (deg)
12 : Voltage peak (Vpk)
13 : Current peak (Apk)
14 : Efficiency and computed result (MATH)
15 : Elapsed time of integration (INTEG-TIME) (possible only for the /INTG model)
24 : Positive watt-hour (Wh+) (possible only for the /INTG model)
25 : Negative watt-hour (Wh-) (possible only for the /INTG model)
26 : Positive ampere-hour (Ah+) (possible only for the /INTG model)
27 : Negative ampere-hour (Ah-) (possible only for the /INTG model)
29 : TORQUE (possible only for the WT1030M)
30 : rpm (possible only for the WT1030M)
31 : SYNC-rpm (possible only for the WT1030M)
32 : SLIP (possible only for the WT1030M)
33 : MECH-POWER (possible only for the WT1030M)
34 : MOTOR η (possible only for the WT1030M)
35 : TOTAL η (possible only for the WT1030M)
"m3" indicates element.
m3=1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
4 : Σ (except for Vpk and Apk)

Query OFm1? <terminator>

Response example
OF1,3,2

Description • It is possible to select no output (m=0), efficiency, MATH, elapsed time of integration (m2=15) and motor related items TORQUE through TOTAL η (m2=29 through 35), whichever element is selected. However, it is best to set m3 to 1 if the OF command is used to select any of those items.

OFD/OFD? Initializes communication output items for normal measurement/queries the current settings. Two sets of default setting are available.

Syntax OFD m <terminator>

"m" indicates default no.
m= 0 : Default for normal measurement
1 : Default for integration
2 : Select mode (possible only for inquiry command)

Query OFD? <terminator>

Response example
OFD1

Description • Select mode (OFD2) is validated automatically when the OF command is executed if "m" is set to "0" (default for normal measurement) or "1" (default for integration).

OH/OH? Sets communication output items for harmonic analysis/queries the current settings.

Syntax OH m1,m2 <terminator>

"m1" indicates output item no.
m1=1 : Analysis voltage value and relative harmonic content are output in numeric. (V)
2 : Analysis current value and relative harmonic content are output in numeric. (A)
3 : Analysis active power value and relative harmonic content are output in numeric. (W)
4 : Phase angle of voltage of each harmonic from 2nd to n*th in relation to voltage of the 1st and phase angle of current of each harmonic from 2nd to n*th in relation to current of the 1st are output in numeric. (deg).
13 : Voltage, current, active power and phase angle are output in numeric. (AAL)
"m2" indicates input.
m2=0 : Elements 1, 2 and 3
1 : Element 1
2 : Element 2 (possible only for the 3-phase 4-wire model)
3 : Element 3
* "n" is the upper limit of the harmonic order.

Query OH? <terminator>

Response example
OH3,1

Output Format for Measured/Computed Data

Data Output Format

The data format is the same as that described in Appendix 1.4 "Data Output Format". Refer to page App 1-16.

Output Format

Up to 14 measured/computed data can be output simultaneously, and the user is allowed to choose any output items. Each output block is of the following format.

Line 1	ch.1	,	ch.2	,	ch.3	,	ch.4	Terminator
Line 2	ch.5	,	ch.6	,	ch.7	,	ch.8	Terminator
Line 3	ch.9	,	ch.10	,	ch.11	,	ch.12	Terminator
Line 4	ch.13	,	ch.14	Terminator				
Line 5	END	Terminator						

Each output block normally consists of 5 lines including the block end line ("END"). However, if all output items on a line are set to "no output", this line will be omitted, reducing the number of output lines to 4. For instance, if all output items (ch.9 to ch.12) are set to "no output", line 3 will be omitted.

Furthermore, if any output item on a line is set to "no output", all data following this item on the line will be shifted forward. For instance, if ch.2 on line 2 is set to "no output", ch.1 will be followed immediately by the data for ch.3.

Output Format when Default for Normal Measurement is Selected (DFD0)

- **3-phase 3-wire model**

Line 1	V1 data	,	V3 data	,	ΣV data	Terminator		
Line 2	A1 data	,	A3 data	,	ΣA data	Terminator		
Line 3	W1 data	,	W3 data	,	ΣW data	Terminator		
Line 4	Display C	,	Display D	Terminator				
Line 5	END	Terminator						

- **3-phase 4-wire mode**

Line 1	V1 data	,	V2 data	,	V3 data	,	ΣV data	Terminator
Line 2	A1 data	,	A2 data	,	A3 data	,	ΣA data	Terminator
Line 3	W1 data	,	W2 data	,	W3 data	,	ΣW data	Terminator
Line 4	Display C	,	Display D	Terminator				
Line 5	END	Terminator						

Output Format when Default for Integration is Selected (DFD1)

- **3-phase 3-wire model**

Line 1	W1 data	,	W3 data	,	ΣW data	Terminator		
Line 2	Wh1 data	,	Wh3 data	,	ΣWh data	Terminator		
Line 3	Ah1 data	,	Ah3 data	,	ΣAh data	Terminator		
Line 4	Frequency	,	Elapsed time of integration	Terminator				
Line 5	END	Terminator						

- **3-phase 4-wire mode**

Line 1	W1 data	,	W2 data	,	W3 data	,	ΣW data	Terminator
Line 2	Wh1 data	,	Wh2 data	,	Wh3 data	,	ΣWh data	Terminator
Line 3	Ah1 data	,	Ah2 data	,	Ah3 data	,	ΣAh data	Terminator
Line 4	Frequency	,	Elapsed time of integration	Terminator				
Line 5	END	Terminator						

Output Format for Harmonic Analysis Data

Data Output Format

The data format is the same as that described in Appendix 1.4 "Data Output Format". Refer to page App 1-19.

Output Format

The output format is specified as shown below according to the output items selected using the OH command.

- **Voltage or current**

Line 1	Total rms value of harmonic from 1st to 50th	,	THD	Terminator
Line 2	Analysis value for fundamental (1st)	,	Frequency	Terminator
Line 3	Analysis value for 2nd harmonic	,	Content for 2nd harmonic	Terminator
	⋮		⋮	⋮
Line 51	Analysis value for 50th harmonic	,	Content for 50th harmonic	Terminator
Line 52	END	Terminator		

- **Active power**

Line 1	Total rms value of harmonic from 1st to 50th	,	Power factor	Terminator
Line 2	Analysis value for fundamental (1st)	,	Frequency	Terminator
Line 3	Analysis value for 2nd harmonic	,	Content for 2nd harmonic	Terminator
	⋮		⋮	⋮
Line 51	Analysis value for 50th harmonic	,	Content for 50th harmonic	Terminator
Line 52	END	Terminator		

- **Phase angle**

Line 1	Phase angle between fundamentals (1st harmonic) of voltage and current,	,	Frequency	Terminator
Line 2	Phase angle between fundamental and 2nd harmonic of voltage	,	Phase angle between fundamental and 2nd harmonic of current	Terminator
Line 3	Phase angle between fundamental and 3rd harmonic of voltage	,	Phase angle between fundamental and 3rd harmonic of current	Terminator
	⋮		⋮	⋮
Line 50	Phase angle between fundamental and 50th harmonic of voltage	,	Phase angle between fundamental and 50th harmonic of current	Terminator
Line 51	END	Terminator		

- **Output order when "ALL" is selected**

  Output items are output in the order of voltage ∅ current ∅ active power ∅ phase angle ∅ END (terminator).
  - Each output data is output in the format specified for each output item.
  - The END line is not output for each output item. The END line is output only at the end of entire output operation.

Output Format for Set-up Information/Error Codes

Refer to the application examples of the OS and OE commands given in the Appendix 1.2. To see the contents of the displays in these examples, refer also to the description of the commands given in the Appendix 1.2.

Appendix1.7 Sample Programs

Before Programming

Required System

- Computer : IBM PC/AT and compatible system with National Instruments AT-GPIB/TNT IEEE-488.2 board installed
- OS : Quick Basic Version 4.0/4.5

Basic Programming Format

The following shows the structure of a programming command statement.
Command + Parameter + Terminator
ASCII codes are used.

Example	DA	2	CR LF
	Command	Parameter	Terminator

Command

Predefined string of 1 to 3 capital letters

Parameter

Numeric values or character string (ASCII code)

Terminator

- GP-IB interface
  When this instrument is used as a listener, "CR+LF", "LF" or "EOI" can be used.
  When this instrument is used as a talker, the terminator set by the DL command will be used. Refer to page App 1-5.
- RS-232-C
  Refer to pages 15-12 and App 1-5.

Multi-Command Statement

A single line can contain multiple commands. In this case, make sure that command statements (command + parameter) are separated by a semicolon (;).

Note

- space or tab between the command and parameter can be omitted.

Query Command

Query commands can easily be identified since "?" is added to the end of the command. Data returned in response to a query command is shown below.

Query command		Returned data
DA?	===>	DA1

Numerical Parameter

Floating-point parameters are correct to four decimal places.

Note

- When the message of GPIBERR or DVMERR is returned, refer to "NI-488.2 Driver Sample Programs".

Sample Programs

```
'*****************************************************************************
'*                                                                           *
'* Sample Program (1) for the WT1000 series                                  *
'*                                                                           *
'* Used to set measurement conditions/ranges for normal measurement mode, and read *
'* and display the following data each time measured/computed data is updated.     *
'*         Voltage (V), current (A), active power (W), voltage frequency (VHz)     *
'*                                                                           *
'*****************************************************************************
   REM $INCLUDE: 'qbdecl.bas'

   DECLARE SUB gpiberr (msg$)
   DECLARE SUB dvmerr (msg$, SPR%)

   CLS
   PRINT

   CALL IBDEV(0, 1, 0, T10s, 1, 0, dvm%)
   IF (dvm% < 0) THEN CALL gpiberr("Ibdev Error")

' Interface clear
   CALL IBCLR(dvm%)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibclr Error")
' set communication command group.
   WRT$ = "CM0"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set measurement condition.
   WRT$ = "HD0;SI2;MV0,0;MA0,0;FL0;SC0;AG0"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set measurement range.
   WRT$ = "RV0,6;RA0,7"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set the function of frequency to measure.
   WRT$ = "QS1"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set communication output item.
   WRT$ = "OFD1;TO0;DL0"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' wait for setting.
   FOR I% = 1 TO 10000: NEXT I%

' initialize status byte.
   WRT$ = "IM1"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' clear status byte.
   CALL IBRSP(dvm%, SPR%)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrsp Error")

   FOR I% = 1 TO 10
      'wait finished measurement.
SBWAIT:  MASK% = &H4800                  ' RQS + TIMO
         CALL IBWAIT(dvm%, MASK%)
         IF (IBSTA% AND (EERR OR TIMO)) THEN CALL gpiberr("Ibwait Error")
         CALL IBRSP(dvm%, SPR%)
         IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrsp Error")
         IF ((SPR% AND &H41) <> &H41) GOTO SBWAIT

      'send request measurement data.
         WRT$ = "OD"
         CALL IBWRT(dvm%, WRT$)
         IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

      'read measurement data.
RDDAT:   RD$ = SPACE$(128)
         CALL IBRD(dvm%, RD$)
         IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd Error")
         PRINT LEFT$(RD$, IBCNT% - 2)
         IF LEFT$(RD$, 3) <> "END" GOTO RDDAT

   NEXT I%

'  Call the IBONL function to disable the hardware and software.
   CALL IBONL(dvm%, 0)

END
```

```
'*****************************************************************************
'*                                                                           *
'* Sample Program (2) for the WT1000 series                                  *
'*                                                                           *
'* Used to carry out integration in standard integration mode, and read      *
'* and display the following data each time measured/computed data is updated.*
'*         Active power (W), watt-hour (Wh, Wh+, Wh-), ampere-hour (Ah, Ah+, Ah-),*
'*         elapsed time of integration (IMTEG-TIME)                          *
'*                                                                           *
'*****************************************************************************

'
   REM $INCLUDE: 'qbdecl.bas'

   DECLARE SUB gpiberr (msg$)
   DECLARE SUB dvmerr (msg$, spr%)

   CLS
   PRINT

   CALL ibdev(0, 1, 0, T10s, 1, 0, dvm%)
   IF (dvm% < 0) THEN CALL gpiberr("Ibdev Error")

' clear the device.
   CALL ibclr(dvm%)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibclr Error")

' set communication command group.
   wrt$ = "CM0"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set measurement condition.
   wrt$ = "HD0;SI2;MV0,0;MA0,0;FL0;SC0;AG0"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set measurement range.
   wrt$ = "RV0,6;RA0,7"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set Integrate condition.
   wrt$ = "IC0;TM1\1,0"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set communication output item.
   wrt$ = "OFD2;OF7,0;TO0;DL0"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' wait for setting.
   FOR i% = 1 TO 10000: NEXT i%

' initialize status byte.
   wrt$ = "IM3"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")
   CALL ibrsp(dvm%, spr%)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibrsp Error")

' start integrate.
   wrt$ = "IS"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' wait finished measurement.
SBWAIT:
   mask% = &H4800                    ' RQS + TIMO
   CALL ibwait(dvm%, mask%)
   IF (ibsta% AND (EERR OR TIMO)) THEN CALL gpiberr("Ibwait Error")
   CALL ibrsp(dvm%, STB%)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibrsp Error")

   IF ((STB% AND &H41) <> &H41) THEN GOTO INTEGEND

' send request measurement data.
   wrt$ = "OD"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' read measurement data.
RDDAT:
   rd$ = SPACE$(512)
   CALL ibrd(dvm%, rd$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibrd Error")

   PRINT LEFT$(rd$, ibcnt% - 2)

   IF LEFT$(rd$, 3) <> "END" GOTO RDDAT
INTEGEND:
   IF ((STB% AND &H42) <> &H42) THEN GOTO SBWAIT

'  Call the IBONL function to disable the hardware and software.
   CALL ibonl(dvm%, 0)

END
```

```
'*****************************************************************************
'*                                                                           *
'* Sample Program (3) for the WT1000 series                                  *
'*                                                                           *
'* Used to read and display the following data in harmonic analysis mode.    *
'* Total rms value of each harmonic from 1st to 50th of current.             *
'* analysis value of fundamental (1st) of current, analysis value of each harmonic  *
'* (2nd to 50th), harmonic distortion of current, PLL source (voltage) frequency    *
'*                                                                           *
'*****************************************************************************
'
   REM $INCLUDE: 'qbdecl.bas'

   DECLARE SUB gpiberr (msg$)
   DECLARE SUB dvmerr (msg$, spr%)

   CLS
   PRINT

   CALL ibdev(0, 1, 0, T10s, 1, 0, dvm%)
   IF (dvm% < 0) THEN CALL gpiberr("Ibdev Error")

' clear the device.
   CALL ibclr(dvm%)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibclr Error")

' set communication command group.
   wrt$ = "CM0"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set harmonic measurement condition.
   wrt$ = "PS1;AF0;DF0;HO50"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' harmonic measurement start.
   wrt$ = "HA1"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' wait for setting.
   FOR J = 1 TO 1000000: NEXT J

' set communication output item.
   wrt$ = "OHD0;OH2,1;OH17,1;OH7,1;TO0;DL0"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' wait for setting.
   FOR I% = 1 TO 10000: NEXT I%

' harmonic measurement hold and request measurement data.
   wrt$ = "HD1"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   wrt$ = "OD"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' read measurement data.
RDDAT:
   rd$ = SPACE$(1024)
   CALL ibrd(dvm%, rd$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibrd Error")

   PRINT LEFT$(rd$, ibcnt% - 2)
   IF LEFT$(rd$, 3) <> "END" GOTO RDDAT
' start harmonic measurement.
   wrt$ = "HD0"
   CALL ibwrt(dvm%, wrt$)
   IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt Error")

'  Call the IBONL function to disable the hardware and software.
   CALL ibonl(dvm%, 0)

END
```

```
'*****************************************************************************
'*                                                                           *
'* Sample Program (4) for the WT1000 series                                  *
'*                                                                           *
'* Used to set measurement conditions/ranges for normal measurement mode, and read  *
'* and display the following data each time measured/computed data is updated.      *
'* Binary data: voltage (V), current (A), active power (W), voltage frequency (VHz) *
'*                                                                           *
'*****************************************************************************
'
   REM  $INCLUDE: 'qbdecl.bas'

   DECLARE SUB gpiberr (msg$)
   DECLARE SUB dvmerr (msg$, SPR%)

   CLS
   PRINT

   DIM DT(13)

   CALL IBDEV(0, 1, 0, T10s, 1, 0, dvm%)
   IF (dvm% < 0) THEN CALL gpiberr("Ibdev Error")

' clear the device.
   CALL IBCLR(dvm%)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibclr Error")

' set communication command group.
   WRT$ = "CM0"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set measurement condition.
   WRT$ = "HD0;SI2;MV0,0;MA0,0;FL0;SC0;AG0"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set measurement range.
   WRT$ = "RV0,6;RA0,7"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set the function of frequency to measure.
   WRT$ = "QS1"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' set communication output item.
   WRT$ = "OFD1;TO1"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

' wait for setting.
  FOR I% = 1 TO 10000: NEXT I%

' initialize status byte.
   WRT$ = "IM1"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   CALL IBRSP(dvm%, SPR%)
'   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrsp Error")

   FOR I = 1 TO 10
      'wait finished measurement.
SBWAIT:  MASK% = &H4800                    ' RQS + TIMO
         CALL IBWAIT(dvm%, MASK%)
         IF (IBSTA% AND (EERR OR TIMO)) THEN CALL gpiberr("Ibwait Error")
         CALL IBRSP(dvm%, STB%)
         IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrsp Error")

         IF ((STB% AND &H41) <> &H41) THEN GOTO SBWAIT

      'send request measurement data.
         WRT$ = "OD"
         CALL IBWRT(dvm%, WRT$)
         IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

      'read measurement data.
         RD$ = SPACE$(512)
         CALL IBRD(dvm%, RD$)
         IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd Error")
```

```
        N = 0
        FOR J = 1 TO 52 STEP 4
                P$ = MID$(RD$, J + 3, 1): SP = CVI(P$ + CHR$(0))
                Q$ = MID$(RD$, J + 2, 1): SQ = CVI(Q$ + CHR$(0))
                R$ = MID$(RD$, J + 1, 1): SR = CVI(R$ + CHR$(0))
                T$ = MID$(RD$, J + 0, 1): SS = CVI(T$ + CHR$(0))
                T$ = RIGHT$("0" + HEX$(SS), 2) + RIGHT$("0" + HEX$(SR), 2) + R
IGHT$("0" + HEX$(SQ), 2) + RIGHT$("0" + HEX$(SP), 2)
                FOR K = 1 TO 8
                        A$(K) = MID$(T$, K, 1)
                        IF A$(K) = "0" THEN B$(K) = "0000"
                        IF A$(K) = "1" THEN B$(K) = "0001"
                        IF A$(K) = "2" THEN B$(K) = "0010"
                        IF A$(K) = "3" THEN B$(K) = "0011"
                        IF A$(K) = "4" THEN B$(K) = "0100"
                        IF A$(K) = "5" THEN B$(K) = "0101"
                        IF A$(K) = "6" THEN B$(K) = "0110"
                        IF A$(K) = "7" THEN B$(K) = "0111"
                        IF A$(K) = "8" THEN B$(K) = "1000"
                        IF A$(K) = "9" THEN B$(K) = "1001"
                        IF A$(K) = "A" THEN B$(K) = "1010"
                        IF A$(K) = "B" THEN B$(K) = "1011"
                        IF A$(K) = "C" THEN B$(K) = "1100"
                        IF A$(K) = "D" THEN B$(K) = "1101"
                        IF A$(K) = "E" THEN B$(K) = "1110"
                        IF A$(K) = "F" THEN B$(K) = "1111"
                NEXT K
                B$ = B$(1) + B$(2) + B$(3) + B$(4) + B$(5) + B$(6) + B$(7) + B$(8)
                U = 0: E = 0: F = 0
                U = VAL(LEFT$(B$, 1))
                E$ = MID$(B$, 2, 8)
                FOR L = 0 TO 7
                        E = E + (2 ^ L) * VAL(MID$(E$, (8 - L), 1))
                NEXT L
                W$ = MID$(B$, 10, 23)
                FOR M = 1 TO 23
                        F = F + (2 ^ (-M)) * VAL(MID$(W$, M, 1))
                NEXT M
                F = F + 1
                DT(N) = ((-1) ^ U) * (2 ^ (E - 127)) * F
                IF DT(N) < 1E-12 THEN DT(N) = 0
                N = N + 1
        NEXT J

        PRINT "MEASURE DATA"
        PRINT "ELEMENT1 : ", DT(0), DT(1), DT(2)
        PRINT "ELEMENT2 : ", DT(3), DT(4), DT(5)
        PRINT "ELEMENT3 : ", DT(6), DT(7), DT(8)
        PRINT "SUM      : ", DT(9), DT(10), DT(11)
        PRINT "FREQUENCY: ", DT(12)
        PRINT

   NEXT I

'  Call the IBONL function to disable the hardware and software.
   CALL IBONL(dvm%, 0)

END
```

Appendix 2.1 IEEE 488.2-1987 Specifications

The GP-IB interface provided with this instrument conforms to IEEE 488.2-1987. This standard requires the following 23 points be stated in this document. This Appendix describes these points.

(1)Subsets supported by IEEE 488.1 interface functions

Refer to page 11-1.

(2)Operation of device when the device is assigned to an address other than addresses 0 to 30

The instrument does not allow assignment to an address other than 0 to 30.

(3)Reaction when the user changes the address

The current address is changed when a new address is set using the INTERFACE key. The newly set address is valid until another new address is set.

(4)Device set-up at power ON. Commands which can be used at power ON

Basically, the previous settings (i.e. the settings which were valid when power was turned OFF) are valid. All commands are available at power ON.

(5)Message transmission options

(a)Input buffer size

1024 bytes

(b)Queries which return multiple response messages

Refer to Appendix 2.3, "Commands".

(c)Queries which generate response data during analysis of the syntax

Every query generates a response data when analysis of the syntax is completed.

(d)Queries which generate response data during reception

No query generates response data when the query is received by the controller.

(e)Commands consisting of parameters which restrict one other

None

(6)Options included in command function elements and composite header elements

Refer to Appendix 2.2 and 2.3.

(7)Buffer size which affects transmission of block data

During transmission of block data, the output queue is extended according to the size of the data blocks.

(8)List of program data elements which can be used in equations, and nesting limit

Refer to the description of the commands given in Appendix 2.3.

(9)Syntax of response to queries

Refer to the description of the commands given in Appendix 2.3.

(10)Communications between devices which do not follow the response syntax

No response syntax is followed in any communication mode other than those specified in IEEE 488.2-1987 (refer to page 15-6).

(11)Size of data block of response data

0 to 4928 bytes

(12)List of supported common commands

Refer to Section 2.3.17, "Common Command Group".

(13)Condition of device when calibration is successfully completed

*CAL? is not supported.

(14)Maximum length of block data which can be used for definition of *DDT trigger macro

Not supported

(15)Maximum length of macro label used in definition of macro, maximum length of block data which can be used for definition of macro, processing when recursion is used in definition of macro

Macro functions are not supported.

(16)Response to *IDN?

Refer to Section 2.3.17, "Common Command Group".

(17)Size of storage area for protected user data for *PUD and *PUD?

*RDT and *RDT? are not supported.

(18)Length of *RDT and *RDT? resource name

*RDT and *RDT? are not supported.

(19)Change in status due to *RST, *LRN?, *RCL and *SAV

*RST

Refer to Section 2.3.17, "Common Command Group"

*LRN?, *RCL, *SAV

These commands are not supported.

(20)Execution range of self-test using the *TST?

Refer to Section 2.3.17, "Common Command Group"

(21)Structure of extended return status

Refer to Appendix 2.4.

(22)To find out whether each command is performed in parallel or sequentially

Refer to Appendix 2.2.6, "Synchronization with the Controller" and to 2.3.

(23)Description of execution of each command

Refer to the description of each command given in Appendix 2.3 and to their corresponding chapters.

Appendix 2.2 Program Format

2.2.1 Syntax Symbols

Symbols which are used in the syntax descriptions in Appendix 2.3 are shown below. These symbols are referred to as BNF notation (Backus-Nour Form). For detailed information, refer to pages App 2-6 to 2-7.

Symbol	Description	Example	Example
<>	Defined value	`ELEMENT<x> <x>=1~3`	`ELEMENT3`
{}	{}One of the options in{} is selected.	`MODE {RMS|MEAN|DC}`	`MODE RMS`
|	Exclusive OR	`MODE {RMS|MEAN|DC}`	`MODE RMS`
[]	Abbreviated	`SCALing[:STATe] {<Boolean>}`	
···	Repeatable		

2.2.2 Messages

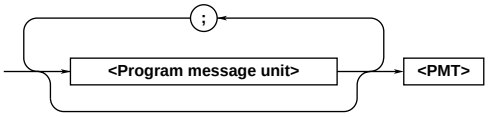
Messages

Blocks of message data are transferred between the controller and this instrument during communications. Messages sent from the controller to the instrument are called program messages, and messages sent back from the instrument to the controller are called response messages.

If a program message contains a query command, i.e. a command which requests a response, the instrument returns a response message. A single response message is always returned in reply to a program message.

Program Messages

As explained above, the data (message) sent from the controller to the instrument is called a program message. The format of a program message is shown below.



<Program message unit>

A program message consists of zero or more program message units; each unit corresponds to one command. The instrument executes commands one by one according to the order in which they are received.

Program message units are delimited by a ";".

For a description of the program message format, refer to the next section.

Example `:CONFIGURE:VOLTAGE:RANGE 100V;MODE RMS <PMT>`

unit unit

<PMT>

PMT is a terminator used to terminate each program message. The following three types of terminator are available.

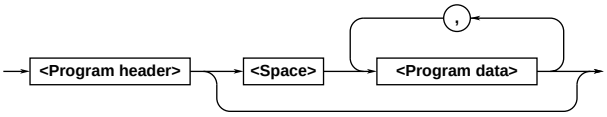
`NL` (New Line) : Same as LF (Line Feed). ASCII code "0AH" is used.

`^END` : END message defined in IEEE488.1. (EOI signal)
(The data byte sent with an END message will be the final item of the program message.)

`NL^END` : NL with an END message attached
(NL is not included in the program message.)

• Program message unit format

The format of a program message unit is shown below.



<Program header>

A program header is used to indicate the command type. For details, refer to page App 2-4.

<Program data>

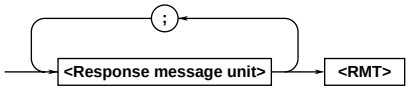
If certain conditions are required for the execution of a command, program data must be added. Program data must be separated from the header by a space (ASCII code "20H"). If multiple items of program data are included, they must be separated by a "," (comma).

Example `:CONFIGURE:AVERAGING:TYPE LINEAR,8<PMT>`

Header Data

Response Message

The data returned by the instrument to the controller is called a response message. The format of a response message is shown below.



<Response message units>

A response message consists of one or more response message units: each response message unit corresponds to one response.

Response message units are delimited by a ";".

For the response message format, refer to the next section.

Example `:SAMPLE:RATE 0.500E+00;HOLD 0<RMT>`

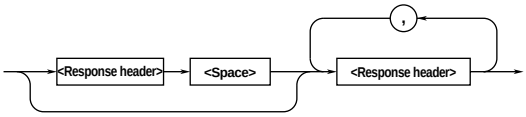
Unit Unit

<RMT>

RMT is the terminator used for every response message. Only one type of response message is available; `NL^END`.

• Response message unit format

The format of a program message unit is shown below.



<Response header>

A response header sometimes precedes the response data. Response data must be separated from the header by a space. For details, refer to page App 2-6.

<Response data>

Response data is used to define a response. If multiple items of response data are used, they must be separated by a "," (comma).

Example `500.0E-03<RMT>`

Data

`:CONFIGURE:VOLTAGE:MODE:ELEMENT1 RMS<RMT>`

Header Data

If a program message contains more than one query, responses are made in the same order as the queries. Normally, each query returns only one response message unit, but there are some queries which return more than one response message unit. The first response message unit always responds to the first query, but it is not always true that the 'n'th unit always responds to the 'n'th query. Therefore, if you want to make sure that a response is made to each query, the program message must be divided up into individual messages.

Points to Note when Sending/Receiving Messages

- If the previous message contained a query, it is not possible to send another program message until a response message has been received.
- An error will occur if a program message is sent before a response message has been received in its entirety. A response message which has not been received will be discarded.
- If an attempt is made by the controller to receive a response message, even if there is no response message, an error will occur. An error will also occur if the controller makes an attempt to receive a response message before transmission of a program message has been completed.
- If a program message of more than one unit is sent and some of the units are incomplete, the instrument receives program message units which the instrument thinks complete and attempts to execute them. However, these attempts may not always be successful and a response may not always be returned, even if the program message contains queries.

Dead Lock

The instrument has a buffer memory in which both program and response messages of 1024 bytes or more can be stored. (The number of bytes available will vary depending on the operating state of the instrument.) If both buffer memories become full at the same time, the instrument becomes inoperative. This state is called dead lock. In this case, operation can be resumed by discarding the response message.

No dead lock will occur, if the size of the program message including the PMT is kept below 1024 bytes. Furthermore, no dead lock will occur if the program message does not contain a query.

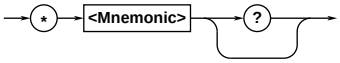
2.2.3 Commands

Commands

There are three two of command (program header) which can be sent from the controller to the instrument. They differ in the format of their program headers.

Common Command Header

Commands defined in IEEE 488.2-1987 are called common commands. The header format of a common command is shown below. An asterisk (*) must always be attached to the beginning of a command.

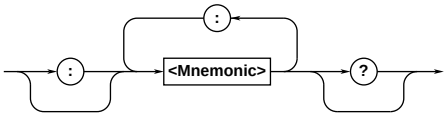


An example of a common command

```
:*CLS
```

Compound Header

Commands designed to be used only with the instrument are classified and arranged in a hierarchy according to their function. The format of a compound header is illustrated below. A colon (:) must be used when specifying a lower-level header.



An example of a compound header

```
:CONFIGURE:VOLTAGE:MODE:ELEMENT1 RMS
```

Note

- A mnemonic is a character string made up of alphanumeric characters.

When Concatenating Commands

• Command Group

A command group is a group of commands which have the same compound header. A command group may contain sub-groups.

Example Commands relating to integration

```
INTEGrate?
INTEGrate:MODE
INTEGrate:RTIMe?
INTEGrate:RTIMe:STARt
INTEGrate:RTIMe:STOP
INTEGrate:TIMer
INTEGrate:POLarity
INTEGrate:STARt
INTEGrate:STOP
INTEGrate:RESet
```

• When Concatenating Commands of the Same Group

This instrument stores the hierarchical level of the command which is currently being executed, and performs analysis on the assumption that the next command to be sent will also belong to the same level. Therefore, it is possible to omit the header if the commands belong to the same group.

Example `DISPLAY1:FUNCTION V;ELEMENT 1<PMT>`

• When Concatenating Commands of Different Groups

A colon (:) must be included before the header of a command, if the command does not belong to the same group as the preceding command.

Example `DISPLAY1:FUNCTION V;:SAMPLE:HOLD ON<PMT>`

• When Concatenating Common Commands

Common commands defined in IEEE 488.2-1987 are independent of hierarchical level. Thus, it is not necessary to add a colon (:) before a common command.

Example `DISPLAY1:FUNCTION V;*CLS:ELEMENT 1<PMT>`

• When Separating Commands with <PMT>

If a terminator is used to separate two commands, each command is a separate message. Therefore, the common header must be typed in for each command even when commands of the same command group are being concatenated.

Example `DISPLAY1:FUNCTION V<PMT>DISPLAY1:ELEMENT 1<PMT>`

Upper-level Query

An upper-level query is the highest-level command of a group to which a question mark is appended. Execution of an upper-level query allows all a group's settings to be output at once. Some query groups comprising more than three hierarchical levels can output all their lower level settings.

Example `SAMPLE?<PMT>∅`
`:SAMPLE:RATE 0.500E+00;HOLD 0`

In reply to an upper-level query, a response can be returned as a program message to the instrument.

Header Interpretation Rules

The instrument interprets the header received according to the following rules.

- Mnemonics are not case sensitive.

Example `"FUNCtion"` can be written as `"function"` or `"Function"`.

- The lower-case part of a header can be omitted.

Example `"FUNCtion"` can be written as `"FUNCT"` or `"FUNC"`.

- If the header ends with a question mark, the command is a query. It is not possible to omit the question mark.

Example `"FUNCtion?"` cannot be abbreviated to anything shorter than `"FUNC?"`.

- If the "x" at the end of a mnemonic is omitted, it is assumed to be "1".

Example If `"ELEMent<x>"` is written as `"ELEM"`, this represents `"ELEMent1"`.

- Any part of a command enclosed by [ ] can be omitted.

Example `[CONFigure]:SCALing[:STATe] ON` can be written as `SCAL ON`.

However, a part enclosed by [ ] cannot be omitted if is located at the end of an upper-level query.

Example `"SCALing?"` and `"SCALing:STATe?"` belong to different query levels.

2.2.4 Response

On receiving a query from the controller, the instrument returns a response message to the controller. A response message is sent in one of the following two forms.

- Response consisting of a header and data
  If the query can be used as a program message without any change, a command header is attached to the query, which is then returned.

Example `INTEGRATE:MODE?<PMT>` ∅
`:INTEGRATE:MODE NORMAL<RMT>`

- Response consisting of data only
  If the query cannot be used as a program message unless changes are made to it (i.e. it is a query-only command), no header is attached and only the data is returned. Some query-only commands can be returned after a header is attached to them.

Example `STATUS:ERROR?<PMT>` ∅ `0,"NO ERROR"<RMT>`

• When returning a response without a header

It is possible to remove the header from a response consisting of a header and data. The `"COMMunicate:HEADer"` command is used to do this.

• Abbreviated form

Normally, a response header is returned with the lower-case part removed. It is also possible to return a response header in full form, without the lower-case part removed. The `"COMMunicate:VERBose"` command is used to do this. The part enclosed by [ ] is also omitted in the abbreviated form.

2.2.5 Data

Data

A data section comes after the header. A space must be included between the header and the data. The data contains conditions and values. Data is classified as below.

Data	Description
<Decimal>	Decimal number
(Example	PT ratio setting ∅ `CONFigure:SCALing:PT 100`)
<Voltage>	Physical value
<Time><Frequency>	
(Example	Voltage range ∅ `CONFigutre:VOLTage:RANGe 150V`)
<Register>	Register value expressed as either binary, octal, decimal or hexadecimal
(Example	Extended event register value ∅`STATus:EESE #HFE`)
<Character data>	Specified character string(mnemonic). Can be selected from { }.
(Example	Measuring mode ∅ `CONFigure:MODE {RMS|MEAN|DC}`
<Boolean>	Indicates ON/OFF. Set to ON, OFF or value
(Example	Averaging ON ∅ `CONFigure:AVERaging[:STATe] ON`)
<Character string data>	Arbitrary character string
(Example	Character string expressing time ∅ `INTEGrate:TIMer "100:00"`)
<Block data>	Arbitrary 32 bit data
(Example	Response to measured/computed data ∅ `#40012ABCDEFGHIJKL`)

<Decimal>

<Decimal> indicates a value expressed as a decimal number, as shown in the table below. Decimal values are given in the NR form specified in ANSI X3. 42-1975.

Symbol	Description	Example
<NR1>	Integer	`125 -1 +1000`
<NR2>	Fixed point number	`125.0 -.90 +001.`
<NR3>	Floating point number	`125.0E+0 -9E-1 +.1E4`
<NRf>	Any of the forms <NR1> to <NR3> is allowed.	

- Decimal values which are sent from the controller to the instrument can be sent in any of the forms <NR1> to <NR3>. In this case, <NRf> appears.
- For response messages which are returned from the instrument to the controller, the form (<NR1> to <NR3> to be used) is determined by the query. The same form is used, irrespective of whether the value is large or small.
- In the case of <NR3>, the "+" after the "E" can be omitted, but the "–" cannot.
- If a value outside the setting range is entered, the value will be normalized so that it is just inside the range.
- If the value has more than the significant number of digits, the value will be rounded.

<Voltage>, <Current>, <Frequency>, <Time>

<Voltage>, <Current>, <Frequency> and <Time> indicate decimal values which have physical significance. <Multiplier> or <Unit> can be attached to <NRf>. They can be entered in any of the following forms.

Form	Example
<NRf><Multiplier><Unit>	5MV
<NRf><Unit>	5E-3V
<NRf><Multiplier>	5M
<NRf>	5E-3

<Multiplier>

Multipliers which can be used are shown below

Symbol	Word	Description
EX	Exa	10^{18}
PE	Peta	10^{15}
T	Tera	10^{12}
G	Giga	10^{9}
MA	Mega	10^{6}
K	Kilo	10^{3}
M	Milli	10^{-3}
U	Micro	10^{-6}
N	Nano	10^{-9}
P	Pico	10^{-12}
F	Femto	10^{-15}

<Unit>

Units which can be used are shown below. Symbol Word Description

Symbol	Word	Description
V	Volt	Voltage
A	Ampere	Current
HZ	Hertz	Frequency
MHZ	Megahertz	Frequency
S	Second	Time (second)

- <Multiplier> and <Unit> are not case sensitive.
- "U" is used to indicate "μ".
- "MA" is used for Mega (M) to distinguish it from Milli, except for in the case of Milli ampere and Megahertz, which is expressed as "MA" and "MHZ". Hence, it is not permissible to use "M" (Milli) for Hertz.
- If both <Multiplier> and <Unit> are omitted, the fundamental unit (V, A, HZ, S) will be used.
- Response messages are always expressed in <NR3> form. Neither <Multiplier> nor <Unit> is used.

<Register>

<Register> indicates an integer, and can be expressed in hexadecimal, octal or binary as well as a decimal number. <Register> is used when each bit of a value has a particular meaning. <Register> is expressed in one of the following forms.

Form	Example
<NRf>	1
#H<Hexadecimal value made up of the digits 0 to 9 and A to F>	#H0F
#Q<Octal value made up of the digits 0 to 7>	#q777
#B<Binary value made up of the digits 0 and 1>	#B001100

- <Register> is not case sensitive.
- A response message is always <NR1>.

<Character Data>

<Character data> is a specified string of character data (a mnemonic). It is mainly used to indicate options, and is chosen from the character strings given in { }. For interpretation rules, refer to "Header Interpretation Rules" on page App 2-6.

Form	Example
{RMS|MEAN|DC}	RMS

- As with a header, the "COMMunicate:VERBose" command can be used to select whether a response message is returned in its full form or abbreviated form.
- "COMMunicate:HEADer" does not affect <character data>.

<Boolean>

<Boolean> is data which indicates ON or OFF, and is expressed in one of the following forms.

Form	Example
{ON|OFF|<NRf>}	ON OFF 1 0

- When <Boolean> is expressed in <NRf> form, OFF is selected if the rounded integer value is "0" and ON is selected if the rounded integer is "Not 0".
- A response message is always "1" if the value is ON and "0" if it is OFF.

<Character String Data>

<Character string data> is not a specified character string like <character data>. It is an arbitrary character string. A character string must be enclosed in single quotation marks (') or double quotation marks (").

Form	Example
<Character string data>	'ABC' "IEEE488.2-1987"

- If a character string contains a double quotation mark ("), the double quotation mark will be replaced by two concatenated double quotation marks (" "). This rule also applies to a single quotation mark within a character string.
- A response message is always enclosed by double quotation marks (").
- <Character string data> is an arbitrary character string, therefore the instrument assumes that the remaining program message units are part of the character string if no single (') or double quotation mark (") is encountered. As a result, no error will be detected if a quotation mark is omitted.

<Block data>

<Block data> is arbitrary 32-bit data. On the instrument, <Block data> is only used for response messages. Block data is expressed in the following form.

Form	Example
#4<4-digit decimal value><Data byte string>	#40012ABCDEFGHIJKL

- #4
  Indicates that the data is <Block data>.
- <4-digit decimal value>
  Indicates the number of bytes of data. (0012 = 12 bytes)
- <Data byte string>
  The actual data. (ABCDEFGHIJKL)
- Data is comprised of 32-bit values (0 to 4294967295). This means that the ASCII code "0AH", which stands for "NL", can also be a code used for data. Hence, care must be taken when programming the controller.

2.2.6 Synchronization with the Controller

There are two kinds of command; overlap commands and sequential commands. Overlap commands, which are allowed to be executed before execution of the previously sent command is completed, are not supported by this instrument. In the case of sequential commands, which are supported by this instrument, the instrument delays execution of a command until execution of the previously sent command is completed. However, synchronization is sometimes required for correct inquiry for measured data, even if a sequential command is used.

For instance, if a program message is sent when an inquiry about measured data is made immediately after the voltage range is changed, the "`MEASure:VALue?`" command will be executed whether update of the measured data has been completed or not and no data is displayed ("------" is displayed instead), possibly causing "`9.91E+37(Not A Number)`" to be output.

```
[CONFigure:]VOLTage:RANGe[:ALL]
60V;:MEASure:VALue?<PMT>
```

In this case, synchronization with the time at which update of measured data is completed must be accomplished, as shown on the next page.

• Using STATus:CONDition? query

A "`STATus:CONDition?`" query is used to make an inquiry about the contents of the condition register (page App 2-51). It is possible to judge whether update of measured data is in progress or not by reading bit 0 of the condition register. Bit 0 is "1" if update is in progress, and "0" if update is stopped therefore making an inquiry is possible.

• Using the extended event register

Changes in the condition register are reflected in the extended event register (page App 2-51).

Example
```
STATus:FILTer1 FALL;:STATus:EESE
1;EESR?;*SRE8;[:CONFigure]:VOLTage
:RANGe[:ALL]60V<PMT>
(Service request is awaited.)
MEASure:VALue?<PMT>
```

"`STATus:FILTer1 FALL`" indicates that the transit filter is set so that bit 0 (`FILTer1`) is set to "`1`" when bit 0 of the condition register is changed from "`1`" to "`0`".

"`STATus:EESE 1`" is a command used to reflect the status of bit 0 of the extended event register in the status byte.
"`STATus:EESR?`" is used to clear the extended event register.
The "`*SRE`" command is used to generate a service request caused solely by the extended event register.
"`MEASure:VALue?`" will not be executed until a service request is generated.

• Using the COMMunicate:WAIT command

The "`COMMunicate:WAIT`" command halts communications until a specific event is generated.

Example
```
STATus:FILTer1 FALL;:STATus:EESR?
;[:CONFigure]:VOLTage:RANGe
[:ALL] 60V<PMT>
(Response to STATus:EESR? is decoded.)
COMMunicate:WAIT 1;:MEASure
:VALue?<PMT>
```

For a description of "`STATus:FILTer FALL`" and "`STATus:EESR?`", refer to "Using the extended event register" on this page.
"`COMMunicate:WAIT 1`" means that communications is halted until bit 0 of the extended event register is set to "`1`".
"`MEASure:VALue`" will not be executed until bit 0 of the extended event register is set to"`1`".

2.3 Commands

2.3.1 Command List

Command	Function	Reference Page
AOUTput Group		
:AOUTput?	Queries all the current D/A output settings.	App 2-13
:AOUTput:HARMonics?	Queries all the current D/A output item settings for harmonic analysis mode.	App 2-13
:AOUTput:HARMonics:CHANnel<x>	Sets D/A output items for the specified channel for harmonic analysis mode /queries the current setting.	App 2-14
:AOUTput:HARMonics:PRESet	Sets D/A output items for harmonic analysis mode at once.	App 2-14
:AOUTput:NORMal?	Queries all the current D/A output item settings for normal measurement mode.	App 2-14
:AOUTput:NORMal:CHANnel<x>	Sets D/A output items for the specified channel for normal measurement mode/queries the current setting.	App 2-14
:AOUTput:NORMal:IRTime	Sets the rated integration time for D/A output of integrated values /queries the current setting.	App 2-14
:AOUTput:NORMal:PRESet	Sets D/A output items for normal measurement mode at once.	App 2-14
COMMunicate Group		
:COMMunicate?	Queries all the communications settings.	App 2-15
:COMMunicate:HEADer	Determines whether a header is to be added or not.	App 2-15
:COMMunicate:LOCKout	Turns the local lock out function ON or OFF.	App 2-15
:COMMunicate:REMote	Selects remote mode or local mode.	App 2-15
:COMMunicate:STATus?	Queries the current network status.	App 2-16
:COMMunicate:VERBose	Determines whether a response to a query is to be returned in full form or in abbreviated form/queries the current setting.	App 2-16
:COMMunicate:WAIT	Waits until one of the specified extended event occurs.	App 2-16
:COMMunicate:WAIT?	Generates a response when one of the specified extended events occurs.	App 2-16
CONFigure Group		
:CONFigure?	Queries all the measurement condition settings.	App 2-19
:[CONFigure]:AVERaging?	Queries all the averaging function settings.	App 2-19
:[CONFigure]:AVERaging[:STATe]	Turns the averaging function ON or OFF/queries the current setting.	App 2-19
:[CONFigure]:AVERaging:TYPE	Sets the averaging type/queries the current setting.	App 2-19
:[CONFigure]:CURRent?	Queries all the current measurement settings	App 2-19
:[CONFigure]:CURRent:AUTO?	Queries ON/OFF state of current auto range for each element.	App 2-19
:[CONFigure]:CURRent:AUTO[:ALL]	Sets current auto range ON or OFF for all the elements at once.	App 2-19
:[CONFigure]:CURRent:AUTO:ELEMent<x>	Sets current auto range ON or OFF for the specified element/queries the current setting.	App 2-20
:[CONFigure]:CURRent:ESCaling?	Queries external sensor scaling constant for each element.	App 2-20
:[CONFigure]:CURRent:ESCaling[:ALL]	Sets external sensor scaling constant for all the elements at once.	App 2-20
:[CONFigure]:CURRent:ESCaling:ELEMent<x>	Sets external sensor scaling constant for the specified element/queries the current setting.	App 2-20
:[CONFigure]:CURRent:MODE?	Queries current measurement mode for each element.	App 2-20
:[CONFigure]:CURRent:MODE[:ALL]	Sets current measurement mode for all the elements at once.	App 2-20
:[CONFigure]:CURRent:MODE:ELEMent<x>	Sets current measurement mode for the specified element/queries the current setting.	App 2-20
:[CONFigure]:CURRent:RANGe?	Queries current range for each element.	App 2-20
:[CONFigure]:CURRent:RANGe[:ALL]	Sets current range for all the elements at once.	App 2-20
:[CONFigure]:CURRent:RANGe:ELEMent<x>	Sets current range for the specified element/queries the current setting.	App 2-20
:[CONFigure]:DEGRee	Sets phase angle display method/queries the current setting	App 2-21
:[CONFigure]:FILTer?	Queries the current line filter setting.	App 2-21
:[CONFigure]:FILTer:CUToff	Sets line filter cut-off frequency/queries the current setting.	App 2-21
:[CONFigure]:FILTer[:STATe]	Turns the line filter ON or OFF/queries the current setting.	App 2-21
:[CONFigure]:FREQuency?	Queries the current frequency setting.	App 2-21
:[CONFigure]:FREQuency:FILTer	Turns the frequency filter ON or OFF/queries the current setting.	App 2-21
:[CONFigure]:FREQuency:SOURce	Sets the input to be used for frequency measurement /queries the current setting.	App 2-21
:[CONFigure]:PHOLd	Turns the peak hold function ON or OFF/queries the current setting.	App 2-21
:[CONFigure]:SCALing?	Queries all the current scaling function settings.	App 2-21
:[CONFigure]:SCALing:{PT|CT|SFACtor}?	Queries the current scaling constant (voltage, current, power) for each element.	App 2-21
:[CONFigure]:SCALing:{PT|CT|SFACtor}[:ALL]	Sets scaling constant (voltage, current, power) for all the elements at once.	App 2-21
:[CONFigure]:SCALing:{PT|CT|SFACtor}:ELEMent<x>	Sets scaling constant (voltage, current, power) for the specified element.	App 2-21
:[CONFigure]:SCALing[:STATe]	Turns the scaling function ON or OFF/queries the current setting.	App 2-22
:[CONFigure]:VOLTage?	Queries all the voltage measurement settings.	App 2-22

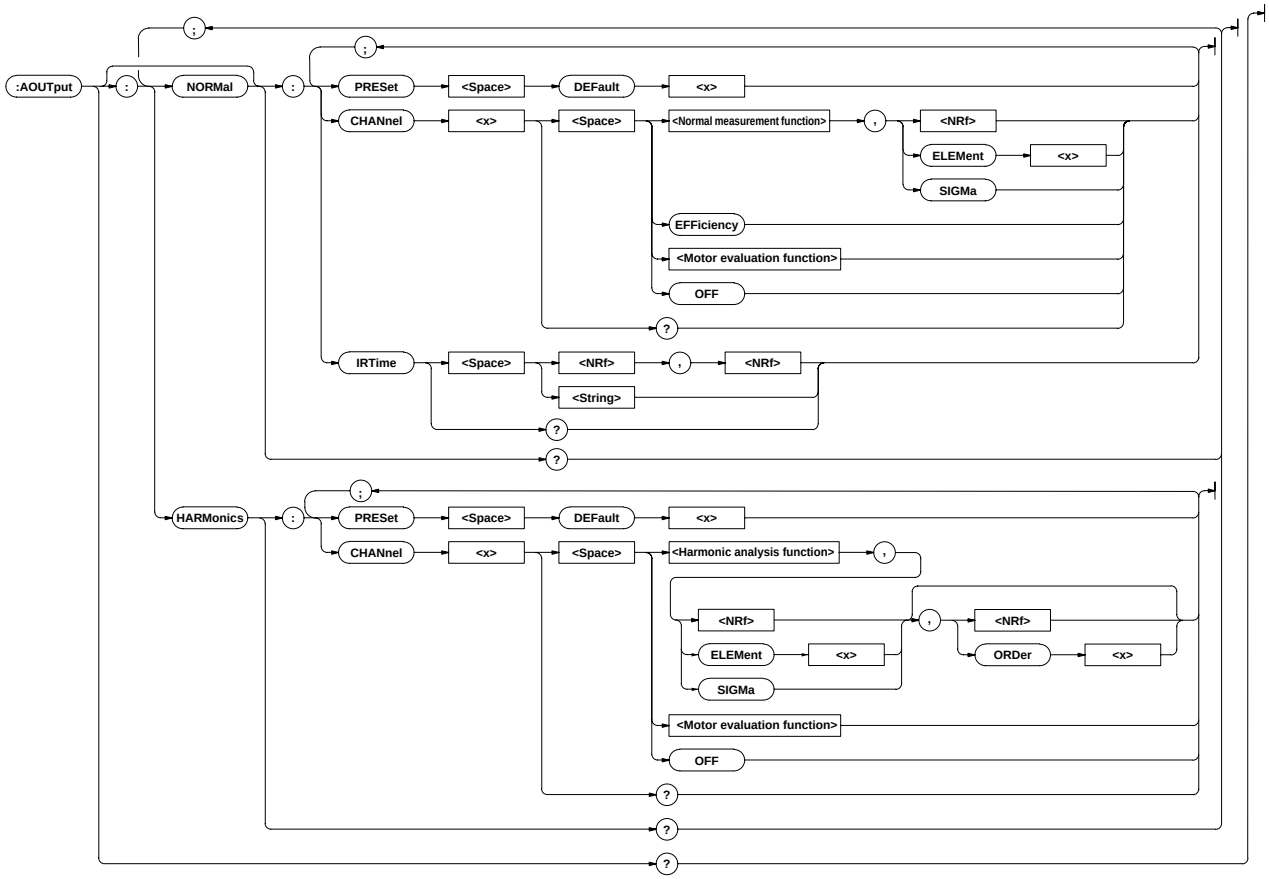
Command	Function	Reference Page
:[CONFigure]:VOLTage:AUTO?	Queries ON/OFF state of voltage auto range for each element.	App 2-22
:[CONFigure]:VOLTage:AUTO[:ALL]	Sets voltage auto range ON or OFF for all the elements at once.	App 2-22
:[CONFigure]:VOLTage:AUTO:ELEMent<x>	Sets voltage auto range ON or OFF for the specified element/queries the current setting.	App 2-22
:[CONFigure]:VOLTage:MODE?	Queries voltage measurement mode for each element.	App 2-22
:[CONFigure]:VOLTage:MODE[:ALL]	Sets voltage measurement mode for all the elements at once.	App 2-22
:[CONFigure]:VOLTage:MODE:ELEMent<x>	Sets voltage measurement mode for the specified element/queries the current setting.	App 2-22
:[CONFigure]:VOLTage:RANGe?	Queries voltage range for each element	App 2-22
:[CONFigure]:VOLTage:RANGe[:ALL]	Sets voltage range for all the elements at once.	App 2-22
:[CONFigure]:VOLTage:RANGe:ELEMent<x>	Sets voltage range for the specified element/queries the current setting.	App 2-22
:[CONFigure]:WIRing	Sets wiring system/queries the current setting.	App 2-22
:[CONFigure]:ZCALibrate	Carries out zero-level calibration.	App 2-22
DISPlay Group		
:DISPlay<x>?	Queries all the current display settings for the specified display.	App 2-23
:DISPlay<x>:ELEMent	Sets the element to be displayed/queries the current setting.	App 2-23
:DISPlay<x>:FUNCtion	Sets the function to be displayed/queries the current setting.	App 2-23
HARMonics Group		
:HARMonics?	Queries all the harmonic analysis settings.	App 2-25
:HARMonics:DEGRee	Sets the object for computation of phase angle (deg) for harmonic analysis/queries the current setting.	App 2-25
:HARMonics:DISPlay?	Queries all the display settings for harmonic analysis.	App 2-25
:HARMonics:DISPlay:MODE	Sets display mode for harmonic analysis items to be displayed on display B/queries the current setting.	App 2-25
:HARMonics:DISPlay:ORDer	Sets harmonic order to be displayed on display A/queries the current setting.	App 2-25
:HARMonics:FILTer	Turns anti-aliasing filter for harmonic analysis ON or OFF/queries the current setting.	App 2-25
:HARMonics:ORDer	Sets the maximum harmonic order for harmonic analysis /queries the current setting.	App 2-25
:HARMonics[:STATe]	Turns harmonic analysis mode ON or OFF/queries the current setting.	App 2-25
:HARMonics:SYNChronize	Sets the input to be used as the fundamental frequency for PLL synchronization/queries the current setting.	App 2-25
:HARMonics:THD		App 2-25
INTEGrate Group		
:INTEGrate?	Queries all the integration settings.	App 2-26
:INTEGrate:MODE	Sets integration mode/queries the current setting.	App 2-26
:INTEGrate:POLarity	Sets polarity of integrated values to be displayed on display D/queries the current setting.	App 2-26
:INTEGrate:RESet	Resets integrated values.	App 2-26
:INTEGrate:RTIMe?	Queries the integration start and stop time for real time counting . integration mode	App 2-26
:INTEGrate:RTIMe:STARt	Sets the integration start time for real time counting integration mode /queries the current setting.	App 2-27
:INTEGrate:RTIMe:STOP	Sets the integration stop time for real time counting integration mode /queries the current setting.	App 2-27
:INTEGrate:STARt	Starts integration.	App 2-27
:INTEGrate:STOP	Stops integration.	App 2-27
:INTEGrate:TIMer	Sets integration timer preset time/queries the current setting.	App 2-27
MATH Group		
:MATH?	Queries all the computation settings.	App 2-28
:MATH:ARIThmetic	Sets equation for four arithmetical operations/queries the current setting.	App 2-28
:MATH:CFACtor	Sets equation for crest factor/queries the current setting.	App 2-28
:MATH:TYPE	Sets computation type/queries the current setting.	App 2-28
MEASure Group		
:MEASure?	Queries all the settings for measured/computed data for communication output.	App 2-30
:MEASure:FORMat	Sets communication output format for measured/computed data /queries the current setting.	App 2-30
:MEASure:ITEM?	Queries all the communication output items settings for measured/computed data.	App 2-30
:MEASure:ITEM:HARMonics?	Queries all the communication output items for harmonic analysis mode.	App 2-30
:MEASure:ITEM:HARMonics:<Harmonic analysis function>?	Queries all the communication output settings for the specified harmonic analysis function.	App 2-30
:MEASure:ITEM:HARMonics:{<Harmonic analysis function>}[:ALL]	Turns communication output for the specified harmonic analysis function ON or OFF for all the elements at once.	App 2-30
:MEASure:ITEM:HARMonics:<Harmonic analysis function>:ELEMent<x>	Turns communication output for the specified harmonic analysis function ON or OFF for the specified element/queries the current setting.	App 2-30

Command	Function	Reference Page
:MEASure:ITEM:HARMonics:<Harmonic analysis function>:SIGMa		
	Turns communication output of Σ data ON or OFF for the specified harmonic analysis function/queries the current setting.	App 2-30
:MEASure:ITEM:HARMonics:{SYNChoronize|<Motor evaluation function>}		
	Turns communication output ON or OFF for the motor evaluation function/queries the current setting.	App 2-30
:MEASure:ITEM:HARMonics:PRESet	Sets communication output items for harmonic analysis mode to the preset settings at once.	App 2-30
:MEASure:ITEM:NORMal?	Queries all the communication output items for normal measurement mode	App 2-31
:MEASure:ITEM[:NORMal]:<Normal measurement function>?		
	Queries all the communication output settings for the specified normal measurement function.	App 2-31
:MEASure:ITEM[:NORMal]:<Normal measurement function >[:ALL]		
	Turns communication output for the specified normal measurement function ON or OFF for all the effective elements and Σ at once.	App 2-31
:MEASure:ITEM[:NORMal]:<Normal measurement function >:ELEMent<x>		
	Turns communication output for the specified normal measurement function ON or OFF for the specified element/queries the current setting.	App 2-31
:MEASure:ITEM[:NORMal]:<Normal measurement function>:SIGMa		
	Turns communication output of sigma? data ON or OFF for the specified harmonic analysis function/queries the current setting.	App 2-31
:MEASure:ITEM[:NORMal]:{TIME|FREQuency|MATH|<Motor evaluation function>}		
	Turns communication output ON or OFF for the motor evaluation function (elapsed time of integration, frequency, computation)/queries the current setting.	App 2-31
:MEASure:ITEM[:NORMal]:PRESet	Sets communication output items for normal measurement mode to the preset settings at once.	App 2-31
:MEASure:VALue?	Queries all the measured/computed data for the items which are set to ON using MEASure:ITEM commands ("MEASure:ITEM:HARMonics" through "MEASure:ITEM[:NORMal]:PRESet").	App 2-31
MOTor Group		
:MOTor?	Queries all the current motor evaluation settings.	App 2-36
:MOTor:POLe	Sets the number of poles/queries the current setting.	App 2-36
:MOTor:RPM?	Queries all the current rpm settings.	App 2-36
:MOTor:RPM:ANALog	Sets scaling value for analog rpm input/queries the current setting.	App 2-36
:MOTor:RPM:PULSe	Sets the number of pulses per revolution/queries the current setting.	App 2-36
:MOTor:RPM:TYPE	Sets the rpm input type/queries the current setting.	App 2-37
:MOTor:TORQue?	Queries all the current torque input settings.	App 2-37
:MOTor:TORQue:FSCale	Sets scaling value for torque input/queries the current setting.	App 2-37
:MOTor:TORQue:UNIT	Sets unit for torque input/queries the current setting.	App 2-37
PRINt Group		
:PRINt?	Queries all the current built-in printer settings.	App 2-39
:PRINt:ABORt	Stops printing.	App 2-39
:PRINt:AUTO?	Queries all the current auto print mode settings.	App 2-39
:PRINt:AUTO:INTerval	Sets print interval for auto print mode/queries the current setting.	App 2-39
:PRINt:AUTO:STARt	Sets start time for auto print mode/queries the current setting.	App 2-39
:PRINt:AUTO[:STATe]	Turns auto print mode ON or OFF/queries the current setting.	App 2-39
:PRINt:AUTO:STOP	Sets stop time for auto print mode/queries the current setting.	App 2-39
:PRINt:AUTO:SYNChronize	Sets print synchronization method for auto print mode/queries the current setting.	App 2-39
:PRINt:FEED	Feeds print paper.	App 2-39
:PRINt:ITEM?	Queries all the printer settings for measured/computed data.	App 2-39
:PRINt:ITEM:HARMonics?	Queries all the print output items for harmonic analysis mode.	App 2-40
:PRINt:ITEM:HARMonics:<Harmonic analysis function>?		
	Queries all the printer output settings for the specified harmonic analysis function.	App 2-40
PRINt:ITEM:HARMonics:<Harmonic analysis function>[:ALL]		
	Turns printer output for the specified harmonic analysis function ON or OFF for all the effective elements at once.	App 2-40
PRINt:ITEM:HARMonics:<Harmonic analysis function>:ELEMent<x>		
	Turns printer output for the specified harmonic analysis function ON or OFF for the specified element/queries the current setting.	App 2-40
:PRINt:ITEM:HARMonics<Motor evaluation function>		
	Turns printer output for <motor evaluation function> ON and OFF/ queries the current setting.	App 2-40
:PRINt:ITEM:HARMonics:PRESet	Sets printer output items for harmonic analysis mode to the specified default setting at once.	App 2-40
:PRINt:ITEM:NORMal?	Queries all the printer output items for normal measurement mode.	App 2-41

Command	Function	Reference Page
:PRINt:ITEM:NORMal:<Normal measurement function>?		
	Queries all the printer output settings for the specified normal measurement function.	App 2-41
:PRINt:ITEM:NORMal:<Normal measurement function >[:ALL]		
	Turns printer output ON or OFF at once.	App 2-41
:PRINt:ITEM:NORMal:<Normal measurement function>:ELEMent<x>		
	Turns printer output ON or OFF for the specified element/queries the current setting.	App 2-41
:PRINt:ITEM:NORMal:<Normal measurement function>:SIGMa		
	Turns printer output of Σ data ON or OFF /queries the current setting.	App 2-41
:PRINt:ITEM:NORMal:{TIME|FREQuency|MATH|<Motor evaluation function>}		
	Turns printer output ON or OFF for the motor evaluation function/ queries the current setting.	App 2-41
:PRINt:ITEM:NORMal:PRESet	Sets printer output items for normal measurement mode at once.	App 2-41
:PRINt:PANel	Prints set-up information.	App 2-41
:PRINt:VALue	Prints all the measured/computed data for the items which are set to ON using "PRINt:ITEM" commands.	App 2-41
RECall Group		
RECall:PANel	Recalls set-up information from the specified file of the internal memory.	App 2-42
SAMPle Group		
:SAMPLe?	Queries all the current sampling settings.	App 2-42
:SAMPLe:HOLD	Turns hold mode for output data (display, communication data) ON and ON/queries the current setting.	App 2-42
:SAMPLe:RATE	Sets sample rate/queries the current setting.	App 2-42
STATus Group		
:STATus?	Queries all the settings relating to the communications status function.	App 2-43
:STATus:CONDition?	Queries the contents of the condition register and clears the register.	App 2-43
:STATus:EESE	Sets the extended event enable register/queries the current setting.	App 2-43
:STATus:EESR?	Queries the contents of the extended event register and clears the register.	App 2-43
:STATus:ERRor?	Queries the code and the message (at the beginning of the error queue) of the error which has occurred.	App 2-43
:STATus:FILTer<x>	Queries all the settings relating to the specified transit filter/queries the current settings.	App 2-44
:STATus:QMESsage	Selects whether or not to add the message contents to a response to "STATus:ERRor?" /queries the current setting.	App 2-44
:STATus:SPOLl?(Serial Poll)	Executes serial poll.	App 2-44
STORe Group		
:STORe:PANel	Stores set-up information in the internal memory.	App 2-44
SYSTem Group		
:SYSTem?	Queries all the system (internal clock) settings.	App 2-45
:SYSTem:DATE	Sets the date/queries the current setting.	App 2-45
:SYSTem:TIME	Sets the time/queries the current setting.	App 2-45
Common Command Group		
*CLS	Clears the standard event register, extended event register and error queue.	App 2-46
*ESE	Sets the value for the standard event enable register/queries the current setting.	App 2-46
*ESR?	Queries the value of the standard event register and clears it at the same time.	App 2-46
*IDN?	Queries the instrument model.	App 2-46
*OPC	(Not supported by this instrument.)	App 2-46
*OPC?	("1" will always be returned since overlap commands are not supported by this instrument.)	App 2-47
*OPT?	Queries installed options.	App 2-47
*PSC	Selects whether or not to clear the registers when power is turned ON/ queries the current setting.	App 2-47
*RST	Resets the current settings.	App 2-47
*SRE	Sets the value of the service request enable register/queries the current setting.	App 2-47
*STB?	Queries the value of the status byte register.	App 2-47
*TRG	Carries out the same function as when the TRIG key (SHIFT + HOLD) is pressed.	App 2-47
*TST?	Executes a self-test and queries the test result.	App 2-47
*WAI	(Not supported by this instrument.)	App 2-47

2.3.2 AOUTput Group

The commands in the AOUTput group are used to make settings relating to and inquire about D/A output. This allows you to make the same settings and inquiries which can be made using the MISC key ("dA-out" menu and "itG-t" menu) on the front panel. These commands are available if the instrument is equipped with the D/A output function (/DA model).



AOUTput?

Function Queries all the current D/A output settings.

Syntax `AOUTput?`

Example `AOUTPUT? ∅:AOUTPUT:NORMAL:CHANNEL1 V,1;CHANNEL2 V,2;CHANNEL3 V,3;CHANNEL4 V,SIGMA;CHANNEL5 A,1;CHANNEL6 A,2;CHANNEL7 A,3;CHANNEL8 A,SIGMA;CHANNEL9 W,1;CHANNEL10 W,2;CHANNEL11 W,3;CHANNEL12 W,SIGMA;CHANNEL13 W,1;CHANNEL14 W,1;IRTIME 1,0;:AOUTPUT:HARMONICS:CHANNEL1 A,1,1;CHANNEL2 A,1,2;CHANNEL3 A,1,3;CHANNEL4 A,1,4;CHANNEL5 A,1,5;CHANNEL6 A,1,6;CHANNEL7 A,1,7;CHANNEL8 A,1,8;CHANNEL9 A,1,9;CHANNEL10 A,1,10;CHANNEL11 A,1,11;CHANNEL12 A,1,12;CHANNEL 13 A,1,13;CHANNEL14 SYNCHRONIZE`

AOUTput:HARMonics?

Function Queries all the current D/A output item settings for harmonic analysis mode.

Syntax `AOUTput:HARMonics?`

Example `AOUTPUT:HARMONICS? ∅:AOUTPUT:HARMONICS:CHANNEL1 A,1,1;CHANNEL2 A,1,2;CHANNEL3 A,1,3;CHANNEL4 A,1,4;CHANNEL5 A,1,5;CHANNEL6 A,1,6;CHANNEL7 A,1,7;CHANNEL8 A,1,8;CHANNEL9 A,1,9;CHANNEL10 A,1,10;CHANNEL11 A,1,11;CHANNEL12 A,1,12;CHANNEL 13 A,1,13;CHANNEL14 SYNCHRONIZE`

AOUTput:HARMonics:CHANnel<x>

Function Sets D/A output items for the specified for harmonic analysis mode /queries the current setting.

Syntax
```
AOUTput:HARMonics:CHANnel<x> {<Harmonic analysis function>,(<NRf>|ELEMent<1-3>|SIGMa),(<NRf>|ORDer<1-50>)|<Motor evaluation function>|OFF}
AOUTput:HARMonics:CHANnel<x>?
<x>1 to 14(output channel)
<Harmonic analysis function>= {V|A|W|VA|VAR|PF|DEG|VTHD|ATHD|VCON|ACON|WCON|VDEG|ADEG|SYNChronize}
<Motor evaluation function>= {TORQue|RPM|SRPM|SLIP|MPOWer|MEFFiciency|TEFFiciency}
```

Example
```
AOUTPUT:HARMONICS:CHANNEL1 A,1,1
AOUTPUT:HARMONICS:CHANNEL2 ATHD,1,1
AOUTPUT:HARMONICS:CHANNEL3 OFF
AOUTPUT:HARMONICS:CHANNEL1? ∅:AOUTPUT:HARMONICS:CHANNEL1 A,1,1
AOUTPUT:HARMONICS:CHANNEL2? ∅:AOUTPUT:HARMONICS:CHANNEL2 ATHD,1
AOUTPUT:HARMONICS:CHANNEL3? ∅:AOUTPUT:HARMONICS:CHANNEL3 OFF
```

Description The element and order are set as follows according to the selected harmonic analysis function.

`{V|A|W}`: If no order is set, total rms value from 1st to 50th will be selected.

`{VA|VAR|PF|DEG|VTHD|ATHD}`: The order can be omitted, since it is meaningless.

`{SYNChronize}`: The element and order can be omitted, since they are meaningless.

AOUTput:HARMonics:PRESet

Function Sets D/A output items for harmonic analysis mode to the specified default setting at once.

Syntax
```
AOUTput:HARMonics:PRESet {DEFault<1-2>}
```

Example
```
AOUTPUT:HARMONICS:PRESET DEFAULT1
```

Description For a description of global setting for `{DEFault<1-2>}`, refer to Section 13.3, "D/A Output".

AOUTput:NORMal?

Function Queries all the current D/A output item settings for normal measurement mode.

Syntax
```
AOUTput:NORMal?
```

Example
```
AOUTPUT:NORMAL? ∅:AOUTPUT:NORMAL:CHANNEL1 V,1;CHANNEL2 V,2;CHANNEL3 V,3;CHANNEL4 V,SIGMA;CHANNEL5 A,1;CHANNEL6 A,2;CHANNEL7 A,3;CHANNEL8 A,SIGMA;CHANNEL9 W,1;CHANNEL10 W,2;CHANNEL11 W,3;CHANNEL12 W,SIGMA;CHANNEL13 W,1;CHANNEL14 W,1;IRTIME 1,0
```

AOUTput[:NORMal]:CHANnel<x>

Function Sets D/A output items for the specified channel for normal measurement mode/queries the current setting.

Syntax
```
AOUTput[:NORMal]:CHANnel<x> {<Normal measurement function>,(<NRf>|ELEMent<1-3>|SIGMa)|<Motor evaluation function>|OFF}
AOUTput[:NORMal]:CHANnel<x>?
<x>1 to 14(output channel)
<Normal measurement function>= {V|A|W|VA|VAR|PF|DEG|VPK|APK|WH|WHP|WHM|AH|AHP|AHM|FREQuency|EFFiciency|TIME}
<Motor evaluation function>={TORQue|RPM|SRPM|SLIP|MPOWer|MEFFiciency|TEFFiciency}
```

Example
```
AOUTPUT:NORMAL:CHANNEL1 V,1
AOUTPUT:NORMAL:CHANNEL2 FREQUENCY
AOUTPUT:NORMAL:CHANNEL3 OFF
AOUTPUT:NORMAL:CHANNEL1? ∅:AOUTPUT:NORMAL:CHANNEL1 V,1
AOUTPUT:NORMAL:CHANNEL2? ∅:AOUTPUT:NORMAL:CHANNEL2 FREQUENCY
AOUTPUT:NORMAL:CHANNEL3? ∅:AOUTPUT:NORMAL:CHANNEL3 OFF
```

Description The element is set as follows according to the selected normal measurement function.

`{FREQuency|EFFiciency|TIME}`: The element can be omitted, since it is meaningless.

AOUTput[:NORMal]:IRTime

Function Sets the rated integration time for D/A output of integrated values/queries the current setting.

Syntax
```
AOUTput[:NORMal]:IRTime {<NRf>,<NRf>|<Character string>}
AOUTput[:NORMal]:IRTime?
{<NRf>,<NRf>}= 0,0 to 999,59
{<Character string>}="HHH:MM"  HHH:Hour MM:Miniute
```

Example
```
AOUTPUT:NORMAL:IRTIME 1,0
AOUTPUT:NORMAL:IRTIME "1:00"
AOUTPUT:NORMAL:IRTIME? ∅:AOUTPUT:NORMAL:IRTIME 1,0
```

AOUTput[:NORMal]:PRESet

Function Sets D/A output items for normal measurement mode to the specified default setting at once.

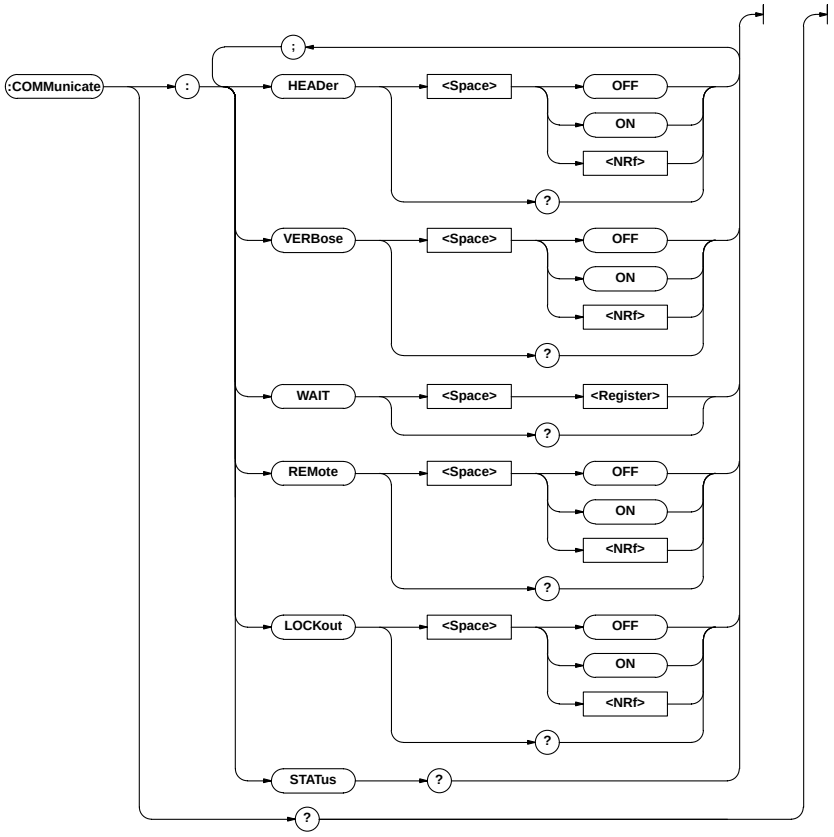
Syntax
```
AOUTput[:NORMal]:PRESet {DEFault<1-2>}
```

Example
```
AOUTPUT:NORMAL:PRESET DEFAULT1
```

Description For a description of global setting for `{DEFault<1-2>}`, refer to Section 13.3, "D/A Output".

2.3.3 COMMunicate Group

The commands in the COMMunicate group are used to make settings relating to and inquire about communications. There is no front panel key for this function.



COMMunicate?

Function Queries all the communications settings.

Syntax `COMMunicate?`

Example `COMMUNICATE?`
`∅:COMMUNICATE:HEADER 1;VERBOSE 1`

COMMunicate:HEADer

Function Determines whether a header is added(example: `CONFIGURE:VOLTAGE:RANGE:ELEMENT1 150.0E+00`) or not (example:`150.0E+00`) when sending a response to a query/queries the current setting.

Syntax `COMMunicate:HEADer {<Boolean>}`
`COMMunicate:HEADer?`

Example `COMMUNICATE:HEADER ON`
`COMMUNICATE:HEADER?∅:COMMUNICATE:HEADER 1`

COMMunicate:LOCKout

Function Turns the local lock out function ON or OFF.

Syntax `COMMunicate:LOCKout {<Boolean>}`
`COMMunicate:LOCKout?`

Example `COMMUNICATE:LOCKOUT ON`
`COMMUNICATE:LOCKOUT?∅:COMMUNICATE:LOCKOUT 1`

Description This command is available only for the RS-232-C interface.

COMMunicate:REMote

Function Selects remote mode or local mode. Remote mode is selected if this command is set to ON.

Syntax `COMMunicate:REMote {<Boolean>}`
`COMMunicate:REMote?`

Example `COMMUNICATE:REMOTE ON`
`COMMUNICATE:REMOTE?∅:COMMUNICATE:REMOTE 1`

Description This command is available only for the RS-232-C interface.

COMMunicate:STATus?

Function Queries the current network status.

Syntax `COMMunicate:STATus?`

Example `COMMUNICATE:STATUS?∅:COMMUNICATE:STATUS 0`

Description Meaning of each bit of the status is given below.

Bit	GP-IB	RS-232-C
0	Transmission error for non-recoverable 7210	Parity error
1	Always set to 0.	Framing error
2	Always set to 0.	Break character detection
3 or more	Always set to 0.	Always set to 0.

A status bit is set when its corresponding cause occurs, and cleared when it is read.

COMMunicate:VERBose

Function Determines whether a response to a query is to be returned full in form (for example:`CONFIGURE : VOLTAGE:RANGE:ELEMENT1 150.0E+00`) or in abbreviated form (for example:`VOLT:RANG:ELEM 150.0E+00`)/queries the current setting.

Syntax `COMMunicate:VERBose {<Boolean>}`
`COMMunicate:VERBose?`

Example `COMMUNICATE:VERBOSE ON`
`COMMUNICATE:VERBOSE?∅:COMMUNICATE:VERBOSE 1`

COMMunicate:WAIT

Function Waits until one of the specified extended event occurs.

Syntax `COMMunicate:WAIT <Register>`
`<Register>= 0 to 65535`(For a description of the extended event register, refer to page App 2-51.)

Example `COMMUNICATE:WAIT 65535`

Description For a description of synchronization using COMMunicate: WAIT, refer to page App 2-8.

COMMunicate:WAIT?

Function Generates a response when one of the specified extended events occurs.

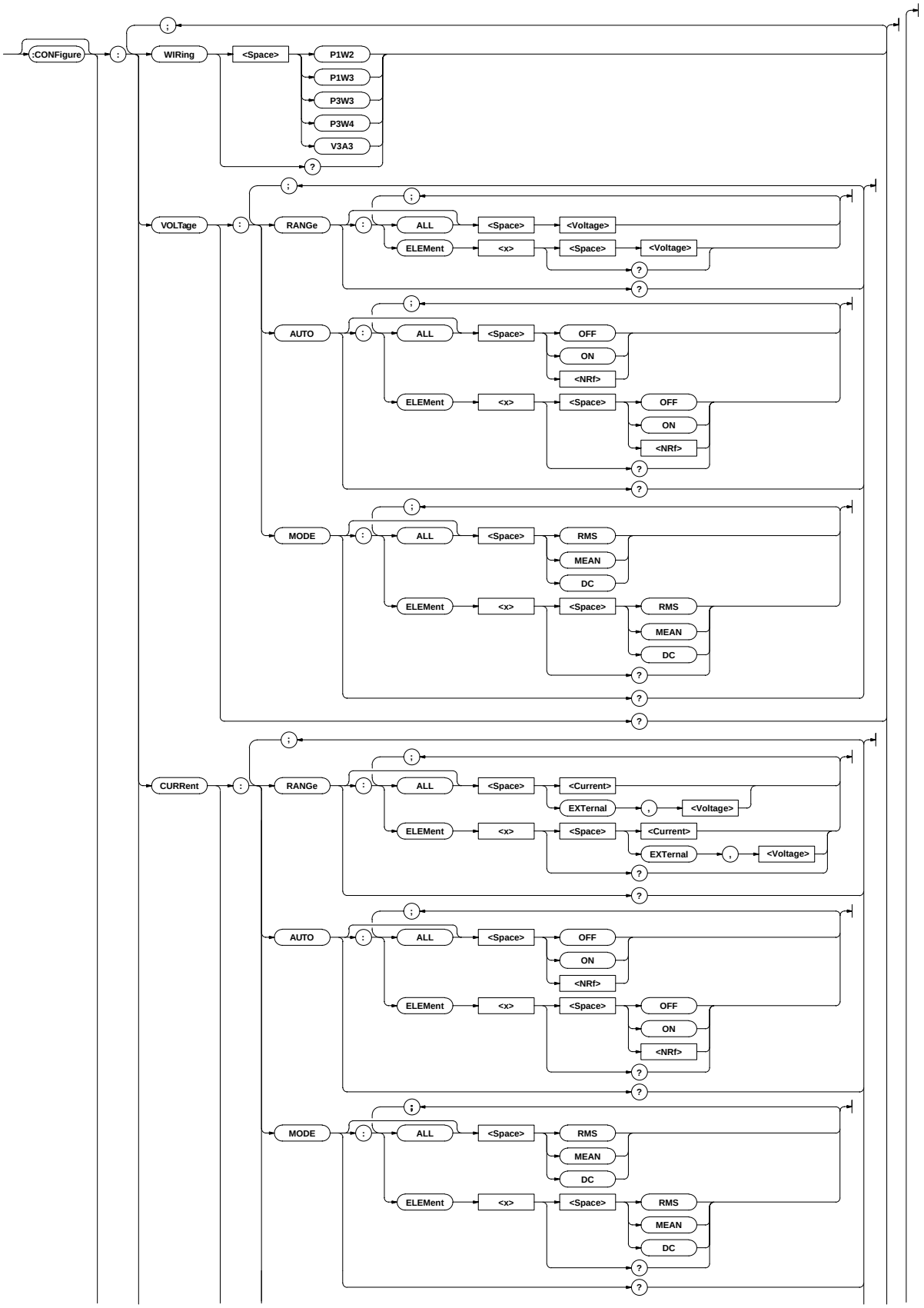
Syntax `COMMunicate:WAIT? <Register>`
`<Register>= 0 to 65535`(For a description of the extended event register, refer to page App 2-51.)

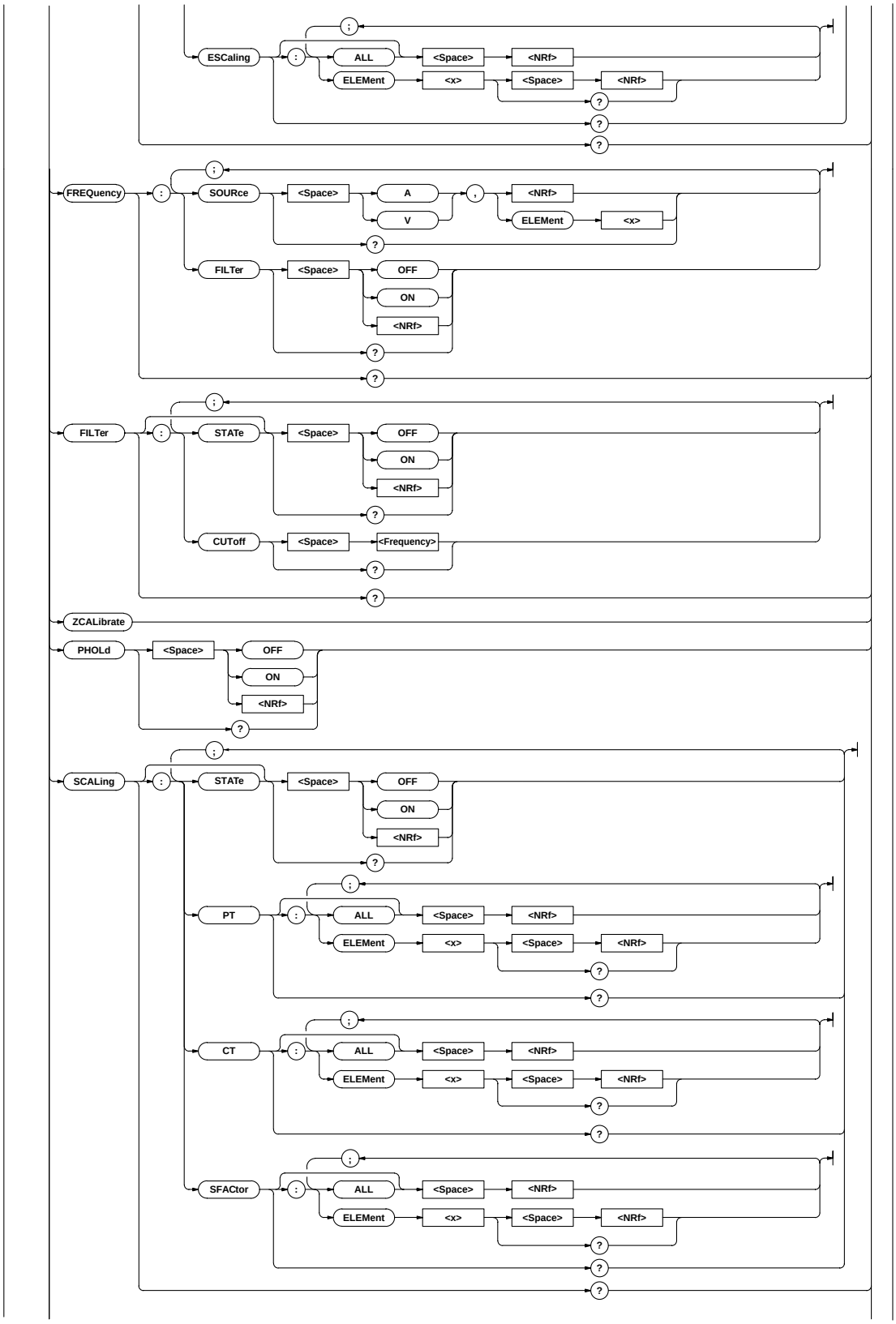
Example `COMMUNICATE:WAIT? 65535∅1`

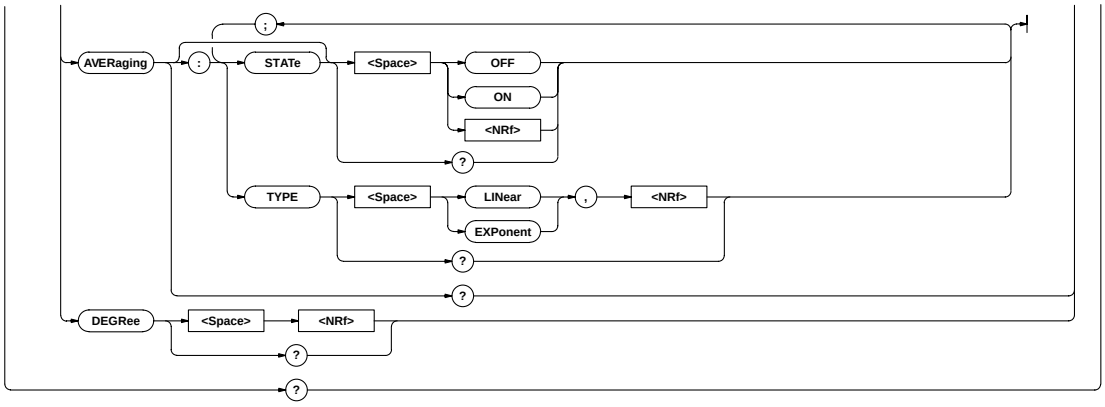
2.3.4 CONFigure Group

The commands in the CONFigure group are used to make settings relating to and to inquire about measurement conditions. This allows you to make the same settings and inquiries which you can make using the WIRING key, VOLTAGE (CURRENT) RANGE related keys, FREQUENCY related keys, and LINE FILTER, SCALING, AVG, PEAK HOLD (SHIFT + RATE) and MISC ("CAL" and "dEG" menus) keys on the front panel.

The external sensor input ranges and scaling constant can be set only when the instrument is equipped with the external sensor input function (/EX2 model).




ESCaling
:
;
ALL
ELEMent
<Space>
<x>
<NRf>
?
FREQuency
SOURce
A
V
,
ELEMent
FILTer
OFF
ON
<NRf>
STATe
CUToff
<Frequency>
ZCALibrate
PHOLd
SCALing
PT
CT
SFACtor



CONFigure?

Function Queries all the measurement condition settings.

Syntax CONFigure?

Example CONFIGURE?∅:CONFIGURE:WIRING P1W2;VOLTAGE:RANGE:ELEMENT1 1.0000E+03;ELEMENT2 1.0000E+03;ELEMENT31.0000E+03;:CONFIGURE:VOLTAGE:AUTO:ELEMENT1 0;ELEMENT2 0;ELEMENT30;:CONFIGURE:VOLTAGE:MODE:ELEMENT1RMS;ELEMENT2RMS;ELEMENT3RMS;:CONFIGURE:CURRENT:RANGE:ELEMENT1 20.0E+00;ELEMENT2 20.0E+00;ELEMENT3 20.0E+00;:CONFIGURE:CURRENT:AUTO:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:CONFIGURE:CURRENT:MODE:ELEMENT1 RMS;ELEMENT2RMS;ELEMENT3RMS;:CONFIGURE:CURRENT:ESCALING:ELEMENT1 10.000E+00;ELEMENT2 10.000E+00;ELEMENT3 10.000E+00;:CONFIGURE:FREQUENCY:SOURCE V,1;FILTER 0;:CONFIGURE:FILTER:STATE 0;CUTOFF 0.500E+03;:CONFIGURE:PHOLD 0;SCALING:STATE 0;PT:ELEMENT1 1.0000E+00;ELEMENT2 1.0000E+00;ELEMENT3 1.0000E+00;:CONFIGURE: SCALING:CT:ELEMENT1 1.0000E+00;ELEMENT2 1.0000E+00;ELEMENT3 1.0000E+00;:CONFIGURE: SCALING:SFACTOR:ELEMENT1 1.0000E+00;ELEMENT2 1.0000E+00;ELEMENT3 1.0000E+00;:CONFIGURE: AVERAGING:STATE 0;TYPE EXPONENT,8;:CONFIGURE:DEGREE 180

[CONFigure]:AVERaging?

Function Queries all the averaging function settings.

Syntax [CONFigure]:AVERaging?

Example CONFIGURE:AVERAGING? ∅:CONFIGURE:AVERAGING:STATE 0;TYPE EXPONENT,8

[CONFigure]:AVERaging[:STATe]

Function Turns the averaging function ON or OFF/queries the current setting.

Syntax [CONFigure]:AVERaging[:STATe] {<Boolean>}
[CONFigure]:AVERaging:STATe?

Example CONFIGURE:AVERAGING:STATE OFF
CONFIGURE:AVERAGING:STATE?∅:CONFIGURE:AVERAGING:STATE 0

[CONFigure]:AVERaging:TYPE

Function Sets the averaging type/queries the current setting.

Syntax [CONFigure]:AVERaging:TYPE {(LINear|EXPonent),<NRf>}
[CONFigure]:AVERaging:TYPE?
{<NRf>}=8,16,32,64,128,256(averaging factor)

Example CONFIGURE:AVERAGING:TYPE EXPONENT,8
CONFIGURE:AVERAGING:TYPE?∅:CONFIGURE:AVERAGING:TYPE EXPONENT,8

[CONFigure]:CURRent?

Function Queries all the current measurement settings.

Syntax [CONFigure]:CURRent?

Example CONFIGURE:CURRENT?∅:CONFIGURE:CURRENT:RANGE:ELEMENT1 20.0E+00;ELEMENT2 20.0E+00;ELEMENT3 20.0E+00;:CONFIGURE:CURRENT:AUTO:ELEMENT1 0;ELEMENT20;ELEMENT30;:CONFIGURE:CURRENT:MODE:ELEMENT1 RMS;ELEMENT2RMS;ELEMENT3 RMS;:CONFIGURE:CURRENT:ESCALING:ELEMENT1 10.000E+00;ELEMENT2 10.000E+00;ELEMENT3 10.000E+00

[CONFigure]:CURRent:AUTO?

Function Queries ON/OFF state of current auto range for each element.

Syntax [CONFigure]:CURRent:AUTO?

Example CONFIGURE:CURRENT:AUTO?∅:CONFIGURE:CURRENT:AUTO:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0

[CONFigure]:CURRent:AUTO[:ALL]

Function Sets current auto range ON or OFF for all the elements at once.

Syntax [CONFigure]:CURRent:AUTO[:ALL] {<Boolean>}

Example CONFIGURE:CURRENT:AUTO:ALL OFF

[CONFigure]:CURRent:AUTO:ELEMent<x>

Function Sets current auto range ON or OFF for the specified element/ queries the current setting.

Syntax `[CONFigure]:CURRent:AUTO:ELEMent<x> {<Boolean>}`
`[CONFigure]:CURRent:AUTO:ELEMent<x>?`
`<x>=1,3(3-phase 3-wire model)`
`1 to 3(3-phase 4-wire model)`

Example `CONFIGURE:CURRENT:AUTO:ELEMENT1 OFF`
`CONFIGURE:CURRENT:AUTO:ELEMENT1?`
`∅:CONFIGURE:CURRENT:AUTO:ELEMENT1 0`

[CONFigure]:CURRent:ESCaling?

Function Queries external sensor scaling constant for each element.

Syntax `[CONFigure]:CURRent:ESCaling?`

Example `CONFIGURE:CURRENT:ESCALING?`
`∅:CONFIGURE:CURRENT:ESCALING:ELEMENT1 10.000E+00;ELEMENT2 10.000E+00;ELEMENT3 10.000E+00`

[CONFigure]:CURRent:ESCaling[:ALL]

Function Sets external sensor scaling constant for all the elements at once.

Syntax `[CONFigure]:CURRent:ESCaling[:ALL] {<NRf>}`
`{<NRf>}=ROM version before 2.01 0.9000 to 10000.`
`ROM version 2.01 or later 0.1000 to 10000.`

Example `CONFIGURE:CURRENT:ESCALING:ALL 10.000`

Description Scaling constants are rounded as follows.
Below 1.0000 Rounded to four decimal places.
1.0000 to 10000 Rounded to five significant digits.

[CONFigure]:CURRent:ESCaling:ELEMent<x>

Function Sets external sensor scaling constant for the specified element/ queries the current setting.

Syntax `[CONFigure]:CURRent:ESCaling:ELEMent<x> {<NRf>}`
`[CONFigure]:CURRent:ESCaling:ELEMent<x>?`
`<x>= 1,3(3-phase 3-wire model)`
`1 to 3(3-phase 4-wire model)`
`{<NRf>}=ROM version before 2.01 0.9000 to 10000.`
`ROM version 2.01 or later 0.1000 to 10000.`

Example `CONFIGURE:CURRENT:ESCALING:ELEMENT1 10.000`
`CONFIGURE:CURRENT:ESCALING:ELEMENT1?`
`∅:CONFIGURE:CURRENT:ESCALING:ELEMENT1 10.000E+00`

Description Scaling constants are rounded in the same way as for `[CONFigure]:CURRent:ESCaling[:ALL]`.

[CONFigure]:CURRent:MODE?

Function Queries current measurement mode for each element.

Syntax `[CONFigure]:CURRent:MODE?`

Example `CONFIGURE:CURRENT:MODE?∅:CONFIGURE:CURRENT :MODE:ELEMENT1 RMS;ELEMENT2 RMS;ELEMENT3 RMS`

[CONFigure]:CURRent:MODE[:ALL]

Function Sets current measurement mode for all the elements at once.

Syntax `[CONFigure]:CURRent:MODE[:ALL] {RMS|MEAN|DC}`

Example `CONFIGURE:CURRENT:MODE:ALL RMS`

[CONFigure]:CURRent:MODE:ELEMent<x>

Function Sets current measurement mode for the specified element/ queries the current setting.

Syntax `[CONFigure]:CURRent:MODE:ELEMent<x> {RMS|MEAN|DC}`
`[CONFigure]:CURRent:MODE:ELEMent<x>?`
`<x>=1,3(3-phase 3-wire model)`
`1 to 3(3-phase 4-wire model)`

Example `CONFIGURE:CURRENT:MODE:ELEMENT1 RMS`
`CONFIGURE:CURRENT:MODE:ELEMENT1?`
`∅:CONFIGURE:CURRENT:MODE:ELEMENT1 RMS`

[CONFigure]:CURRent:RANGe?

Function Queries current range (external sensor input range) for each element.

Syntax `[CONFigure]:CURRent:RANGe?`

Example `CONFIGURE:CURRENT:RANGE?∅:CONFIGURE: CURRENT:RANGE:ELEMENT1 20.0E+00;ELEMENT2 20.0E+00;ELEMENT3 20.0E+00`

[CONFigure]:CURRent:RANGe[:ALL]

Function Sets current range (external sensor input range) for all the elements at once.

Syntax `[CONFigure]:CURRent:RANGe[:ALL] {<Current>|(EXTernal,<Voltage>)}`
`<Current>=500mA to 20A(0.5,1,2,5,10,20A)`
`<Voltage>=250mV to 10V(250,500mV,1,2.5,5,10V /for the EX2 model)`

Example Setting current range
`CONFIGURE:CURRENT:RANGE:ALL 20A`
Setting external sensor input range
`CONFIGURE:CURRENT:RANGE:ALL EXTERNAL,250MV`

[CONFigure]:CURRent:RANGe:ELEMent<x>

Function Sets current range (external sensor input range) for the specified element/queries the current setting.

Syntax `[CONFigure]:CURRent:RANGe:ELEMent<x> {<Current>|(EXTernal,<Voltage>)}`
`[CONFigure]:CURRent:RANGe:ELEMent<x>?`
`<x>=1,3<Voltage>`
`1 to 3(3-phase 4-wire model)`
`<Current>= 500mA to 20A (0.5,1,2,5,10,20A)`
`<Voltage>= 250mV to 10V(250,500mV,1,2.5,5,10V /for the EX2 model)`

Example Setting/inquiring about current range
`CONFIGURE:CURRENT:RANGE:ELEMENT1 20A`
`CONFIGURE:CURRENT:RANGE:ELEMENT1?`
`∅:CONFIGURE:CURRENT:RANGE:ELEMENT1 20.0E+00`
Setting/inquiring about external sensor input range
`CONFIGURE:CURRENT:RANGE:ELEMENT1 EXTERNAL,250MV`
`CONFIGURE:CURRENT:RANGE:ELEMENT1?`
`∅:CONFIGURE:CURRENT:RANGE:ELEMENT1 EXTERNAL,0.25E+00`

[CONFigure]:DEGRee

Function Sets phase angle display method/queries the current setting.

Syntax [CONFigure]:DEGRee {<NRf>}
[CONFigure]:DEGRee?
{<NRf>}=180,360

Example CONFIGURE:DEGREE 180
CONFIGURE:DEGREE?∅:CONFIGURE:DEGREE 180

[CONFigure]:FILTer?

Function Queries the current line filter setting.

Syntax [CONFigure]:FILTer?

Example CONFIGURE:FILTER?∅:CONFIGURE:FILTER:STATE 0;CUTOFF 0.500E+03

[CONFigure]:FILTer:CUToff

Function Sets line filter cut-off frequency/queries the current setting.

Syntax [CONFigure]:FILTer:CUToff {<Frequency>}
[CONFigure]:FILTer:CUToff?
<Frequency>= 500HZ to 6.5KHZ(0.5,1.0,2.0, 6.5kHz)

Example CONFIGURE:FILTER:CUTOFF 0.5KHZ
CONFIGURE:FILTER:CUTOFF?∅:CONFIGURE:FILTER: CUTOFF 0.500E+03

[CONFigure]:FILTer[:STATe]

Function Turns the line filter ON or OFF/queries the current setting.

Syntax [CONFigure]:FILTer[:STATe] {<Boolean>}
[CONFigure]:FILTer:STATe?

Example CONFIGURE:FILTER:STATE OFF
CONFIGURE:FILTER:STATE?∅:CONFIGURE:FILTER: STATE 0

[CONFigure]:FREQuency?

Function Queries the current frequency setting.

Syntax [CONFigure]:FREQuency?

Example CONFIGURE:FREQUENCY?∅:CONFIGURE:FREQUENCY :SOURCE V,1;FILTER 0

[CONFigure]:FREQuency:FILTer

Function Turns the frequency filter ON or OFF/queries the current setting.

Syntax [CONFigure]:FREQuency:FILTer {<Boolean>}
[CONFigure]:FREQuency:FILTer?

Example CONFIGURE:FREQUENCY:FILTER OFF
CONFIGURE:FREQUENCY:FILTER?∅:CONFIGURE: FREQUENCY:FILTER 0

[CONFigure]:FREQuency:SOURce

Function Sets the input to be used for frequency measurement /queries the current setting.

Syntax [CONFigure]:FREQuency:SOURce {(A|V),(<NRf>|ELEMent<1-3>)}
[CONFigure]:FREQuency:SOURce?

Example CONFIGURE:FREQUENCY:SOURCE V,1
CONFIGURE:FREQUENCY:SOURCE?∅:CONFIGURE: FREQUENCY:SOURCE V,1

[CONFigure]:PHOLd

Function Turns the peak hold function ON or OFF/queries the current setting.

Syntax [CONFigure]:PHOLd {<Boolean>}
[CONFigure]:PHOLd?

Example CONFIGURE:PHOLD OFF
CONFIGURE:PHOLD?∅:CONFIGURE:PHOLD 0

[CONFigure]:SCALing?

Function Queries all the current scaling function settings.

Syntax [CONFigure]:SCALing?

Example CONFIGURE:SCALING?∅:CONFIGURE:SCALING:STATE 0;PT:ELEMENT1 1.0000E+00;ELEMENT2 1.0000E+00;ELEMENT31.0000E+00;:CONFIGURE:SCALING:CT: ELEMENT1 1.0000E+00;ELEMENT2 1.0000E +00;ELEMENT31.0000E+00;:CONFIGURE:SCALING: SFACTOR:ELEMENT1 1.0000E+00;ELEMENT2 1.0000E+00;ELEMENT3 1.0000E+00

[CONFigure]:SCALing:{PT|CT|SFACtor}?

Function Queries the current scaling constant (voltage, current, power) for each element.

Syntax [CONFigure]:SCALing:{PT|CT|SFACtor}?

Example CONFIGURE:SCALING:PT?∅:CONFIGURE:SCALING: PT:ELEMENT1 1.0000E+00;ELEMENT2 1.0000E+00;ELEMENT3 1.0000E+00

[CONFigure]:SCALing:{PT|CT|SFACtor}[:ALL]

Function Sets scaling constant (voltage, current, power) for all the elements at once.

Syntax [CONFigure]:SCALing:{PT|CT|SFACtor}[:ALL] {<NRf>}
{<NRf>}=0.0001 to 10000

Example CONFIGURE:SCALING:PT:ALL 1.0000

Description Scaling constants are rounded as follows.
Below 1.0000 Rounded to four decimal places.
1.0000 to 10000 Rounded to five significant digits.

[CONFigure]:SCALing:{PT|CT|SFACtor}:ELEMent<x>

Function Sets scaling constant (voltage, current, power) for the specified element.

Syntax [CONFigure]:SCALing:{PT|CT|SFACtor}: ELEMent<x> {<NRf>}
[CONFigure]:SCALing:{PT|CT|SFACtor}:ELEMent<x>?
<x>=1,3(3-phase 3-wire model)
1 to 3(3-phase 4-wire model)
{<NRf>}=0.0001 to 10000

Example CONFIGURE:SCALING:PT:ELEMENT1 1.0000
CONFIGURE:SCALING:PT:ELEMENT1?∅:CONFIGURE :SCALING:PT:ELEMENT1 1.0000E+00

Description Scaling constants are rounded in the same way as for [CONFigure]:SCALing:{PT|CT|SFACtor}[:ALL].

[CONFigure]:SCALing[:STATe]

Function Turns the scaling function ON or OFF/queries the current setting.

Syntax `[CONFigure]:SCALing[:STATe] {<Boolean>}`
`[CONFigure]:SCALing:STATe?`

Example `CONFIGURE:SCALING:STATE OFF`
`CONFIGURE:SCALING:STATE?∅:CONFIGURE:SCALING:STATE 0`

[CONFigure]:VOLTage?

Function Queries all the voltage measurement settings.

Syntax `[CONFigure]:VOLTage?`

Example `CONFIGURE:VOLTAGE?∅:CONFIGURE:VOLTAGE:RANGE:ELEMENT1 1.0000E+03;ELEMENT2 1.0000E+03;ELEMENT31.0000E+03;:CONFIGURE:VOLTAGE:AUTO:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:CONFIGURE:VOLTAGE:MODE:ELEMENT1 RMS;ELEMENT2 RMS;ELEMENT3 RMS`

[CONFigure]:VOLTage:AUTO?

Function Queries ON/OFF state of voltage auto range for each element.

Syntax `[CONFigure]:VOLTage:AUTO?`

Example `CONFIGURE:VOLTAGE:AUTO?∅:CONFIGURE:VOLTAGE:AUTO:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0`

[CONFigure]:VOLTage:AUTO[:ALL]

Function Sets voltage auto range ON or OFF for all the elements at once.

Syntax `[CONFigure]:VOLTage:AUTO[:ALL] {<Boolean>}`

Example `CONFIGURE:VOLTAGE:AUTO:ALL OFF`

[CONFigure]:VOLTage:AUTO:ELEMent<x>

Function Sets voltage auto range ON or OFF for the specified element/queries the current setting.

Syntax `[CONFigure]:VOLTage:AUTO:ELEMent<x> {<Boolean>}`
`[CONFigure]:VOLTage:AUTO:ELEMent<x>?`
`<x>=1,3(3-phase 3-wire model)`
`1 to 3(3-phase 4-wire model)`

Example `CONFIGURE:VOLTAGE:AUTO:ELEMENT1 OFF`
`CONFIGURE:VOLTAGE:AUTO:ELEMENT1?∅:CONFIGURE:VOLTAGE:AUTO:ELEMENT1 0`

[CONFigure]:VOLTage:MODE?

Function Queries voltage measurement mode for each element.

Syntax `[CONFigure]:VOLTage:MODE?`

Example `CONFIGURE:VOLTAGE:MODE?∅:CONFIGURE:VOLTAGE:MODE:ELEMENT1 RMS;ELEMENT2 RMS;ELEMENT3 RMS`

[CONFigure]:VOLTage:MODE[:ALL]

Function Sets voltage measurement mode for all the elements at once.

Syntax `[CONFigure]:VOLTage:MODE[:ALL] {RMS|MEAN|DC}`

Example `CONFIGURE:VOLTAGE:MODE:ALL RMS`

[CONFigure]:VOLTage:MODE:ELEMent<x>

Function Sets voltage measurement mode for the specified element/queries the current setting.

Syntax `[CONFigure]:VOLTage:MODE:ELEMent<x> {RMS|MEAN|DC}`
`[CONFigure]:VOLTage:MODE:ELEMent<x>?`
`<x>=1,3(3-phase 3-wire model)`
`1 to 3(3-phase 4-wire model)`

Example `CONFIGURE:VOLTAGE:MODE:ELEMENT1 RMS`
`CONFIGURE:VOLTAGE:MODE:ELEMENT1?∅:CONFIGURE`
`CONFIGURE:VOLTAGE:MODE:ELEMENT1 RMS`

[CONFigure]:VOLTage:RANGe?

Function Queries voltage range for each element.

Syntax `[CONFigure]:VOLTage:RANGe?`

Example `CONFIGURE:VOLTAGE:RANGE?∅:CONFIGURE:VOLTAGE:RANGE:ELEMENT1 1.0000E+03;ELEMENT2 1.0000E+03;ELEMENT3 1.0000E+03`

[CONFigure]:VOLTage:RANGe[:ALL]

Function Sets voltage range for all the elements at once.

Syntax `[CONFigure]:VOLTage:RANGe[:ALL] {<Voltage>}`
`<Voltage>=15V to 1000V(15,30,60,100,150,300,600,1000V)`

Example `CONFIGURE:VOLTAGE:RANGE:ALL 1000V`

[CONFigure]:VOLTage:RANGe:ELEMent<x>

Function Sets voltage range for the specified element/queries the current setting.

Syntax `[CONFigure]:VOLTage:RANGe:ELEMent<x> {<Voltage>}`
`[CONFigure]:VOLTage:RANGe:ELEMent<x>?`
`<x>=1,3(3-phase 3-wire model)`
`1 to 3(3-phase 4-wire model)`
`<Voltage>=15V to 1000V(15,30,60,100,150,300,600,1000V)`

Example `CONFIGURE:VOLTAGE:RANGE:ELEMENT1 1000V`
`CONFIGURE:VOLTAGE:RANGE:ELEMENT1?∅:CONFIGURE:VOLTAGE:RANGE:ELEMENT1 1.0000E+03`

[CONFigure]:WIRing

Function Sets wiring system/queries the current setting.

Syntax `[CONFigure]:WIRing {P1W2|P1W3|P3W3|P3W4|V3A3}`
`[CONFigure]:WIRing?`

Example `CONFIGURE:WIRING P1W2`
`CONFIGURE:WIRING?∅:CONFIGURE:WIRING P1W2`

Description

P1W2 : 1-phase 2-wire system
P1W3 : 1-phase 3-wire system
P3W3 : 3-phase 3-wire system
P3W4 : 3-phase 4-wire system (possible only for the 3-phase 4-wire model)
V3A3 3-voltage 3-ampere system (possible only for the 3-phase 4-wire model)

[CONFigure]:ZCALibrate

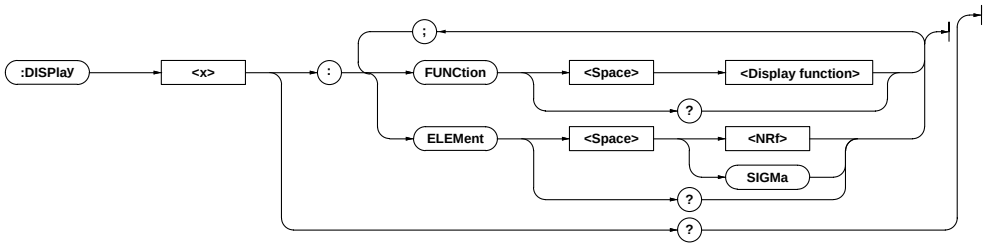
Function Carries out zero-level calibration.

Syntax `[CONFigure]:ZCALibrate`

Example `CONFIGURE:ZCALIBRATE`

2.3.5 DISPlay Group

The commands in the DISPlay group are used to make settings relating to and inquirie about display. This allows you to make the same settings and inquiries which you can make using the FUNCTION and ELEMENT keys.



DISPlay<x>?

Function Queries all the current display settings for the specified display.

Syntax DISPlay<x>?
<x>=1 to 4
1:Display A
2:Display B
3:Display C
4:Display D

Example DISPLAY1?∅:DISPLAY1:FUNCTION V;ELEMENT 1

DISPlay<x>:ELEMent

Function Sets the element to be displayed/queries the current setting.

Syntax DISPlay<x>:ELEMent {<NRf>|SIGMa}
DISPlay<x>:ELEMent?
{<NRf>}=1,3 (3-phase 3-wire model)
1 to 3 (3-phase 4-wire model)

Example DISPLAY1:ELEMENT 1
DISPLAY1:ELEMENT?∅:DISPLAY1:ELEMENT 1

DISPlay<x>:FUNCtion

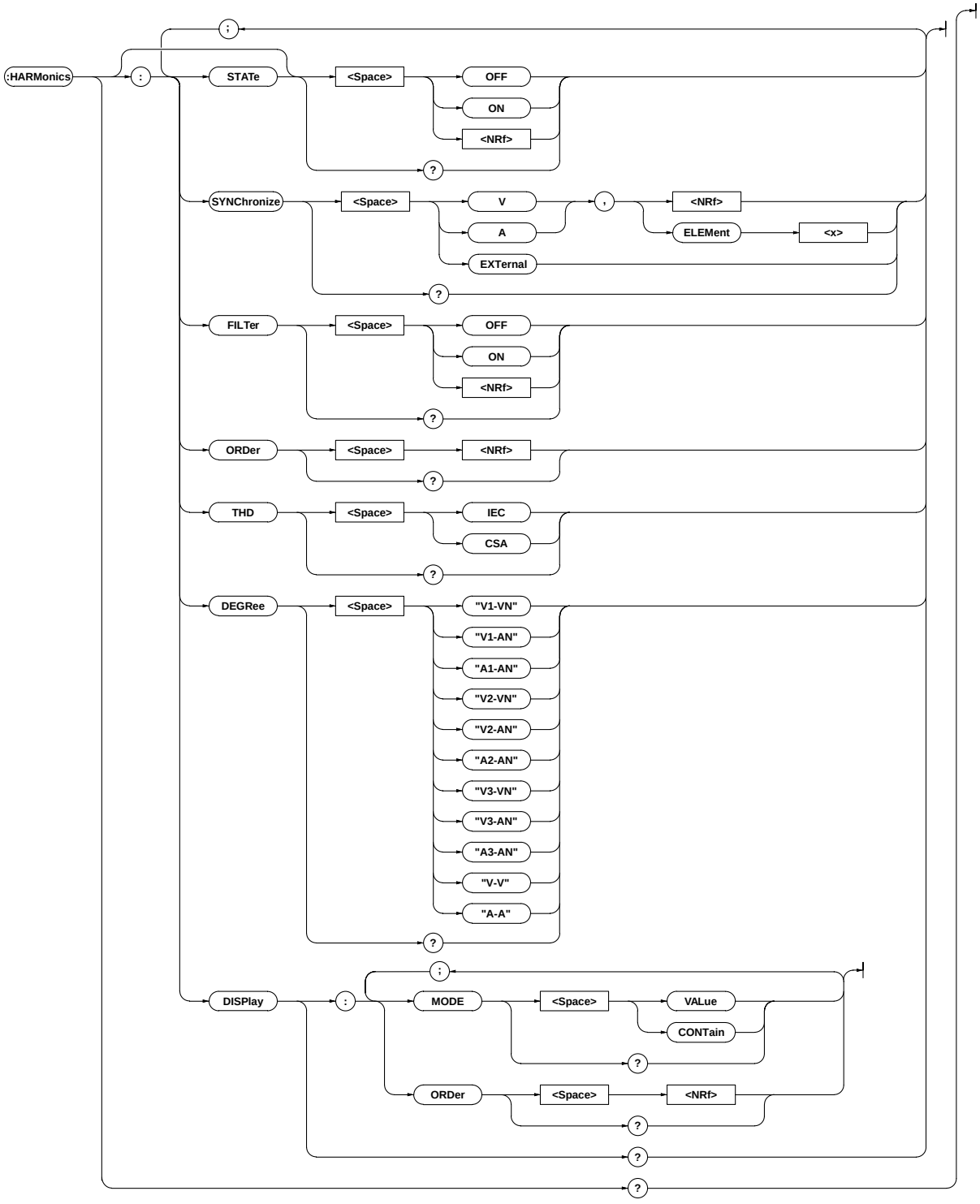
Function Sets the function to be displayed/queries the current setting.

Syntax DISPlay<x>:FUNCtion {<Display function>|
DISPlay<x>:FUNCtion?
·During normal measurement
<Display function>={V|A|W|VA|VAR|PF|DEG|VPK|AP
K|VHZ|AHZ|WH|WHP|WHM|AH|AHP
|AHM|MATH|TIME|TORQue|RPM|S
RPM|SLIP|MPOWer|MEFFiciency
|TEFFiciency}
·During harmonic analsysis
<Display function>= {V|A|W|VA|VAR|PF|DEG|VHZ|AH
Z|VTHD|ATHD|VDEG|ADEG|TORQu
e|RPM|SRPM|SLIP|MPOWer|MEFF
iciency|TEFFiciency}

Example DISPLAY1:FUNCTION V
DISPLAY1:FUNCTION?∅:DISPLAY1:FUNCTION V

2.3.6 HARMonics Group

The commands in the HARMonics group are used to make settings relating to and to inquire about harmonic analysis. This allows you to make the same settings and inquiries which can be made using the ANALYZE (HARMONICS) and SET UP keys on the front panel. These commands are available if the instrument is equipped with the harmonic analysis function (/HRM model).



HARMonics?

Function Queries all the harmonic analysis settings.

Syntax HARMonics?

Example HARMONICS?∅:HARMONICS:STATE 0;SYNCHRONIZE V,1;FILTER 0;ORDER 50;THD IEC;DEGREE "V1-VN";DISPLAY:MODE VALUE;ORDER 1

HARMonics:DEGRee

Function Sets the object for computation of phase angle (deg) for harmonic analysis/queries the current setting.

Syntax HARMonics:DEGRee {"V1-VN"|"V1-AN"|"A1-AN"|"V2-VN"|"V2-AN"|"A2-AN"|"V3-VN"|"V3-AN"|"A3-AN"|"V-V"|"A-A"}
HARMonics:DEGRee?

Example HARMONICS:DEGREE "V1-VN"
HARMONICS:DEGREE? ∅:HARMONICS:DEGREE "V1-VN"

Description For the meaning of the choices of the object being computed for the phase angle, refer to page 9-12.

HARMonics:DISPlay?

Function Queries all the display settings for harmonic analysis.

Syntax HARMonics:DISPlay?

Example HARMONICS:DISPLAY?∅:HARMONICS:DISPLAY:MODE MODE VALUE;ORDER 1

HARMonics:DISPlay:MODE

Function Sets display mode for harmonic analysis items (V, A, W) to be displayed on display B/queries the current setting.

Syntax HARMonics:DISPlay:MODE {VALue|CONTain}
HARMonics:DISPlay:MODE?
{VALue|CONTain}={Analysis value (measured value) display | Content display}

Example HARMONICS:DISPLAY:MODE VALUE
HARMONICS:DISPLAY:MODE?∅:HARMONICS:DISPLAY:MODE VALUE

HARMonics:DISPlay:ORDer

Function Sets harmonic order to be displayed on display A/queries the current setting.

Syntax HARMonics:DISPlay:ORDer {<NRf>}
HARMonics:DISPlay:ORDer?
{<NRf>}=1 to 50

Example HARMONICS:DISPLAY:ORDER 1
HARMONICS:DISPLAY:ORDER?∅:HARMONICS:DISPLAY:ORDER 1

HARMonics:FILTer

Function Turns anti-aliasing filter for harmonic analysis ON or OFF/queries the current setting.

Syntax HARMonics:FILTer {<Boolean>}
HARMonics:FILTer?

Example HARMONICS:FILTER OFF
HARMONICS:FILTER?∅:HARMONICS:FILTER 0

HARMonics:ORDer

Function Sets the maximum harmonic order for harmonic analysis / queries the current setting.

Syntax HARMonics:ORDer {<NRf>}
HARMonics:ORDer?
{<NRf>}=1 to 50

Example HARMONICS:ORDER 50
HARMONICS:ORDER?∅:HARMONICS:ORDER 50

HARMonics[:STATe]

Function Turns harmonic analysis mode ON or OFF/queries the current setting.

Syntax HARMonics[:STATe] {<Boolean>}
HARMonics:STATe?

Example HARMONICS:STATE OFF
HARMONICS:STATE?∅:HARMONICS:STATE 0

HARMonics:SYNChronize

Function Sets the input (PLL source) to be used as the fundamental frequency for PLL synchronization/queries the current setting.

Syntax HARMonics:SYNChronize{(V|A),(<NRf>|ELEMent<1-3>)|EXTernal}
HARMonics:SYNChronize?

Example HARMONICS:SYNCHRONIZE V,1
HARMONICS:SYNCHRONIZE?∅:HARMONICS:SYNCHRONIZE V,1

HARMonics:THD

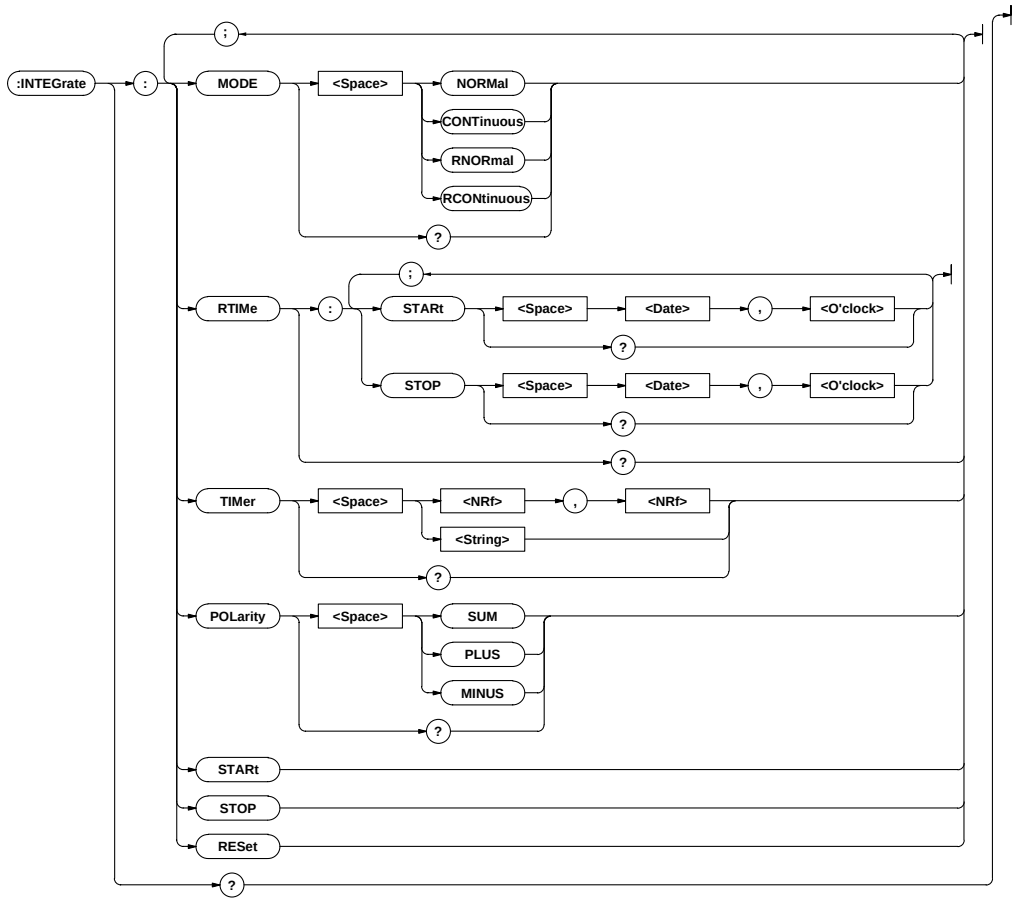
Function Sets the equation to be used for harmonic distortion (VTHD, ATHD)/queries the current setting.

Syntax HARMonics:THD {IEC|CSA}
HARMonics:THD?

Example HARMONICS:THD IEC
HARMONICS:THD?∅:HARMONICS:THD IEC

2.3.7 INTEGrate Group

IThe commands in the INTEGrate group are used to make settings relating to and to inquire about integration function. This allows you to make the same settings and inquiries which can be made using the INTEGRATOR keys (START, STOP, RESET and MODE keys) on the front panel. These commands are available if the instrument is equipped with the integration function (/INTG model).



INTEGrate?

Function Queries all the integration settings.

Syntax `INTEGrate?`

Example `INTEGRATE?∅:INTEGRATE:MODE NORMAL;RTIME:START 96,4,1,17,35,0;STOP96,4,3,19,35,0;:INTEGRATE:TIMER 10,0;POLARITY SUM`

INTEGrate:MODE

Function Sets integration mode/queries the current setting.

Syntax `INTEGrate:MODE{NORMal|CONTinuous|RNORmal|RCONtinuous}`
`INTEGrate:MODE?`

Example `INTEGRATE:MODE NORMAL`
`INTEGRATE:MODE?∅:INTEGRATE:MODE NORMAL`

Description Selectable modes are given below.

NORMal	:	Standard integration mode
CONTinuous	:	Continuous integration mode
RNORmal	:	Real time counting standard integration mode RCONtinuous
RCONtinuous	:	Real time counting continuous integration mode

INTEGrate:POLarity

Function Sets polarity of integrated values to be displayed on display D/ queries the current setting.

Syntax `INTEGrate:POLarity {SUM|PLUS|MINUS}`
`INTEGrate:POLarity?`

Example `INTEGRATE:POLARITY SUM`
`INTEGRATE:POLARITY?∅:INTEGRATE:POLARITY SUM`

INTEGrate:RESet

Function Resets integrated values.

Syntax `INTEGrate:RESet`

Example `INTEGRATE:RESET`

INTEGrate:RTIMe?

Function Queries the integration start and stop time for real time counting integration mode.

Syntax `INTEGrate:RTIMe?`

Example `INTEGRATE:RTIME?∅:INTEGRATE:RTIME:START 96,4,1,17,35,0;STOP 96,4,3,19,35,0`

INTEGrate:RTIMe:STARt

Function Sets the integration start time for real time counting integration mode/queries the current setting.

Syntax `INTEGrate:RTIMe:STARt {<Date>,<O'clock>}`
`INTEGrate:RTIMe:STARt?`
`<Date>={<NRf>,<NRf>,<NRf>|<Character string>}`
`<O'clock>={<NRf>,<NRf>[,<NRf>]|<Character string>}`

Example
```
INTEGRATE:RTIME:START 96,4,1,17,35,0
INTEGRATE:RTIME:START "1996/04/01","17:35:00"
INTEGRATE:RTIME:START?∅:INTEGRATE:RTIME:START 96,4,1,17,35,0
```

Description For `<Date>` and `<O'clock>` data, refer to Section 2.3.16, "SYSTem Group".

INTEGrate:RTIMe:STOP

Function Sets the integration stop time for real time counting integration mode/queries the current setting.

Syntax `INTEGrate:RTIMe:STOP{<Date>,<O'clock>}`
`INTEGrate:RTIMe:STOP?`
`<Date>={<NRf>,<NRf>,<NRf>|<Character string>}`
`<O'clock>={<NRf>,<NRf>[,<NRf>]|<Character string>}`

Example
```
INTEGRATE:RTIME:STOP 1996,04,03,19,35,0
INTEGRATE:RTIME:STOP "96/4/3","19:35:0"
INTEGRATE:RTIME:STOP?∅:INTEGRATE:RTIME:STOP 96,4,3,19,35,0
```

Description For `<Date>` and `<O'clock>` data, refer to Section 2.3.16, "SYSTem Group".

INTEGrate:STARt

Function Starts integration.

Syntax `INTEGrate:STARt`

Example
```
INTEGRATE:START
```

INTEGrate:STOP

Function Stops integration.

Syntax `INTEGrate:STOP`

Example
```
INTEGRATE:STOP
```

INTEGrate:TIMer

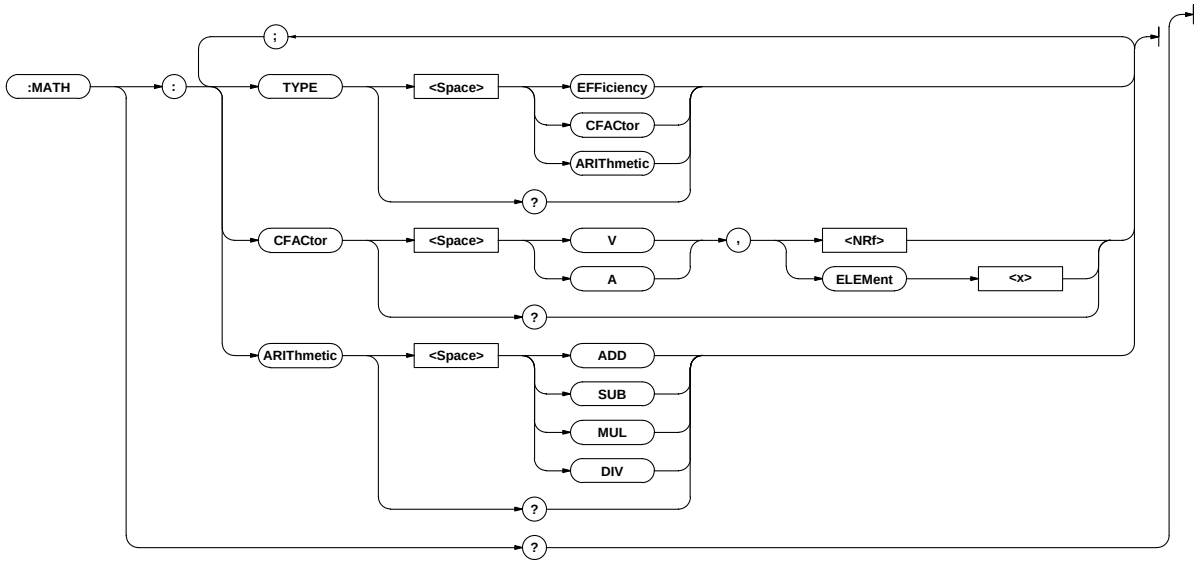
Function Sets integration timer preset time/queries the current setting.

Syntax `INTEGrate:TIMer {<NRf>,<NRf>|<Character string>}`
`INTEGrate:TIMer?`
`{<NRf>,<NRf>}=0,0 to 999,59`
`{<Character string>}="HHH:MM" HHH:Hour MM:Hour`

Example
```
INTEGRATE:TIMER 10,0
INTEGRATE:TIMER "10:00"
INTEGRATE:TIMER?∅:INTEGRATE:TIMER 10,0
```

2.3.8 MATH Group

The commands in the MATH group are used to make settings relating to and to inquire about computation. This allows you to make the same settings and inquiries which can be made using the MATH (SHIFT + >) key on the front panel.



MATH?

Function Queries all the computation settings.

Syntax `MATH?`

Example `MATH?∅:MATH:TYPE EFFICIENCY`

MATH:ARIThmetic

Function Sets equation for four arithmetical operations/queries the current setting.

Syntax `MATH:ARIThmetic {ADD|SUB|MUL|DIV}`
`MATH:ARIThmetic?`

Example `MATH:ARITHMETIC ADD`
`MATH:ARITHMETIC?∅:MATH:ARITHMETIC ADD`

Description "MATH:TYPE ARIThmetic" must be selected, otherwise this command is meaningless.

MATH:CFACtor

Function Sets equation for crest factor/queries the current setting.Sets equation for crest factor/queries the current setting.

Syntax `MATH:CFACtor {(V|A),(<NRf>|ELEMent<1-3>)}`
`MATH:CFACtor?`

Example `MATH:CFACTOR V,1`
`MATH:CFACTOR?∅:MATH:CFACTOR V,1`

Description "MATH:TYPE CFACtor" must be selected, otherwise this command is meaningless.

MATH:TYPE

Function Sets computation type/queries the current setting.

Syntax `MATH:TYPE {EFFiciency|CFACtor|ARIThmetic}`
`MATH:TYPE?`

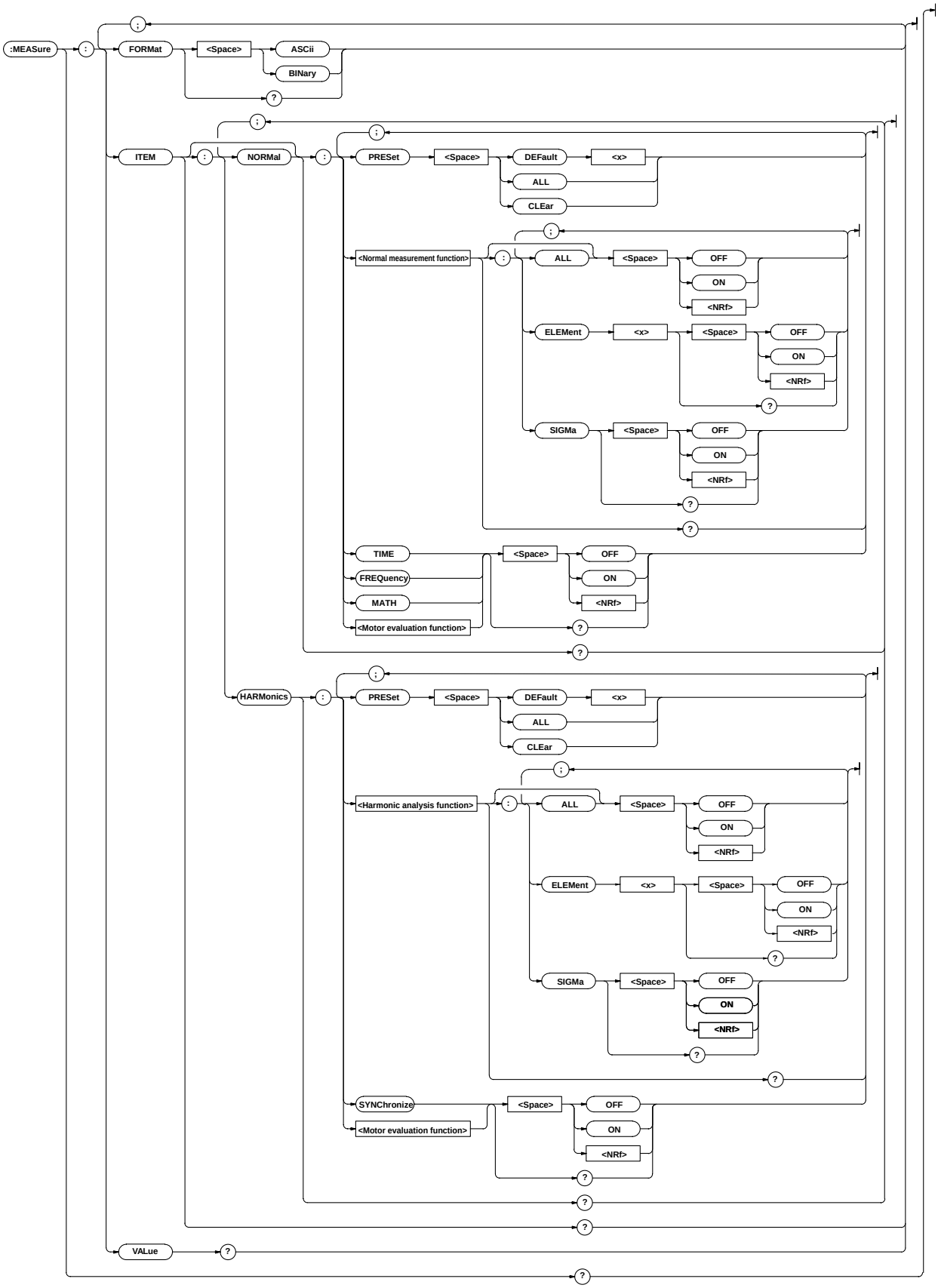
Example `MATH:TYPE EFFICIENCY`
`MATH:TYPE?∅:MATH:TYPE EFFICIENCY`

Description Selectable computation types are given below.

EFFiciency : Efficiency
CFACtor : Crest factor
ARIThmetic : Four arithmetical operations

2.3.9 MEASure Group

The commands in the MEASure group are used to make settings relating to and to inquire about measured/computed data to be output via communication. This allows you to make the same settings and inquiries which can be made using the MISC ("co-out" menu) on the front panel.



MEASure?

Function Queries all the communication output settings for measured/computed data.

Syntax MEASure?

Example MEASURE? ∅:MEASURE:FORMAT ASCII;(":MEASURE:" part is excluded from the response made to the MEASure:ITEM? query command)

MEASure:FORMat

Function Sets communication output format for measured/computed data/queries the current setting.

Syntax MEASure:FORMat {ASCii|BINary}
MEASure:FORMat?

Example MEASURE:FORMAT ASCII
MEASURE:FORMAT?∅:MEASURE:FORMAT ASCII

MEASure:ITEM?

Function Queries all the communication output items settings for measured/computed data.

Syntax MEASure:ITEM?

Example MEASURE:ITEM?∅(Response to MEASure:ITEM:NORMal?);(Response to MEASure:ITEM:HARMonics?)

MEASure:ITEM:HARMonics?

Function Queries all the communication output items for harmonic analysis mode.

Syntax MEASure:ITEM:HARMonics?

Example MEASURE:ITEM:HARMONICS? ∅:MEASURE:ITEM:HARMONICS:V:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 0;:MEASURE:ITEM:HARMONICS:A:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 0;:MEASURE:ITEM:HARMONICS:W:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 0;:MEASURE:ITEM:HARMONICS:VA:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:HARMONICS:VAR:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:HARMONICS:PF:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:HARMONICS:DEG:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:MEASURE:ITEM:HARMONICS:VTHD:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;:MEASURE:ITEM:HARMONICS:ATHD:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;:MEASURE:ITEM:HARMONICS:VCON:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;:MEASURE:ITEM:HARMONICS:ACON:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;:MEASURE:ITEM:HARMONICS:WCON:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;:MEASURE:ITEM:HARMONICS:VDEG:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:MEASURE:ITEM:HARMONICS:ADEG:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:MEASURE:ITEM:HARMONICS:SYNCHRONIZE 1;TORQUE 0;RPM 0;SRPM 0;SLIP 0;MPOWER 0;MEFFICIENCY 0;TEFFICIENCY 0

MEASure:ITEM:HARMonics:<Harmonic analysis function>?

Function Queries all the communication output settings for the specified harmonic analysis function.

Syntax MEASure:ITEM:HARMonics:<Harmonic analysis function>?

Example MEASURE:ITEM:HARMONICS:V?∅:MEASURE:ITEM:HARMONICS:V:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 0

MEASure:ITEM:HARMonics:{<Harmonic analysis function>}[:ALL]

Function Turns communication output for the specified harmonic analysis function ON or OFF for all the effective elements at once.

Syntax MEASure:ITEM:HARMonics:<Harmonic analysis function>[:ALL] {<Boolean>}

Example MEASURE:ITEM:HARMONICS:V:ALL ON

MEASure:ITEM:HARMonics:<Harmonic analysis function>:ELEMent<x>

Function Turns communication output for the specified harmonic analysis function ON or OFF for the specified element/queries the current setting.

Syntax MEASure:ITEM:HARMonics:<Harmonic analysis function>:ELEMent<x> {<Boolean>}
MEASure:ITEM:HARMonics:<Harmonic analysis function>:ELEMent<x>?
<x>=1,3(3-phase 3-wire model)
=1 to 3(3-phase 4-wire model)

Example MEASURE:ITEM:HARMONICS:V:ELEMENT1 ON
MEASURE:ITEM:HARMONICS:V:ELEMENT1?∅:MEASURE:ITEM:HARMONICS: V:ELEMENT1 1

MEASure:ITEM:HARMonics:<Harmonic analysis function>:SIGMa

Function Turns communication output of Σ data ON or OFF for the specified harmonic analysis function/queries the current setting.

Syntax MEASure:ITEM:HARMonics:<Harmonic analysis function>SIGMa {<Boolean>}

Example MEASURE:ITEM:HARMONICS:V:SIGMA OFF
MEASURE:ITEM:HARMONICS:V:SIGMA?∅:MEASURE:ITEM:HARMONICS:V:SIGMA 0

Description • The following harmonic analysis functions can be set with this command. <Harmonic analysis function> =|V|A|W|VA|VAR|PF }

MEASure:ITEM:HARMonics:{SYNChoronize|<Motor evaluation function>}

Function Turns communication output ON or OFF for the PLL source or motor evaluation function/queries the current setting.

Syntax MEASure:ITEM:HARMonics:{SYNChronize|<Motor evaluation function> {<Boolean>}
MEASure:ITEM:HARMonics:{SYNChronize|<Motor evaluation function>?

Example MEASURE:ITEM:HARMONICS:SYNCHRONIZE ON
MEASURE:ITEM:HARMONICS:SYNCHRONIZE?∅
MEASURE:ITEM: HARMONICS:SYNCHRONIZE 1

MEASure:ITEM:HARMonics:PRESet

Function Sets communication output items for harmonic analysis mode to the preset settings at once.

Syntax MEASure:ITEM:HARMonics:PRESet {DEFault<1-2>|ALL|CLEar}

Example MEASURE:ITEM:HARMONICS:PRESET DEFAULT1

Description For a description of global setting, refer to Section 15.1, "Selecting the Output Items".

MEASure:ITEM:NORMal?

Function Queries all the communication output items for normal measurement mode.

Syntax MEASure:ITEM:NORMal?

Example MEASURE:ITEM:NORMAL?∅:MEASURE:ITEM:NORMAL:V:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 1;:MEASURE:ITEM:NORMAL:A:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 1;:MEASURE:ITEM:NORMAL:W:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 1;:MEASURE:ITEM:NORMAL:VA:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:VAR:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:PF:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:DEG:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:VPK:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:APK:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:WH:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:WHP:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:WHM:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:AH:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:AHP:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:AHM:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:MEASURE:ITEM:NORMAL:TIME 0;FREQUENCY 1;MATH 0;TORQUE 0;RPM 0;SRPM 0;SLIP 0;MPOWER 0;MEFFICIENCY 0;TEFFICIENCY 0;

MEASure:ITEM[:NORMal]:<Normal measurement function>?

Function Queries all the communication output settings for the specified normal measurement function.

Syntax MEASure:ITEM[:NORMal]:<Normal measurement function>?

Example MEASURE:ITEM:NORMAL:V?∅:MEASURE:ITEM:NORMAL:V:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 1

MEASure:ITEM[:NORMal]:<Normal measurement function >[:ALL]

Function Turns communication output for the specified normal measurement function ON or OFF for all the effective elements and Σ at once.

Syntax MEASure:ITEM[:NORMal]:<Normal measurement function>[:ALL] {<Boolean>}

Example MEASURE:ITEM:NORMAL:V:ALL ON

MEASure:ITEM[:NORMal]:<Normal measurement function>:ELEMent<x>

Function Turns communication output for the specified normal measurement function ON or OFF for the specified element/queries the current setting.

Syntax MEASure:ITEM[:NORMal]:<Normal measurement function>:ELEMent<x> {<Boolean>}
MEASure:ITEM[:NORMal]:<Normal measurement function>:ELEMent<x>?
<x>=1,3(3-phase 3-wire model)
=1 to 3(3-phase 4-wire model)

Example MEASURE:ITEM:NORMAL:V:ELEMENT1 ON
MEASURE:ITEM:NORMAL:V:ELEMENT1?∅:MEASURE:ITEM:NORMAL:V:ELEMENT1 1

MEASure:ITEM[:NORMal]:<Normal measurement function>:SIGMa

Function Turns communication output of Σ data ON or OFF for the specified harmonic analysis function/queries the current setting.

Syntax MEASure:ITEM[:NORMal]:<Normal measurement function>:SIGMa {<Boolean>}
MEASure:ITEM[:NORMal]:<Normal measurement function>:SIGMa?

Example MEASURE:ITEM:NORMAL:V:SIGMA ON
MEASURE:ITEM:NORMAL:V:SIGMA?∅:MEASURE:ITEM:NORMAL:V:SIGMA 1

MEASure:ITEM[:NORMal]:{TIME|FREQuency|MATH|<Motor evaluation function>}

Function Turns communication output ON or OFF for the motor evaluation function(elapsed time of integration, frequency, computation)/queries the current setting.

Syntax MEASure:ITEM[:NORMal]:{TIME|FREQuency|MATH|<Motor evaluation function>} {<Boolean>}
MEASure:ITEM[:NORMal]:{TIME|FREQuency|MATH|<Motor evaluation function>}?

Example MEASURE:ITEM:NORMAL:FREQUENCY ON
MEASURE:ITEM:NORMAL:FREQUENCY?∅:MEASURE:ITEM:NORMAL:FREQUENCY 1

MEASure:ITEM[:NORMal]:PRESet

Function Sets communication output items for normal measurement mode to the preset settings at once.

Syntax MEASure:ITEM[:NORMal]:PRESet {DEFault<1-2>|ALL|CLE ar}

Example MEASURE:ITEM:NORMAL:PRESET DEFAULT1

Description For a description of global setting, refer to Section 15.1, "Selecting the Output Items".

MEASure:VALue?

Function Queries all the measured/computed data for the items which are set to ON using "MEASure:ITEM" commands ("MEASure :ITEM:HARMonics" through "MEASure:ITEM[:NORMal]:PRESet").

Syntax MEASure:VALue?

Example MEASURE:VALUE?∅7.006E+00,6.386E+00,-36.68E+00,...

Description Measured/computed data output by this query command is updated at the rise of bit 0 (UPD) of the condition register (refer to page App 2-51). For details, refer to Section 2.2.6, "Synchronization with the Controller".

Output/Data Format for Normal Measurement and Harmonic Analysis Mode

The output and data formats for data obtained during normal measurement and harmonic analysis modes which is output by "MEASure:VALue?" are described below.

Data format for normal measurement data

- Data for <normal measurement function> is always output in <NR3> format.
  (Exampl) 99.99E+00
  WH,WHP,WHM,AH,AHP,AHM ∅Mantissa: floating-point number of the maximum 6 digits + Exponent: 2 digits
  Except for WH, WHP, WHM, AH, AHP, AHM ∅Mantissa: floating-point number of the maximum 5 digits + Exponent: 2 digits
- The sign for the mantissa is provided only when the value is negative. However, phase lag and phase lead for phase angle (DEG) are expressed as follows.
  (LEAD) ∅ +180.0E+00
  (LAG) ∅ —180.0E+00
  Not detectable ∅ 0.0E+00 (preceded by a space)
- "9.9E+37" (+×) is output in case of overrange or computation overflow. (-oL-, -oF-, PFErr, dEGEr, ErrLo or ErrHi is displayed.)
- "9.91E+37" (NAN) is output in case of no data ("------" is displayed).
- For elapsed time of integration (TIME), 3 data (hour, minute and second) is output in <NR1> format. Example 999,59,59

Output format for normal measurement data

Output format for normal measurement data for all the items which are set to ON as described in Section 15.1, "Selecting the Output Items" or using "MEASure: ITEM[:NORMal] commands is output in one line at once. The order in which each data is output is given below. (Numbers indicate element numbers.)

V1∅A1∅W1∅VA1∅VAR1∅PF1∅DEG1∅VPK1∅APK1∅
TIME∅WH1∅WHP1∅WHM1∅AH1∅AHP1∅AHM1∅
V2∅A2∅W2∅VA2∅VAR2∅PF2∅DEG2∅VPK2∅APK2∅
TIME∅WH2∅WHP2∅WHM2∅AH2∅AHP2∅AHM2∅
V3∅A3∅W3∅VA3∅VAR3∅PF3∅DEG3∅VPK3∅APK3∅
TIME∅WH3∅WHP3∅WHM3∅AH3∅AHP3∅AHM3∅
VΣ∅AΣ∅WΣ∅VAΣ∅VARΣ∅PFΣ∅DEGΣ∅
TIME∅WHΣ∅WHPΣ∅WHMΣ∅AHΣ∅AHPΣ∅AHMΣ∅
FREQuency∅MATH∅
TORQue∅RPM∅SRPM∅SLIP∅MPOWer∅MEFFiciency∅TEFFiciency

A comma is inserted between data to separate them, and a terminator (<RMT>) is added at the end of the last data.

Output examples for normal measurement data

- When the following commands are sent (3-phase 3-wire model)
  (Command) MEASURE:ITEM:NORMAL:PRESET DEFAULT1
  MEASURE:VALUE?
  (Received data) 5.721E+00,2.4567E+00,-10.48E+00,5.717E+00,2.4573E+00,
  -10.48E+00,5.719E+00,2.4570E+00,-20.96E+00,63.998E+00
  (Description of each received data)
  V1 :5.721E+00 A1 :2.4567E+00 W1 :-10.48E+00
  V3 :5.717E+00 A3 :2.4573E+00 W3 :-10.48E+00
  VΣ :5.719E+00 AΣ :2.4570E+00 WΣ :-20.96E+00
  FREQ:63.998E+00

- When the following commands are sent during integration (3-phase 4-wire model with the integration function)

  (Command) MEASURE:ITEM:NORMAL:PRESET DEFAULT2
  MEASURE:VALUE?

  (Received data)

  -10.49E+00,0,10,0,-1.7469E+00,0.0524E+00,-1.7993E+00,409.26E-03,409.26E-03,0.00E-03,-10.50E+00,0,10,0,-1.7500E+00,0.0523E+00,-1.8024E+00,409.71E-03,409.71E-03,0.00E-03,-10.48E+00,0,10,0,-1.7478E+00,0.0524E+00,-1.8012E+00,409.20E-03,409.20E-03,0.00E-03,-31.47E+00,0,10,0,-5.2447E+00,0.1572E+00,-5.4029E+00,1.2282E+00,1.2282E+00,0.0000E+00,64.001E+00

(Description of each received data)

W1 :-10.49E+00
WH1 :-1.7469E+00 WHP1 : 0.0524E+00 WHM1 :-1.7993E+00
AH1 :409.26E-03 AHP1 : 409.26E-03 AHM1 :0.00E-03
W2 :-10.50E+00
WH2 :-1.7500E+00 WHP2 : 0.0523E+00 WHM2 :-1.8024E+00
AH2 :409.71E-03 AHP2 : 409.71E-03 AHM2 :0.00E-03
W3 :-10.48E+00
WH2 :-1.7478E+00 WHP3 : 0.0524E+00 WHM3 : -1.8012E+00
AH3 :409.20E-03 AHP3 : 409.20E-03 AHM3 :0.00E-03
WΣ : -31.47E+00
WHΣ : -5.2447E+00 WHPΣ : 0.1572E+00 WHMΣ : -5.4029E+00
AHΣ : 1.2282E+00 AHPΣ : 1.2282E+00 AHMΣ : 0.0000E+00
FREQ:64.001E+00
lapsed time of integration: 0 (hour) 10 (minute) 0 (second)

Data format for harmonic analysis data

Data is always output in <NR3> format. (Mantissa: floating-point number of the maximum 5 digits + Exponent: 2 digits)

Output format for harmonic analysis data

Data for all the items which are set to ON as described in Section 15.1, "Selecting the Output Items" or using "MEASure:ITEM[:HARMonics] commands is output in one line at once. The order in which each data is output is given below. (Numbers indicate element numbers.)

V1∅A1∅W1∅
VA1∅VAR1∅PF1∅DEG1∅VTHD1∅ATHD1∅
VCON1∅ACON1∅WCON1∅
VDEG1∅ADEG1∅
V2∅A2∅W2∅
VA2∅VAR2∅PF2∅DEG2∅VTHD2∅ATHD2∅
VCON2∅ACON2∅WCON2∅
VDEG2∅ADEG2∅
V3∅A3∅W3∅
VA3∅VAR3∅PF3∅DEG3∅VTHD3∅ATHD3∅
VCON3∅ACON3∅WCON3∅
VDEG3∅ADEG3∅
VΣ∅AΣ∅WΣ∅VAΣ∅VARΣ∅PFΣ∅
SYNChronize∅
TORQue∅RPM∅SRPM∅SLIP∅MPOWer∅MEFFiciency∅TEFFiciency

The following number of data sets are output by one <harmonic analysis function> or SYNChronize (PLL source frequency).

"n" is the upper limit of the harmonic order. The harmonic data above the upper limit are not outputted.

- V,A,W : n*+1 data (1 data for V Σ, A Σ, W Σ)
  Total rms value of 1st to n*th harmonic ∅ Analysis value of fundamental ∅ Analysis value of 2nd harmonic ∅ ... ∅ Analysis value of n*th harmonic
- VA,VAR,PF,DEG : 1 data
  Apparent power, reactive power, power factor or phase angle of fundamental (1st) is output. Executing the HARMonics:DEGRee? query command allows you to know which object is used for phase angle.
- VTHD,ATHD : 1 data
  Harmonic distortion of voltage or current is output. (Either IEC or CSA) Executing the HARMonics:THD? query command allows you to know which equation is used.
- VCON,ACON,WCON : n*–1 data
  ontent of 2nd harmonic ∅ .... ∅ Content of n*th harmonic
- VDEG : n* data
  hase angle of current of 1st in relation to voltage of 1s ∅ Phase angle of voltage of 2nd in relation to voltage of 1st ∅ Phase angle of voltage of n*th in relation to voltage of 1st
- ADEG : n* data
  Phase angle of current of 1st in relation to voltage of 1s ∅ Phase angle of current of 2nd in relation to current of 1st ∅ Phase angle of current of n*th in relation to current of 1st
- SYNChronize (PLL source frequency): 1 data
  Executing the HARMonics:SYNChronize? query command allows you to know which PLL source is used.

A comma is inserted between data to separate them, and a terminator (<RMT>) is added at the end of the last data.

Output examples for harmonic analysis data

• When the following commands are sent:

(Command) MEASURE:ITEM:HARMONICS:PRESET CLEAR
MEASURE:ITEM:HARMONICS:A:ELEMENT1 ON
MEASURE:ITEM:HARMONICS:ACON:ELEMENT1 ON
MEASURE:VALUE?

(Received data) 8.195E+00,8.136E+00,0.003E+00,0.903E+00,0.001E+00,0.326E+00,
0.001E+00,0.168E+00,0.000E+00,0.100E+00,0.001E+00,0.067E+00,
0.000E+00,0.049E+00,0.001E+00,0.038E+00,0.000E+00,0.028E+00,
0.001E+00,0.022E+00,0.000E+00,0.019E+00,0.001E+00,0.016E+00,
0.000E+00,0.013E+00,0.001E+00,0.012E+00,0.001E+00,0.010E+00,
0.001E+00,0.011E+00,0.001E+00,0.006E+00,0.001E+00,0.006E+00,
0.001E+00,0.006E+00,0.000E+00,0.006E+00,0.000E+00,0.006E+00,
0.000E+00,0.005E+00,0.001E+00,0.005E+00,0.001E+00,0.005E+00,
0.000E+00,0.003E+00,0.001E+00,0.04E+00,11.10E+00,0.01E+00,
4.01E+00,0.02E+00,2.07E+00,0.01E+00,1.23E+00,0.01E+00,
0.82E+00,0.00E+00,0.60E+00,0.02E+00,0.46E+00,0.00E+00,
0.34E+00,0.01E+00,0.28E+00,0.00E+00,0.23E+00,0.01E+00,
0.20E+00,0.00E+00,0.17E+00,0.01E+00,0.14E+00,0.01E+00,
0.13E+00,0.01E+00,0.13E+00,0.02E+00,0.07E+00,0.01E+00,
0.08E+00,0.01E+00,0.08E+00,0.00E+00,0.07E+00,0.01E+00,
0.07E+00,0.00E+00,0.06E+00,0.01E+00,0.06E+00,0.01E+00,
0.06E+00,0.00E+00,0.04E+00,0.01E+00

(Description of each received data)

Total rms value from 1st to 50th harmonic of current	: 8.195E+00 (A)
Analysis value of fundamental (1st)	: 8.136E+00 (A)
Analysis value of 2nd harmonic	: 0.003E+00 (A)
Analysis value of 3rd harmonic	: 0.903E+00 (A)
. . .	
. . .	
Analysis value of 50th harmonic	: 0.001E+00 (A)
Content of 2nd harmonic	: 0.04E+00 (%)
Content of 3rd harmonic	: 11.10E+00 (%)
. . .	
. . .	
Content of 50th harmonic	: 0.01E+00 (%)

A total of 100 data sets are output.

Data format for binary data

Refer to "Data Section" on page App 1-22.

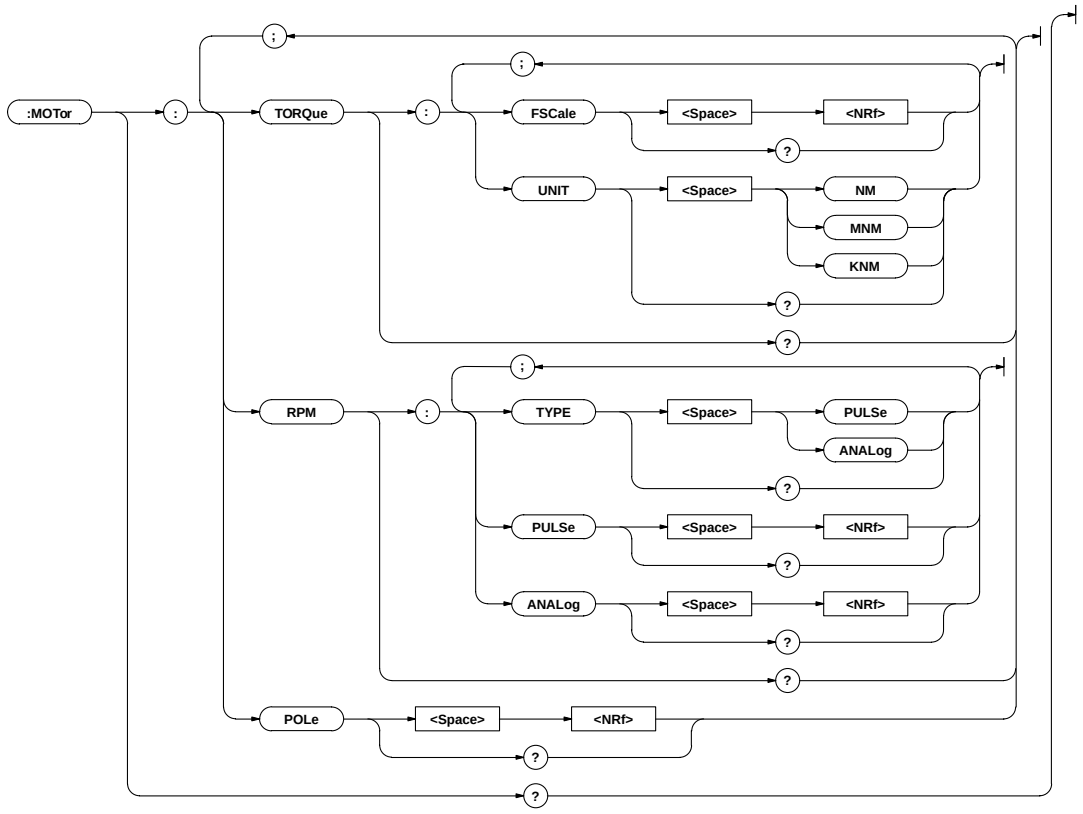
Output format for binary data

Following the steps described in Section 15.1 "Selecting the Output Items" or using the "MEASure:ITEM" group command, all data which have their communication output turned ON are outputted together as block data of "4 bytes ∗ number of data sets."

- There is a 6-byte header in front of the block data. (Refer to App2-7 <Block data>.)
- Data of each items is output in the same order as ASCII format.
- No comma is inserted between data of each item to separate them.
- A terminator (<RMT>), which is normally added at the end of each line, is added. "EOI" becomes TRUE immediately the terminator is output.

2.3.10 MOTor Group

The commands in the MOTor group are used to make settings relating to and inquire about motor evaluation function. This allows you to make the same settings and inquiries which can be made using the SET UP (MOTOR) key on the front panel. These commands are available only if the instrument is equipped with the motor evaluation function (WT1030M).



MOTor?

Function Queries all the current motor evaluation settings.

Syntax MOTor?

Example MOTOR?∅:MOTOR:TORQUE:FSCALE 2.0000E+03;UNIT NM;:MOTOR:RPM:TYPE PULSE;PULSE 60;ANALOG 10.000E+03;:MOTOR:POLE 2

MOTor:POLe

Function Sets the number of poles/queries the current setting.

Syntax MOTor:POLe {<NRf>}
MOTor:POLe?
{<NRf>}=2 to 98(Even number only)

Example MOTOR:POLE 2
MOTOR:POLE?∅MOTOR:POLE 2

Description If an odd number is set, "1" will be deducted from it to make it an even number.

MOTor:RPM?

Function Queries all the current rpm settings.

Syntax MOTor:RPM?

Example MOTOR:RPM?∅:MOTOR:RPM:TYPE PULSE;PULSE 60;ANALOG 10.000E+03

MOTor:RPM:ANALog

Function Sets scaling value for analog rpm input/queries the current setting.

Syntax MOTor:RPM:ANALog {<NRf>}
MOTor:RPM:ANALog?
{<NRf>}=ROM version before 2.01 0.0001 to 10000
ROM version 2.01 or later 0.0001 to 70000

Example MOTOR:RPM:ANALOG 10000
MOTOR:RPM:ANALOG?∅:MOTOR:RPM:ANALOG 10.000E+03

Description Scaling Value is rounded as follows.
Below 1.0000 Rounded to four decimal places.
1.0000 to 10000 (or 70000) Rounded to five significant digits.

MOTor:RPM:PULSe

Function Sets the number of pulses per revolution/queries the current setting.

Syntax MOTor:RPM:PULSe {<NRf>}
MOTor:RPM:PULSe?
{<NRf>}=ROM version before 2.08 1 to 1000
ROM version 2.08 or later 1 to 9999

Example MOTOR:RPM:PULSE 60
MOTOR:RPM:PULSE?∅:MOTOR:RPM:PULSE 60

MOTor:RPM:TYPE

Function Sets the rpm input type/queries the current setting.

Syntax MOTor:RPM:TYPE {PULSe|ANALog}
MOTor:RPM:TYPE?

Example MOTOR:RPM:TYPE PULSE
MOTOR:RPM:TYPE?∅:MOTOR:RPM:TYPE PULSE

MOTor:TORQue?

Function Queries all the current torque input settings.

Syntax MOTor:TORQue?

Example MOTOR:TORQUE?∅:MOTOR:TORQUE:FSCALE 2.0000E+03;UNIT NM

MOTor:TORQue:FSCale

Function Sets scaling value for torque input/queries the current setting.

Syntax MOTor:TORQue:FSCale {<NRf>}
MOTor:TORQue:FSCale?
{<NRf>}=0.0001 to 10000

Example MOTOR:TORQUE:FSCALE 2000
MOTOR:TORQUE:FSCALE?∅:MOTOR:TORQUE:FSCALE 2.0000E+03

Description ScalingValueis rounded in same way as for "MOTor:RPM:ANALog"

MOTor:TORQue:UNIT

Function Sets unit for torque input/queries the current setting.

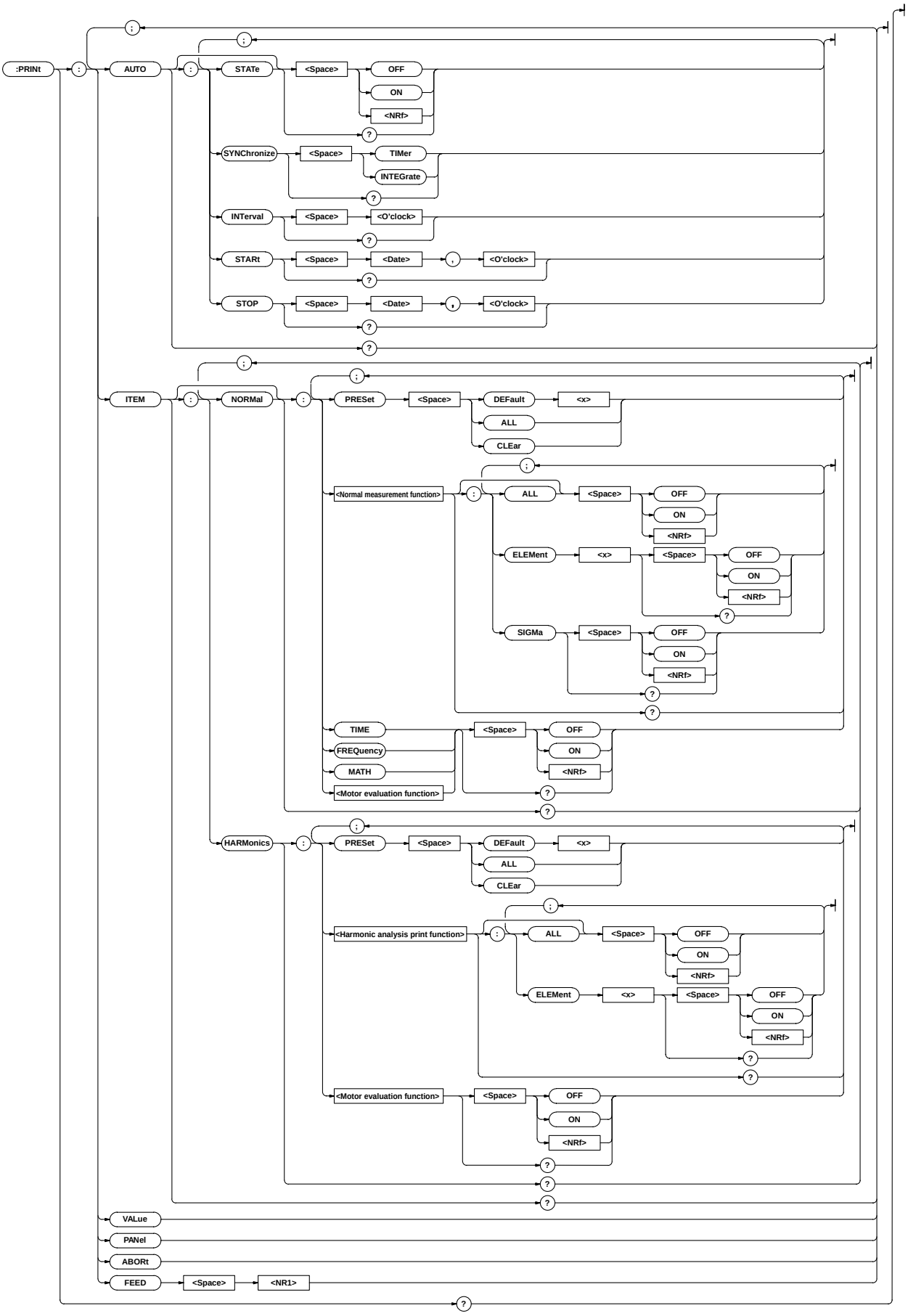
Syntax MOTor:TORQue:UNIT
{NM|KGM|KGCM|MNM|KNM|FTLB|OZIN|LBIN}
MOTor:TORQue:UNIT?

Example MOTOR:TORQUE:UNIT NM
MOTOR:TORQUE:UNIT?∅:MOTOR:TORQUE:UNIT NM

Description {KGM|KGCM||FTLB|OZIN|LBIN} can be selected when /U1 option is used.

2.3.11 PRINt Group

The commands in the PRINt group are used to make settings relating to and to inquire about built-in printer. This allows you to make the same settings and inquiries which you can make using the PRINTER keys (AUTO, PRINT, FEED SET UP (SHIFT + AUTO)) on the front panel. These commands are available only if the instrument is equipped with the built-in printer (/B5 model).



PRINt?

Function Queries all the current built-in printer settings.

Syntax PRINt?

Example PRINT?∅(Response to PRINT:AUTO?); (Response to PRINT:ITEM?)

PRINt:ABORt

Function Stops printing.

Syntax PRINt:ABORt

Example PRINT:ABORT

PRINt:AUTO?

Function Queries all the current auto print mode settings.

Syntax PRINt:AUTO?

Example PRINT:AUTO?∅:PRINT:AUTO:STATE 0;SYNCHRONIZE TIMER;INTERVAL 0,1,0;START 96,4,1,8,30,50;STOP 96,4,1,12,5,30

PRINt:AUTO:INTerval

Function Sets print interval for auto print mode/queries the current setting.

Syntax PRINt:AUTO:INTerval {<O'clock>}
PRINt:AUTO:INTerval?
{<O'clock>}={<NRf>,<NRf>[,<NRf>]|<Character string>}
{<NRf>,<NRf>[,<NRf>]}=0,0,10,99,59,59
{<Character string>}="HH:MM[:SS]"
HHH: Hour MM: Miniute SS: Second

Example PRINT:AUTO:INTERVAL 0,1,0
PRINT:AUTO:INTERVAL "0:1:0"
PRINT:AUTO:INTERVAL? ∅:PRINT:AUTO:INTERVAL 0,1,0

Description If second (SS) is not set, the print interval will be 0 second.

PRINt:AUTO:STARt

Function Sets start time for auto print mode/queries the current setting.

Syntax PRINt:AUTO:STARt {<Date>,<O'clock>}
PRINt:AUTO:STARt?
<Date>={<NRf>,<NRf>,<NRf>|<Character string>}
<O'clock>={<NRf>,<NRf>[,<NRf>]|<Character string>}

Example PRINT:AUTO:START 96,4,1,8,30,50
PRINT:AUTO:START "1996/04/01","08:30:50"
PRINT:AUTO:START∅:PRINT:AUTO:START 96,4,1,8,30,50

Description For <Date> and <O'clock> data, refer to Section 2.3.16, "SYSTem Group".

PRINt:AUTO[:STATe]

Function Turns auto print mode ON or OFF/queries the current setting.

Syntax PRINt:AUTO[:STATe] {<Boolean>}
PRINt:AUTO:STATe?

Example PRINT:AUTO:STATE OFF
PRINT:AUTO:STATE?∅:PRINT:AUTO:STATE 0

PRINt:AUTO:STOP

Function Sets stop time for auto print mode/queries the current setting.

Syntax PRINt:AUTO:STOP {<Date>,<O'clock>}
PRINt:AUTO:STOP?
<Date>={<NRf>,<NRf>,<NRf>|<Character string>}
<O'clock>={<NRf>,<NRf>[,<NRf>]|<Character string>}

Example PRINT:AUTO:STOP 1996,04,01,12,05,30
PRINT:AUTO:STOP "96/4/1","12:5:30"
PRINT:AUTO:STOP∅:PRINT:AUTO:STOP 96,4,1,12,5,30

Description For <Date> and <O'clock> data, refer to Section 2.3.16, "SYSTem Group".

PRINt:AUTO:SYNChronize

Function Sets print synchronization method for auto print mode/queries the current setting.

Syntax PRINt:AUTO:SYNChronize {TIMer|INTEGrate}
PRINt:AUTO:SYNChronize?

Example PRINT:AUTO:SYNCHRONIZE TIMER
PRINT:AUTO:SYNCHRONIZE?∅:PRINT:AUTO:SYNCHRONIZE TIMER

Description Selectable print synchronization methods are given below.
TIMer : Start/stop time synchronization
INTEGrate : Integration time synchronization

PRINt:FEED

Function Feeds print paper.

Syntax PRINt:FEED {<NR1>}
{<NR1>}=1 to 20

Example PRINT:FEED 5

PRINt:ITEM?

Function Queries all the printer settings for measured/computed data.

Syntax PRINt:ITEM?

Example PRINT:ITEM?∅(Response to PRINT:ITEM: NORMal?); (Response to PRINT:ITEM: HARMonics?)

PRINt:ITEM:HARMonics?

Function Queries all the print output items for harmonic analysis mode.

Syntax PRINt:ITEM:HARMonics?

Example PRINT:ITEM:HARMONICS?∅:PRINT:ITEM:HARMONICS:V:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;:PRINT:ITEM:HARMONICS:A:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;:PRINT:ITEM:HARMONICS:W:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;:PRINT:ITEM:HARMONICS:DEG:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:PRINT:ITEM:HARMONICS:GV:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:PRINT:ITEM:HARMONICS:GA:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:PRINT:ITEM:HARMONICS:GW:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:PRINT:ITEM:HARMONICS:GVD:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:PRINT:ITEM:HARMONICS:GAD:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:PRINT:ITEM:HARMONICS:CGV:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:PRINT:ITEM:HARMONICS:CGA:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:PRINT:ITEM:HARMONICS:CGW:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;:PRINT:ITEM:HARMONICS:TORQUE 0;RPM 0;SRPM 0;SLIP 0;MPOWER 0;MEFFICIENCY 0;TEFFICIENCY 0

PRINt:ITEM:HARMonics:<Harmonic analysis function>?

Function Queries all the printer output settings for the specified harmonic analysis function.

Syntax PRINt:ITEM:HARMonics:<Harmonic analysis function>?

Example PRINT:ITEM:HARMONICS:V?∅:PRINT:ITEM:HARMONICS:V:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1

Description Selectable functions are given below.

- V : Analysis voltage value and relative harmonic content are printed in numeric.
- A : Analysis current value and relative harmonic content are printed in numeric.
- W : Analysis active power value and relative harmonic content are printed in numeric.
- DEG : Phase angle of voltage of each harmonic from 2nd to n*th in relation to voltage of the 1st and phase angle of voltage of each harmonic from 2nd to n*th in relation to current of the 1st are printed in numeric.
- GV : Analysis voltage value is printed in graph.
- GA : Analysis current value is printed in graph.
- GW : Analysis active power value is printed in graph.
- GVD : Phase angle of voltage of each harmonic from 2nd to n*th in relation to voltage of the 1st is printed in graph.
- GAD : Phase angle of current of each harmonic from 2nd to n*th in relation to current of the 1st is printed in graph.
- CGV : Relative harmonic content of voltage is printed in graph.
- CGA : Relative harmonic content of current is printed in graph.
- CGW : Relative harmonic content of active power is printed in graph.

* "n" is the upper limit of the harmonic order.

PRINt:ITEM:HARMonics:<Harmonic analysis function>[:ALL]

Function Turns printer output for the specified harmonic analysis function ON or OFF for all the effective elements at once.

Syntax PRINt:ITEM:HARMonics:Turns printer output for the specified harmonic analysis function ON or OFF for all the effective elements at once.[:ALL] {<Boolean>}

Example PRINT:ITEM:HARMONICS:V:ALL ON

PRINt:ITEM:HARMonics:<Harmonic analysis function>:ELEMent<x>

Function Turns printer output for the specified harmonic analysis function ON or OFF for the specified element/queries the current setting.

Syntax PRINt:ITEM:HARMonics:<Harmonic analysis function>:ELEMent<x> {<Boolean>}
PRINt:ITEM:HARMonics:<Harmonic analysis function>:ELEMent<x>?
<x>=1,3(3-phase 3-wire model)
=1 to 3(3-phase 4-wire model)

Example PRINT:ITEM:HARMONICS:V:ELEMENT1 ON
PRINT:ITEM:HARMONICS:V:ELEMENT1?
∅:PRINT:ITEM:HARMONICS: V:ELEMENT1 1

PRINt:ITEM:HARMonics:<Motor evaluation function>

Function Turns printer output for <motor evaluation function> ON and OFF/queries the current setting.

Syntax PRINt:ITEM:HARMonics:< Motor evaluation function> {<Boolean>}
PRINt:ITEM:HARMonics:< Motor evaluation function>?

Example PRINT:ITEM:HARMONICS:TORQUE ON
PRINT:ITEM:HARMONICS:TORQUE?
∅:PRINT:ITEM:HARMONICS: TORQUE 1

PRINt:ITEM:HARMonics:PRESet

Function ets printer output items for harmonic analysis mode to the specified default setting at once.

Syntax PRINt:ITEM:HARMonics:PRESet {DEFault<1-2>|ALL|CLEar}

Example PRINT:ITEM:HARMONICS:PRESET DEFAULT1

Description For a description of global setting, refer to Section 12.2, "Setting Printer Output Functions".

PRINt:ITEM:NORMal?

Function Queries all the printer output items for normal measurement mode.

Syntax PRINt:ITEM:NORMal?

Example PRINT:ITEM:NORMAL?∅:PRINT:ITEM:NORMAL:V:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 1;:PRINT:ITEM:NORMAL:A:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 1;:PRINT:ITEM:NORMAL:W:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 1;:PRINT:ITEM:NORMAL:VA:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:VAR:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:PF:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:DEG:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:VPK:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:APK:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:WH:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:WHP:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:WHM:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:AH:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:AHP:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:AHM:ELEMENT1 0;ELEMENT2 0;ELEMENT3 0;SIGMA 0;:PRINT:ITEM:NORMAL:TIME 0;FREQUENCY 1; MATH 0;TORQUE 0;RPM 0;SRPM 0;SLIP 0;MPOWER 0;MEFFICIENCY 0;TEFFICIENCY 0

PRINt:ITEM[:NORMal]:<Normal measurement function>?

Function Queries all the printer output settings for the specified normal measurement function.

Syntax PRINt:ITEM[:NORMal]:<Normal measurement function>?

Example PRINT:ITEM:NORMAL:V?∅:PRINT:ITEM:NORMAL:V:ELEMENT1 1;ELEMENT2 1;ELEMENT3 1;SIGMA 1

PRINt:ITEM[:NORMal]:<Normal measurement function >[:ALL]

Function Turns printer output for the specified normal measurement function ON or OFF for all the effective elements and Σ at once.

Syntax PRINt:ITEM[:NORMal]:<Normal measurement function>[:ALL] {<Boolean>}

Example PRINT:ITEM:NORMAL:V:ALL ON

PRINt:ITEM[:NORMal]:<Normal measurement function>:ELEMent<x>

Function Turns printer output for the specified normal measurement function ON or OFF for the specified element/queries the current setting.

Syntax PRINt:ITEM[:NORMal]:<Normal measurement function>:ELEMent<x> {<Boolean>}
PRINt:ITEM[:NORMal]:<Normal measurement function>:ELEMent<x>?
<x>=1, 3(3-phase 3-wire model)
=1 to 3(3-phase 4-wire model)

Example PRINT:ITEM:NORMAL:V:ELEMENT1 ON
PRINT:ITEM:NORMAL:V:ELEMENT1?∅:PRINT:ITEM:NORMAL:V:ELEMENT1 1

PRINt:ITEM[:NORMal]:<Normal measurement function>:SIGMa

Function Turns printer output of Σ data ON or OFF for the specified harmonic analysis function/queries the current setting.

Syntax PRINt:ITEM[:NORMal]:<Normal measurement function>:SIGMa {<Boolean>}
PRINt:ITEM[:NORMal]:<Normal measurement function>:SIGMa?

Example PRINT:ITEM:NORMAL:V:SIGMA ON
PRINT:ITEM:NORMAL:V:SIGMA?∅:PRINT:ITEM:NORMAL:V:SIGMA 1

PRINt:ITEM[:NORMal]:{TIME|FREQuency|MATH|<Motor evaluation function>}

Function Turns printer output ON or OFF for the motor evaluation function(elapsed time of integration, frequency, computation)/queries the current setting.

Syntax PRINt:ITEM[:NORMal]:{TIME|FREQuency|MATH|<Motor evaluation function>} {<Boolean>}
PRINt:ITEM[:NORMal]:{TIME|FREQuency|MATH|<Normal measurement function>}?

Example PRINT:ITEM:NORMAL:FREQUENCY ON
PRINT:ITEM:NORMAL:FREQUENCY?∅:PRINT:ITEM:NORMAL:FREQUENCY 1

PRINt:ITEM[:NORMal]:PRESet

Function Sets printer output items for normal measurement mode to the preset settings at once.

Syntax PRINt:ITEM[:NORMal]:PRESet {DEFault<1-2>|ALL|CLEar}

Example PRINT:ITEM:NORMAL:PRESET DEFAULT1

Description For a description of global setting, refer to Section 12.2, "Setting Printer Output Functions (Optional)".

PRINt:PANel

Function Prints set-up information.

Syntax PRINt:PANel

Example PRINT:PANEL

PRINt:VALue

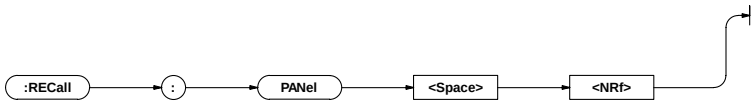
Function Prints all the measured/computed data for the items which are set to ON using "PRINt:ITEM" commands ("PRINt:ITEM:HARMonics" through"PRINt:ITEM[:NORMal]:PRESet").

Syntax PRINt:VALue

Example PRINT:VALUE

2.3.12 RECall Group

The commands in the RECall group are used to recall set-up information. This allows you to make the same settings and inquiries which can be made using the MISC key ("RECALL" menu) on the front panel.



RECall:PANel

Function Recalls set-up information from the specified file of the internal memory.

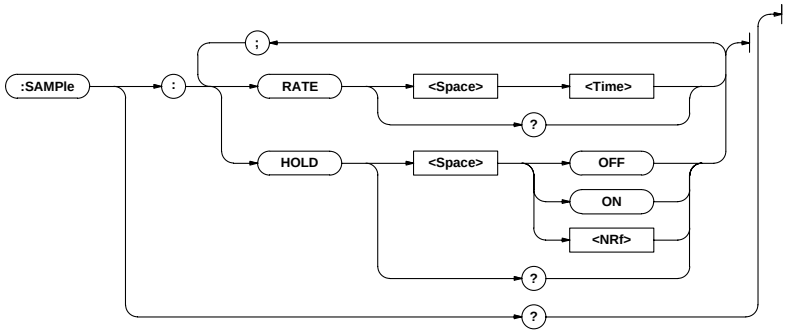
Syntax RECall:PANel {<NRf>}

{<NRf>}=1 to 8 :File no.

Example RECALL:PANEL 1

2.3.13 SAMPle Group

The commands in the SAMPle group are used to make settings relating to and to inquire about sampling. This allows you to make the same settings and inquiries which can be made using the HOLD and RATE keys on the front panel



SAMPle?

Function Queries all the current sampling settings.

Syntax SAMPle?

Example SAMPLE?∅:SAMPLE:RATE 0.500E+00;HOLD 0

SAMPle:HOLD

Function Turns hold mode for output data (display, communication data) ON and ON/queries the current setting.

Syntax SAMPle:HOLD {<Boolean>}

SAMPle:HOLD?

Example SAMPLE:HOLD ON

SAMPLE:HOLD?∅:SAMPLE:HOLD 1

SAMPle:RATE

Function Sets sample rate/queries the current setting.

Syntax SAMPle:RATE {<Time>}

SAMPle:RATE?

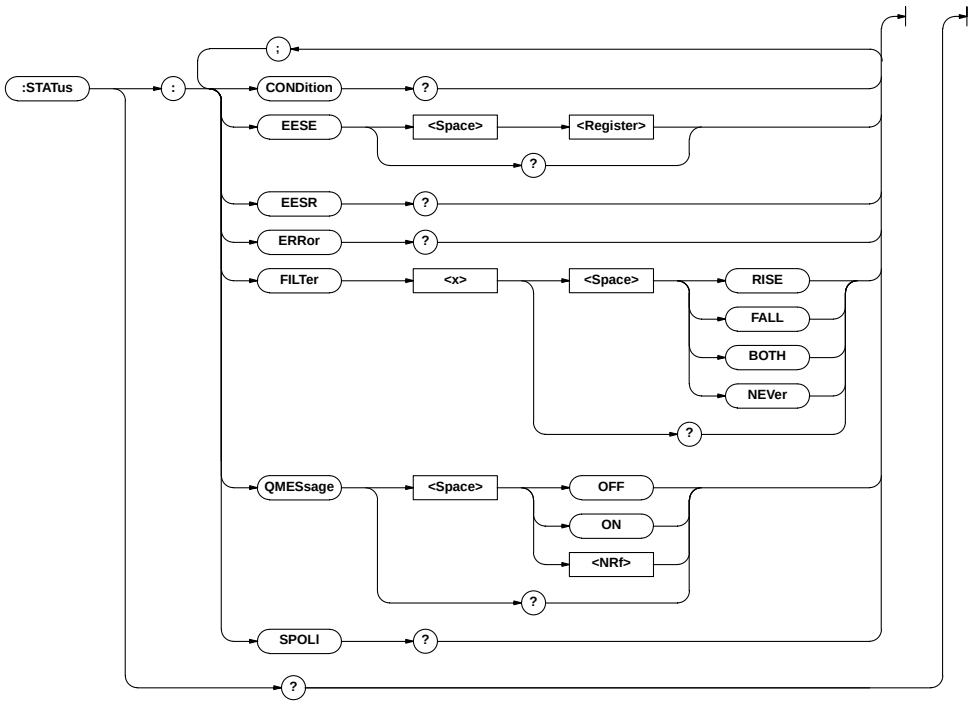
<Time>= 0.1 to 5.0sec(0.1,0.25,0.5,2.0, 5.0sec)

Example SAMPLE:RATE 500MS

SAMPLE:RATE?∅:SAMPLE:RATE 0.500E+00

2.3.14 STATus Group

The commands in the STATus group are used to make settings relating to and to inquire about the communications status function. There is no front panel key for this function. For details of the status report, refer to Appendix 2.4.



STATus?

Function Queries all the settings relating to the communications status function.

Syntax STATus?

Example STATUS?∅:STATUS:EESE 0;FILTER1 NEVER;FILTER2 NEVER;FILTER3 NEVER;FILTER4 NEVER;FILTER5 NEVER;FILTER6 NEVER;FILTER7 NEVER;FILTER8 NEVER;FILTER9 NEVER;FILTER10 NEVER;FILTER11 NEVER;FILTER12 NEVER;FILTER13 NEVER;FILTER14 NEVER;FILTER15 NEVER;FILTER16 NEVER;QMESSAGE1

STATus:CONDition?

Function Queries the contents of the condition register and clears the register.

Syntax STATus:CONDition?

Example STATUS:CONDITION∅16

Description For a description of the condition register, refer to Appendix 2.4, "Status Report".

STATus:EESE

Function Sets the extended event enable register/queries the current setting.

Syntax STATus:EESE <Register>
STATus:EESE?
<Register>=0 to 65535

Example STATUS:EESE 257
STATUS:EESE?∅:STATUS:EESE 257

Description For a description of the extended event enable register, refer to Appendix 2.4, "Status Report".

STATus:EESR?

Function Queries the contents of the extended event register and clears the register.

Syntax STATus:EESR?

Example STATUS:EESR?∅1

Description For a description of the extended event register, refer to Appendix 2.4, "Status Report".

STATus:ERRor?

Function Queries the code and the message (at the beginning of the error queue) of the error which has occurred.

Syntax STATus:ERRor?

Example STATUS:ERROR?∅113,"Undefined header"

STATus:FILTer<x>

Function Queries all the settings relating to the specified transit filter/ queries the current settings.

Syntax STATus:FILTer<x>
{RISE|FALL|BOTH|NEVer}
STATus:FILTer<x>?
<x>=1~16

Example STATUS:FILTER2 RISE
STATUS:FILTER2?∅:STATUS:FILTER2 RISE

Description For a description of the transit filter, refer to Appendix 2.4, "Status Report".

STATus:QMESsage

Function Selects whether or not to add the message contents to a response to "STATus:ERROr?"/queries the current setting.

Syntax STATus:QMESsage {<Boolean>}
STATus:QMESsage?

Example STATUS:QMESSAGE OFF
STATUS:QMESSAGE?∅:STATUS:QMESSAGE 0

STATus:SPOLl?(Serial Poll)

Function Executes serial poll.

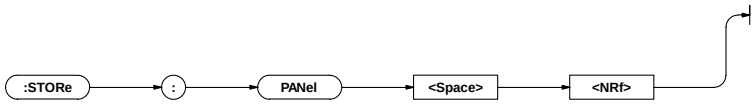
Syntax STATus:SPOLl?

Example STATUS:SPOLL?∅STATUS:SPOLL 0

Description This command is available only for the RS-232-C interface.

2.3.15 STORe Group

The commands in the STORe group are used to make settings relating to and to inquire about storage of set-up information. This allows you to make the same settings and inquiries which can be made using the MISC key ("StoreE" menu) on the front panel.



STORe:PANel

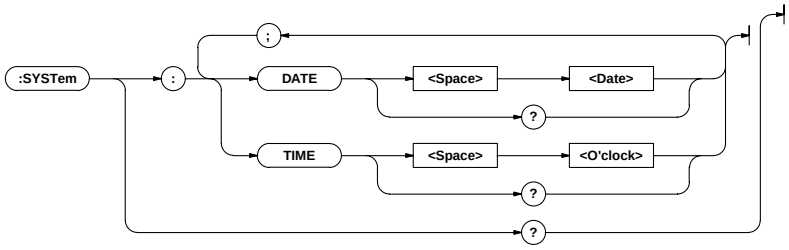
Function Stores set-up information in the internal memory

Syntax STORe:PANel {<NRf>}
{<NRf>}=1 to 8 :File no.

Example STORE:PANEL 1

2.3.16 SYSTem Group

The commands in the SYSTem group are used to make settings relating to and to inquire about system (internal clock). This allows you to make the same settings and inquiries which you can make using the MISC key ("dAtE" menu) on the front panel.



SYSTem?

Function Queries all the system (internal clock) settings.

Syntax SYSTem?

Example SYSTEM?∅:SYSTEM:DATE 96,4,1;TIME 17,15,0

SYSTem:DATE

Function Sets the date/queries the current setting.

Syntax SYSTem:DATE {<Date>}
SYSTem:DATE?
{<Date>}={<NRf>,<NRf>,<NRf>|<Character string>}
{<NRf>,<NRf>,<NRf>}=[19]96,1,1,[20]95,12,31{<Character string>}="[YY]YY/MM/DD"
[YY]YY: Year MM: Month DD: Day

Example SYSTem:DATE 96,4,1
SYSTem:DATE 1996,04,01
SYSTem:DATE "96/04/01"
SYSTem:DATE "1996/4/1"
SYSTEM:DATE?∅:SYSTEM:DATE 96,4,1

SYSTem:TIME

Function Sets the time/queries the current setting.

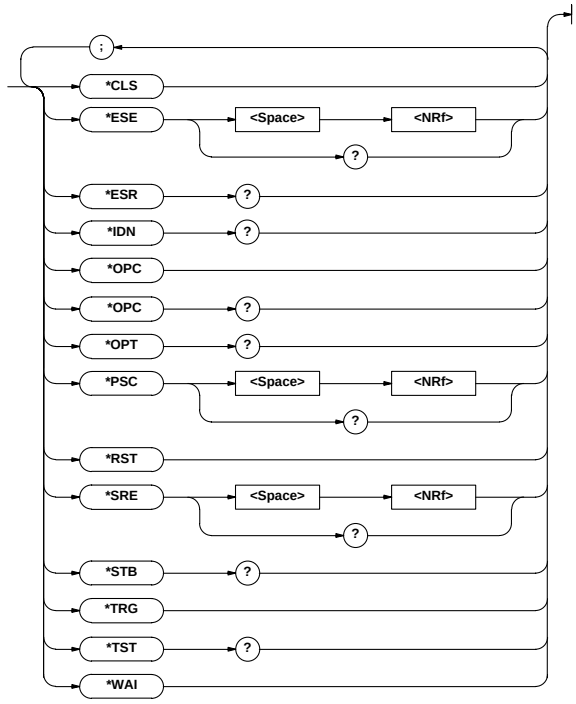
Syntax SYSTem:TIME {<O'clock>}
SYSTem:TIME?
{<O'clock>}={<NRf>,<NRf>[,<NRf>]|<Character string>}
{<NRf>,<NRf>[,<NRf>]}=0,0,0,23,59,59
{<Character string>}="HH:MM[:SS]"
HH: Hour MM: Minute SS: Second

Example SYSTem:TIME 17,15,0
SYSTem:TIME 17,15
SYSTem:TIME "17:15:0"
SYSTem:TIME "17:15"
SYSTEM:TIME?∅:SYSTEM:TIME 17,15,0

Description If second (SS) is not set, it will be 0 second.

2.3.17 Common Command Group

The commands in the common command group are independent of the instrument's functions, and are specified in IEEE 488.2-1987. There is no front panel key that corresponds to this group.



*CLS

Function Clears the standard event register, extended event register and error queue.

Syntax *CLS

Example *CLS

Description
- The output queue will also be cleared if a "*CLS" command is appended after the program message terminator.
- For details of the registers and queues, refer to Appendix 2.4.

*ESE

Function Sets the value for the standard event enable register/queries the current setting.

Syntax *ESE {<NRf>}
*ESE?
{<NRf>}=0 to 255

Example *ESE 251
*ESE?∅251

Description
- <NRf> is the sum of the bits expressed as a decimal number.
- For example, if "*ESE 251" is set, the standard event enable register will be set to "111111011". This means that bit 2 of the standard event register is disabled so that bit 5 (ESB) of the status byte register will not be set to "1", even if a query error occurs.
- Default is "0", i.e. all bits are disabled.
- The standard event enable register will not be cleared, even if a query is made using "*ESE?".
- For details of the standard event enable register, refer to App 2-50.

*ESR?

Function Queries the value of the standard event register and clears it at the same time.

Syntax *ESR?

Example *ESR?∅32

Description
- The sum of the bits is returned as a decimal value.
- It is possible to ascertain the type of event which has occurred, while SRQ is occurring.
- For example, if "32" is returned, this means that the standard event register is "00100000", i.e. the SRQ has occurred due to a command syntax error.
- If a query is made using "*ESR?", the standard event register will be cleared.
- For details of the standard event register, refer to page App 2-50.

*IDN?

Function Queries the instrument model.

Syntax *IDN?

Example *IDN?∅YOKOGAWA,253630,0,F1.01

Description A reply consists of the following sequence: <Manufacturer>, <Model>, <Serial No.> and <Firmware version>.

*OPC

Function This command sets bit 0 of the standard event register to "1" when execution of the specified overlap command has been completed. This command will be ignored since overlap commands are not supported by this instrument.

Syntax *OPC

*OPC?

Function "1" will be returned if execution of the designated overlap command has been completed. "1" will always be returned since overlap commands are not supported by this instrument.

Syntax *OPC?

*OPT?

Function Queries installed options.

Syntax *OPT?

Example *OPT?∅DA,PRINTER,HARMONICS,INTEGRATOR, EXT-SENSOR,WAVEFORM,MOTOR

Description
- "None" will be attached to the reply if no options are installed.
- "*OPT?" must always be the last query in a program message. If there is another query after "*OPT?" , an error will occur.

*PSC

Function Selects whether or not to clear the following registers when power is turned ON/queries the current setting. However, they cannot be cleared if the parameter is "0".
- Standard event enable register
- Extended event enable register
- Transit filter

Syntax *PSC {<NRf>}
*PSC?
{<NRf>}= 0 (does not clear the registers) value other than 0 (clears the registers)

Example *PSC 1
*PSC?∅1

Description For details of each register, refer to Appendix 2.4.

*RST

Function Resets (initialize) the current settings.

Syntax *RST

Example *RST

Description For a detailed description, refer to Section 14.1, "Storing, Recalling and Initializing Set-up Information". All the set-up information except for those relating to communication are reset.

*SRE

Function Sets the value of the service request enable register/queries the current setting.

Syntax *SRE {<NRf>}
*SRE?
{<NRf>}=0 to 255

Example *SRE 239
*SRE?∅175(since the setting of bit 6 (MSS) is ignored)

Description
- <NRf> is the sum of the bits expressed as a decimal number.
- For example, if "*SRE 239" is set, the service request enable register will be set to "11101111". This means that bit 4 of the service request enable register is disabled, so that bit 4 (MAV) of the status byte register will not be set to "1", even if the output queue is not empty.
- However, bit 6 (MSS) of the status byte register is the MSS bit, so it will be ignored.
- Default is "0", i.e. all bits are disabled.
- The service request enable register will not be cleared, even if a query is made using "*SRE?".
- For details of the service request enable register, refer to page App 2-48.

*STB?

Function Queries the value of the status byte register.

Syntax *STB?

Example *STB?∅4

Description
- The sum of the bits expressed as a decimal value is returned.
- Bit 6 is MSS not RQS, since the register is read without serial polling.
- For example, if "4" is returned, the status byte register is set to "00000100", i.e. the error queue is not empty (an error has occurred).
- The status byte register will not be cleared, even if a query is made using "*STB?".
- For details of the status byte register, refer to page App 2-48.

*TRG

Function Carries out the same function as when the TRIG key (SHIFT + HOLD) is pressed.

Syntax *TRG

Description The GET (Group Execute Trigger) multi-line message also carried out the same function as this command.

*TST?

Function Executes a self-test and queries the test result. All internal memories boards are tested.

Syntax *TST?

Example *TST?∅0

Description
- "0" will be returned if the self test result is satisfactory. "1" will be returned if an abnormality is detected during the test.

*WAI

Function Waits for the command following "*WAI" until execution of the designated overlap command has been completed. This command will be ignored since overlap commands are not supported by this instrument.

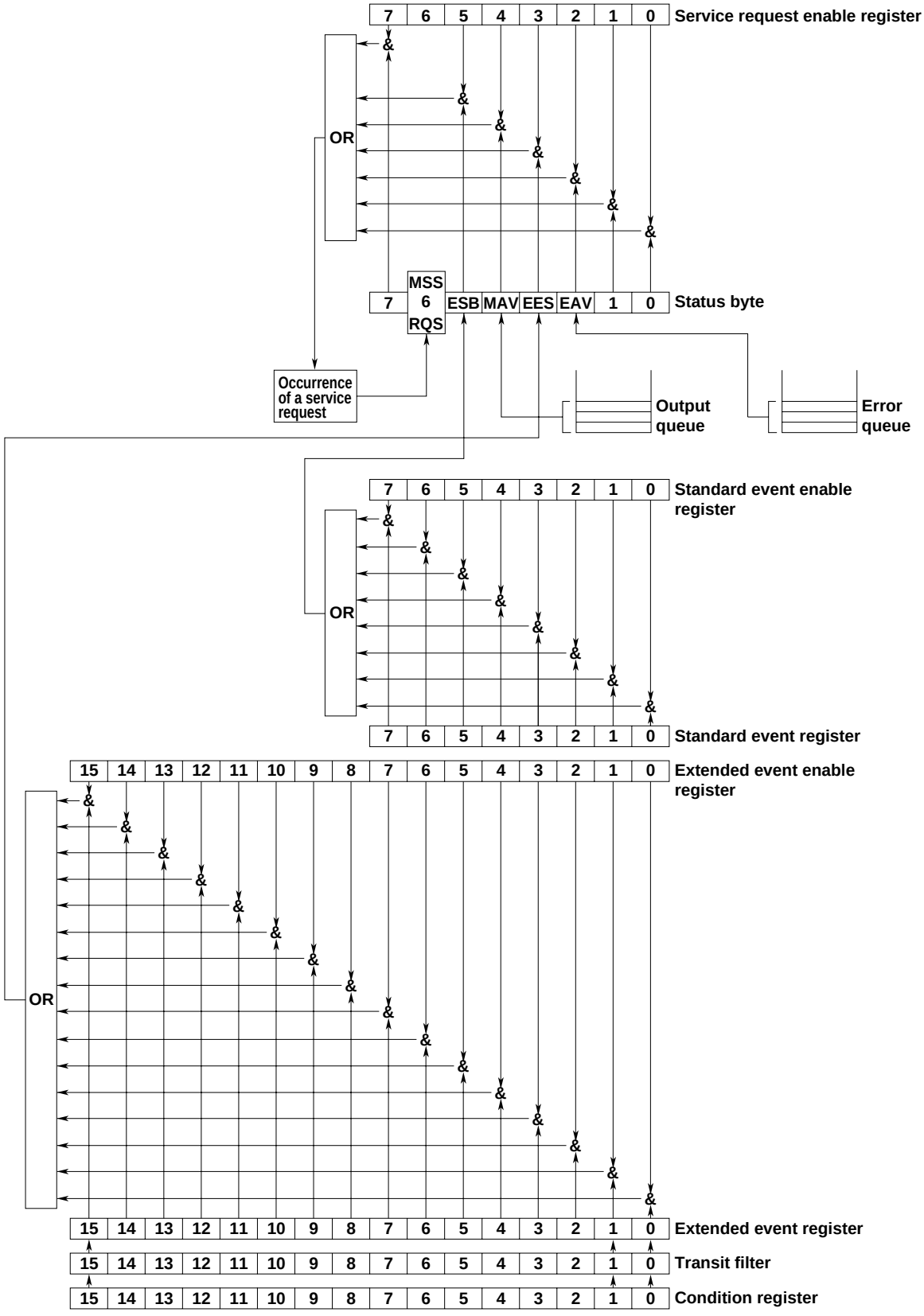
Syntax *WAI

Appendix 2.4 Status Report

2.4.1 Status Report

Overview of the Status Report

The figure below shows the status report which is read by a serial poll. This is an extended version of the one specified in IEEE 488.2-1987.



Overview of Registers and Queues

Name	Function	Writing	Reading
Status byte	—		Serial poll RQS), *STB?(MSS)
Service request enable register	Masks status byte.	*SRE	*SRE?
Standard event register	Event in the instrument	—	*ESR?
Standard event enable register	Masks standard event register.	*ESE	*ESE?
Extended event register	**Event in the instrument**	—	STATus:EESR?
Extended event enable register	Masks extended event register.	STATus:EESE	STATus:EESE?
Condition register	Current instrument status	—	STATus:CONDition?
Transit filter	Extended event occurrence register conditions	STATus:FILTer <x>	STATus:FILTer<x>?
Output queue	Stores response message to a query.	All queries	
Error queue	Stores error Nos. and messages.	—	STATus:ERRor?

Registers and Queues which Affect the Status Byte

Registers which affect each bit of the status byte are shown below

Standard event register : Sets bit 5 (ESB) of status byte to "1" or "0".

Output queue : Sets bit 4 (MAV) of status byte to "1" or "0".

Extended event register : Sets bit 3 (EES) of status byte to "1" or "0".

Error queue : Sets bit 2 (EAV) of status byte to "1" or "0".

Enable Registers

Registers which mask a bit so that the bit does not affect the status byte, even if the bit is set to "1", are shown below.

Status byte : Masks bits using the service event enable register.

Extended event register : Masks bits using the extended event enable register.

Writing/Reading from Registers

The *ESE command is used to set bits in the standard event enable register to "1" or "0", and the *ESE? query is used to check whether bits in that register are set to "1" or "0". For details of these commands, refer to Appendix 2.3.

2.4.2 Status Byte

Overview of Status Byte

- **Bits 0, 1 and 7**

  Not used (always "0")

- **Bit 2 EAV (Error Available)**

  Set to "1" when the error queue is not empty, i.e. when an error occurs. For details, refer to page App 2-39.

- **Bit 3 EES (Extended Event Summary Bit)**

  Set to "1" when a logical AND of the extended event register and the corresponding enable register is "1", i.e. when an event takes place in the instrument. Refer to page App 2-51.

- **Bit 4 MAV (Message Available)**

  Set to "1" when the output queue is not empty, i.e. when there is data which is to be output when a query is made. Refer to page App 2-52.

- **Bit 5 ESB (Event Summary Bit)**

  Set to "1" when a logical AND of the standard event register and the corresponding enable register is "1", i.e. when an event takes place in the instrument. Refer to page App 2-51.

- **Bit 6 RQS (Request Service)/MSS (Master Status Summary)**

  Set to "1" when a logical AND of the status byte (except for bit 6) and the service request enable register is not "0", i.e. when the instrument is requesting service from the controller. RQS is set to "1" when MSS changes from "0" to "1", and is cleared when a serial poll is performed or when MSS changes to "0".

Bit Masking

To mask a bit in the status byte so that it does not cause an SRQ, set the corresponding bit of the service request enable register to "0". For example, to mask bit 2 (EAV) so that no service will be requested, even if an error occurs, set bit 2 of the service request enable register to "0". This can be done using the *SRE command. To query whether each bit of the service request enable register is "1" or "0", use *SRE?. For details of the *SRE command, refer to Appendix 2.3.

Operation of the Status Byte

A service request is issued when bit 6 of the status byte becomes "1". Bit 6 becomes "1" when any of the other bits becomes "1" (or when the corresponding bit in the service request enable register becomes "1"). For example, if an event takes place and the logical OR of each bit of the standard event register and the corresponding bit in the enable register is "1", bit 5 (ESB) will be set to "1". In this case, if bit 5 of the service request enable register is "1", bit 6 (MSS) will be set to "1", thus requesting service from the controller. It is also possible to check what type of event has occurred by reading the contents of the status byte.

Reading from the Status Byte

The following two methods are provided for reading the status byte.

- **Query using the `*STB?` query**
  Making a query using the `*STB?` query sets bit 6 to MSS. This causes the MSS to be read. After completion of the read-out, none of the bits in the status byte will be cleared.
- **Serial poll**
  Execution of a serial poll changes bit 6 to RQS. This causes RQS to be read. After completion of the read-out, only RQS is cleared. Using a serial poll, it is not possible to read MSS.

Clearing the Status Byte

No method is provided for forcibly clearing all the bits in the status byte. Bits which are cleared are shown below.

- **When a query is made using the `*STB?` query**
  No bit is cleared.
- **When a serial poll is performed**
  Only the RQS bit is cleared.
- **When the `*CLS` command is received**
  When the `*CLS` command is received, the status byte itself is not cleared, but the contents of the standard event register (which affects the bits in the status byte) are cleared. As a result, the corresponding bits in the status byte are cleared, except bit 4 (MAV), since the output queue cannot be emptied by the `*CLS` command. However, the output queue will also be cleared if the `*CLS` command is received just after a program message terminator.

2.4.3 Standard Event Register

Overview of the Standard Event Register

7	6	5	4	3	2	1	0
PON	URQ	CME	EXE	DDE	QYE	RQC	OPC

- **Bit 7 PON (Power ON)**
  Set to "1" when power to the instrument is turned ON
- **Bit 6 URQ (User Request)**
  Not used (always "0")
- **Bit 5 CME (Command Error)**
  Set to "1" when the command syntax is incorrect.
  Examples: Incorrectly spelled command name
- **Bit 4 EXE (Execution Error)**
  Set to "1" when the command syntax is correct but the command cannot be executed in the current state.
  Examples: Parameters are outside the setting range.
- **Bit 3 DDE (Device Error)**
  Set to "1" when execution of the command is not possible due to an internal problem in the instrument that is not a command error or an execution error.
- **Bit 2 QYE (Query Error)**
  Set to "1" if the output queue is empty or if the data is missing even after a query has been sent.
  Examples: No response data; data is lost due to an overflow in the output queue.
- **Bit 1 RQC (Request Control)**
  Not used (always "0")
- **Bit 0 OPC (Operation Complete)**
  Set to "1" when the operation designated by the `*OPC` command has been completed.

Bit Masking

To mask a bit in the standard event register so that it does not cause bit 5 (ESB) of the status byte to change, set the corresponding bit in the standard event enable register to "0". For example, to mask bit 2 (QYE) so that ESB will not be set to "1", even if a query error occurs, set bit 2 of the standard event enable register to "0". This can be done using the `*ESE` command. To query whether each bit of the standard event enable register is "1" or "0", use the `*ESE?`. For details of the `*ESE` command, refer to Appendix 2.3.

Operation of the Standard Event Register

The standard event register is provided for eight different kinds of event which can occur inside the instrument. Bit 5 (ESB) of the status byte is set to "1" when any of the bits in this register becomes "1" (or when the corresponding bit of the standard event enable register becomes "1").

Examples

1. A query error occurs.
2. Bit 2 (QYE) is set to "1".
3. Bit 5 (ESB) of the status byte is set to "1" if bit 2 of the standard event enable register is "1"

It is also possible to check what type of event has occurred inside the instrument by reading the contents of the standard event register.

Reading from the Standard Event Register

The contents of the standard event register can be read by the `*ESR` command. After completion of the read-out, the register will be cleared.

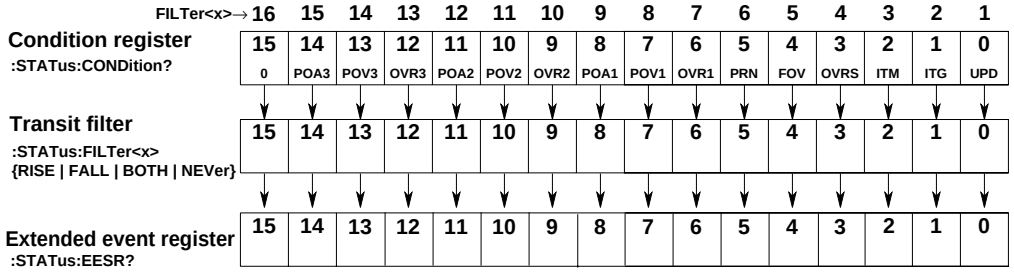
Clearing the Standard Event Register

The standard event register is cleared in the following three cases.

- When the contents of the standard event register are read using `*ESR?`
- When the `*CLS` command is received
- When power is turned ON again

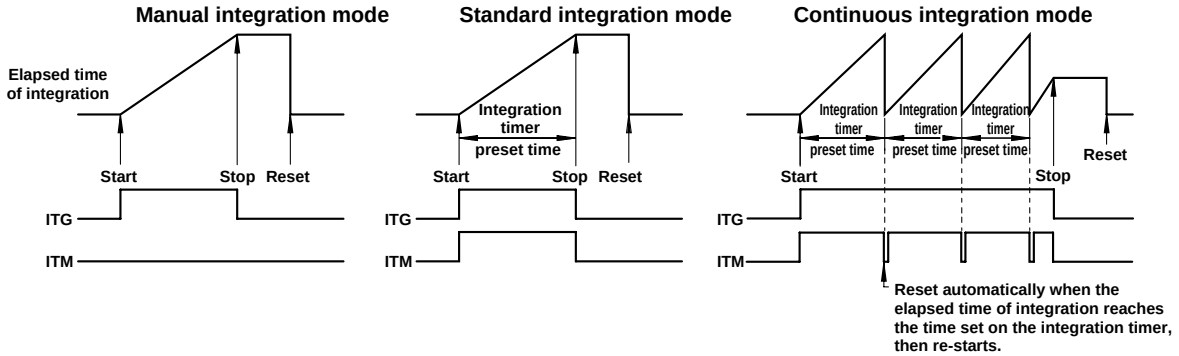
2.4.4 Extended Event Register

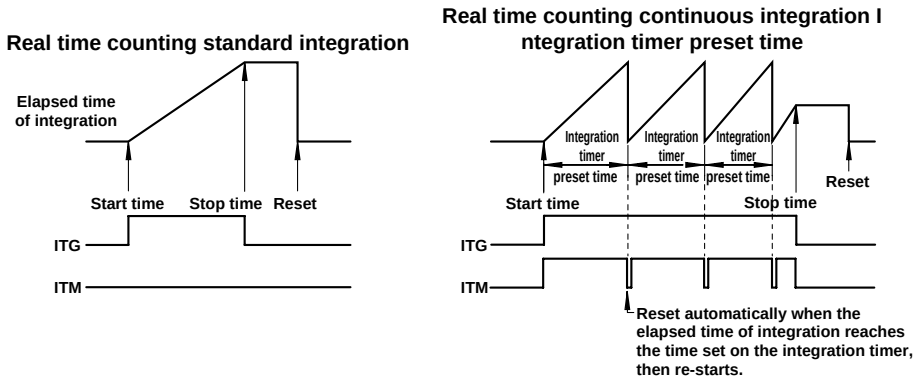
The extended event register contains the results obtained due to a change in state of the condition register (indicating the internal state of the instrument) which is detected by the transit filter.



Function of each bit of the condition register is described below.

Bit 0	UPD(Updating)	Bit 0 Set to "1" during update of measured data. UPD changes from "1" to "0" when update is complete.
Bit 1	ITG(Integrate busy)	Set to "1" during integration. (See the figure below.)
Bit 2	ITM(Integrate timer busy)	Set to "1" while integration time is in operation. (See the figure below.)
Bit 3	OVRS(Σ results overflow)	Set to "1" when an overflow occurs in measured/computed data (Σ and computation result, motor evaluation function) for which the element cannot be identified. ("--oF--" is displayed.)
Bit 4	FOV(Frequency Over)	Set to "1" when the measured frequency is outside the range. ("ErrLo", "ErrHi" or "FrqEr" is displayed.)
Bit 5	PRN(PRiNter busy)	Set to "1" while the built-in printer is in operation.
Bit 6	OVR1(Element1 mesured data over)	Set to "1" when an overflow or error occurs in measured/computed data for element 1. ("--oL--", "PFErr", "dEGEr" or "--oF--" is displayed.)
Bit 7	POV1(Element1 voltage peak over)	Set to "1" when a peak over occurs in voltage value for element 1.
Bit 8	POA1(Element1 current peak over)	Set to "1" when a peak over occurs in current value for element 1.
Bit 9	OVR2(Element2 mesured data over)	Set to "1" when an overflow or error occurs in measured/computed data for element 2. ("--oL--", "PFErr", "dEGEr" or "--oF--" is displayed.)
Bit 10	POV2(Element2 voltage peak over)	Set to "1" when a peak over occurs in voltage value for element 2.
Bit 11	POA2(Element2 current peak over)	Set to "1" when a peak over occurs in current value for element 2.
Bit 12	OVR3(Element3 mesured data over)	Set to "1" when an overflow or error occurs in measured/computed data for element 3. ("--oL--", "PFErr", "dEGEr" or "--oF--" is displayed.)
Bit 13	POV3(Element3 voltage peak over)	Set to "1" when a peak over occurs in voltage value for element 3.
Bit 14	POA3(Element3 current peak over)	Set to "1" when a peak over occurs in current value for element 3.





Parameters of the transit filter detect a change in the specified bit of the condition register, then re-write the contents of the extended event register as shown below.

RISE	Sets the specified bit of the extended event register to "1" when changes from "0" to "1".
FALL	Sets the specified bit of the extended event register to "1" when changes from "1" to "0".
BOTH	Sets the specified bit of the extended event register to "1" when changes from "0" to "1" or from "1" to "0".
NEVer	Always set to "0".

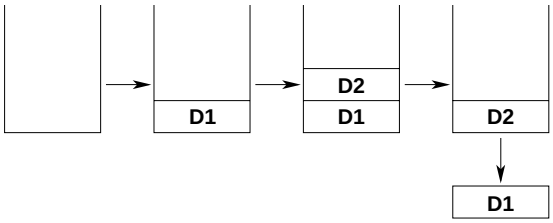
2.4.5 Output Queue and Error Queue

Overview of the Output Queue

The output queue is provided to store response messages to queries. For example, when the `MEASure[:NORMal]:VALue?` query is sent to request output of the measured data, the response data will be stored in the output queue until it is read out. The example below shows that data is stored record by record in the output queue, and is read out oldest item first, newest item last.
The output queue is emptied in the following cases (in addition to when read-out is performed).

- When a new message is received from the controller
- When dead lock occurs (page App 2-4)
- When a device clear command (DCL or SDC) is received
- When power is turned ON again

The output queue cannot be emptied using the `*CLS` command. To see whether the output queue is empty or not, check bit 4 (MAV) of the status byte.



Overview of the Error Queue

The error queue stores the error No. and message when an error occurs. For example, when the controller sends an incorrect program message, an error occurs and its error No. `113` and message `"Undefined header"` will be stored in the error queue.
The contents of the error queue can be read using the `STATus:ERRor?` query. Like the output queue, messages are read in the order oldest first, newest last. If the error queue is full, the final message will be replaced by message `350`, `"Queue overflow"`
The error queue is emptied in the following cases (in addition to when read-out is performed).

- When the `*CLS` command is received
- When power is turned ON again

To see whether the error queue is empty or not, check bit 2 (EAV) of the status byte.

Appendix 2.5 Sample Programs

Operating Environment for Sample Programs

- Computer : IBM PC/AT and compatible system with National Instruments AT-GPIB/TNT IEEE-488.2 board installed
- OS : Quick Basic version 4.0/4.5

Note

- When the message of GPIBERR or DVMERR is returned, refer to "NI-488.2 Driver Sample Programs".

Sample Programs

```
'*****************************************************************************
'*                                                                           *
'* Sample Program (1) for the WT1000 series                                  *
'*                                                                           *
'* Used to set measurement conditions/ranges for normal measurement mode, and read  *
'* and display the following data each time measured/computed data is updated.      *
'*         Voltage (V), current (A), active power (W), voltage frequency (VHz)      *
'*                                                                           *
'*****************************************************************************
'
   REM $INCLUDE: 'qbdecl.bas'

   DECLARE SUB gpiberr (msg$)
   DECLARE SUB dvmerr (msg$, SPR%)

   DIM D$(13)

   CLS
   PRINT

'   CALL IBDEV(0, 1, 0, T10s, 1, 0, dvm%)
   CALL IBFIND("DEV1", dvm%)
   IF (dvm% < 0) THEN CALL gpiberr("Ibdev Error")

' clear the device.
   CALL IBCLR(dvm%)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibclr Error")

' set measurement condition.
   WRT$ = "SAMPLE:RATE 0.5S;HOLD OFF"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "VOLTAGE:MODE RMS"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "CURRENT:MODE RMS"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "FILTER OFF"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "SCALING OFF;AVERAGING OFF"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "VOLTAGE:RANGE 150V"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "CURRENT:RANGE 5A"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "FREQUENCY:SOURCE V,1"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "MEASURE:ITEM:PRESET DEFAULT1"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "MEASURE:FORMAT ASCII"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   FOR J = 1 TO 500000: NEXT J

   WRT$ = "STATUS:FILTER1 FALL"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   FOR I = 1 TO 10
        WRT$ = "STATUS:EESR?"
        CALL IBWRT(dvm%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

        WRT$ = "COMMUNICATE:WAIT 1"
        CALL IBWRT(dvm%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

        WRT$ = "MEASURE:VALUE?"
        CALL IBWRT(dvm%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

      'read measurement data.
         RD$ = SPACE$(512)
         CALL IBRD(dvm%, RD$)
         IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd Error")

        C$ = RD$
        FOR K = 0 TO 12
                L = INSTR(C$, " ")
                B = INSTR(C$, ",")
                IF B = 0 THEN B = INSTR(C$, " ")
                D$(K) = LEFT$(C$, (B - 1))
                C$ = MID$(C$, (B + 1), L)
        NEXT K
        PRINT "ELEMENT1: ", D$(0), D$(1), D$(2)
        PRINT "ELEMENT2: ", D$(3), D$(4), D$(5)
        PRINT "ELEMENT3: ", D$(6), D$(7), D$(8)
        PRINT "SUM     : ", D$(9), D$(10), D$(11)
        PRINT "Frquency: ", D$(12)
   NEXT I

'  Call the IBONL function to disable the hardware and software.
   CALL IBONL(dvm%, 0)

END
```

```
“
  '*****************************************************************************
  '*                                                                           *
  '* Sample Program (2) for the WT1000 series                                  *
  '*                                                                           *
  '* Used to carry out integration in standard integration mode, and read      *
  '* and display the following data each time measured/computed data is updated.*
  '*         Active power (W), watt-hour (Wh, Wh+, Wh-), ampere-hour (Ah, Ah+, Ah-),  *
  '*         elapsed time of integration (IMTEG-TIME)                          *
  '*                                                                           *
  '*****************************************************************************
  '
     REM $INCLUDE: 'qbdecl.bas'

     DECLARE SUB gpiberr (msg$)
     DECLARE SUB dvmerr (msg$, SPR%)

     DIM D$(28)

     CLS
     PRINT

     CALL IBDEV(0, 1, 0, T10s, 1, 0, dvm%)
     IF (dvm% < 0) THEN CALL gpiberr("Ibdev Error")

  ' clear the device.
     CALL IBCLR(dvm%)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibclr Error")

  ' set measurement condition.
     WRT$ = "SAMPLE:RATE 0.5S;HOLD OFF"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "VOLTAGE:MODE RMS"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "CURRENT:MODE RMS"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "FILTER OFF"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "SCALING OFF;AVERAGING OFF"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "VOLTAGE:RANGE 150V"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "CURRENT:RANGE 5A"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "INTEGRATE:MODE NORMAL"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "INTEGRATE:TIMER 1,0"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "MEASURE:ITEM:PRESET DEFAULT2"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "MEASURE:ITEM:FREQUENCY OFF;AH OFF;AHP OFF;AHM OFF"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "MEASURE:FORMAT ASCII"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     'wait
     FOR I = 1 TO 500000: NEXT I

     WRT$ = "STATUS:FILTER1 FALL"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "STATUS:FILTER2 FALL"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "STATUS:EESR?"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     RD$ = SPACE$(10)
     CALL IBRD(dvm%, RD$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd Error")

     WRT$ = "INTEGRATE:START"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")
     FLAG = 0
  RDDAT:
     WRT$ = "COMMUNICATE:WAIT 3"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "STATUS:EESR?"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     RD$ = SPACE$(10)
     CALL IBRD(dvm%, RD$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd Error")

     IF (VAL(RD$) AND &H2) <> 0 THEN FLAG = 1

     WRT$ = "MEASURE:VALUE?"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     RD$ = SPACE$(512)
     CALL IBRD(dvm%, RD$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd Error")

     C$ = LEFT$(RD$, IBCNT%)
     FOR K = 0 TO 27
          L = LEN(C$)
          B = INSTR(C$, ",")
          IF B = 0 THEN B = L + 1
          D$(K) = LEFT$(C$, (B - 1))
          C$ = MID$(C$, (B + 1), L)
     NEXT K
     PRINT "Itg Time: ", D$(1) + ":" + D$(2) + ":" + D$(3)
     PRINT "ELEMENT1: ", D$(0), D$(4), D$(5), D$(6)
     PRINT "ELEMENT2: ", D$(7), D$(11), D$(12), D$(13)
     PRINT "ELEMENT3: ", D$(14), D$(18), D$(19), D$(20)
     PRINT "SUM     : ", D$(21), D$(25), D$(26), D$(27)
     PRINT

     IF FLAG <> 1 THEN GOTO RDDAT

  '  Call the IBONL function to disable the hardware and software.
     CALL IBONL(dvm%, 0)

  END
```

```
“
  '*****************************************************************************
  '*                                                                           *
  '* Sample Program (3) for the WT1000 series                                  *
  '*                                                                           *
  '* Used to read and display the following data in harmonic analysis mode.    *
  '* Total rms value of each harmonic from 1st to 50th of current.             *
  '* analysis value of fundamental (1st) of current, analysis value of each harmonic *
  '* (2nd to 50th), harmonic distortion of current, PLL source (voltage) frequency *
  '*                                                                           *
  '*****************************************************************************
  '
     REM $INCLUDE: 'qbdecl.bas'

     DIM D$(52)

     DECLARE SUB gpiberr (msg$)
     DECLARE SUB dvmerr (msg$, SPR%)

     CLS
     PRINT

     CALL IBDEV(0, 1, 0, T10s, 1, 0, dvm%)
     IF (dvm% < 0) THEN CALL gpiberr("Ibdev Error")

  ' clear the device.
     CALL IBCLR(dvm%)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibclr Error")

  ' set measurement condition.
     WRT$ = "HARMONICS:SYNCHRONIZE V,1"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "HARMONICS:FILTER OFF"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "HARMONICS:THD IEC"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "HARMONICS:ORDER 50"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "HARMONICS ON"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     FOR I = 1 TO 1000000: NEXT I

     WRT$ = "MEASURE:ITEM:HARMONICS:PRESET CLEAR"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "MEASURE:ITEM:HARMONICS:A:ELEMENT1 ON"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "MEASURE:ITEM:HARMONICS:ATHD:ELEMENT1 ON"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "MEASURE:ITEM:HARMONICS:SYNCHRONIZE ON"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "MEASURE:FORMAT ASCII"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "SAMPLE:HOLD ON"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     WRT$ = "MEASURE:VALUE?"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

     'read measurement data.
     RD$ = SPACE$(1024)
     CALL IBRD(dvm%, RD$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd Error")

     C$ = LEFT$(RD$, IBCNT%)
     FOR J = 0 TO 52
          L = LEN(C$)
          B = INSTR(C$, ",")
          IF B = 0 THEN B = L + 1
          D$(J) = LEFT$(C$, (B - 1))
          C$ = MID$(C$, (B + 1), L)
     NEXT J

     PRINT "TOTAL    : ", D$(0)
     PRINT "FREQUENCY: ", D$(52)
     PRINT " 1:", D$(1), "   2:", D$(2)
     PRINT " 3:", D$(3), "   4:", D$(4)
     PRINT " 5:", D$(5), "   6:", D$(6)
     PRINT " 7:", D$(7), "   8:", D$(8)
     PRINT " 9:", D$(9), "  10:", D$(10)
     PRINT "11:", D$(11), "  12:", D$(12)
     PRINT "13:", D$(13), "  14:", D$(14)
     PRINT "15:", D$(15), "  16:", D$(16)
     PRINT "17:", D$(17), "  18:", D$(18)
     PRINT "19:", D$(19), "  20:", D$(20)
     PRINT "21:", D$(21), "  22:", D$(22)
     PRINT "23:", D$(23), "  24:", D$(24)
     PRINT "25:", D$(25), "  26:", D$(26)
     PRINT "27:", D$(27), "  28:", D$(28)
     PRINT "29:", D$(29), "  30:", D$(30)
     PRINT "31:", D$(31), "  32:", D$(32)
     PRINT "33:", D$(33), "  34:", D$(34)
     PRINT "35:", D$(35), "  36:", D$(36)
     PRINT "37:", D$(37), "  38:", D$(38)
     PRINT "39:", D$(39), "  40:", D$(40)
     PRINT "41:", D$(41), "  42:", D$(42)
     PRINT "43:", D$(43), "  44:", D$(44)
     PRINT "45:", D$(45), "  46:", D$(46)
     PRINT "47:", D$(47), "  48:", D$(48)
     PRINT "49:", D$(49), "  50:", D$(50)
     PRINT "THD:", D$(51)

     WRT$ = "SAMPLE:HOLD OFF"
     CALL IBWRT(dvm%, WRT$)
     IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

  '  Call the IBONL function to disable the hardware and software.
     CALL IBONL(dvm%, 0)

  END
```

```
'*****************************************************************************
'*                                                                           *
'* Sample Program (4) for the WT1000 series                                  *
'*                                                                           *
'* Used to set measurement conditions/ranges for normal measurement mode, and read    *
'* and display the following data each time measured/computed data is updated.        *
'* Binary data: voltage (V), current (A), active power (W), voltage frequency (VHz)   *
'*                                                                           *
'*****************************************************************************
'
   REM  $INCLUDE: 'qbdecl.bas'

   DECLARE SUB gpiberr (msg$)
   DECLARE SUB dvmerr (msg$, SPR%)

   DIM DT(13)

   CLS
   PRINT

   CALL IBDEV(0, 1, 0, T10s, 1, 0, dvm%)
   IF (dvm% < 0) THEN CALL gpiberr("Ibdev Error")

' clear the device.
   CALL IBCLR(dvm%)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibclr Error")

' set measurement condition.
   WRT$ = "SAMPLE:RATE 0.5S;HOLD OFF"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "VOLTAGE:MODE RMS"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "CURRENT:MODE RMS"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "FILTER OFF"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "SCALING OFF;AVERAGING OFF"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "VOLTAGE:RANGE 150V"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "CURRENT:RANGE 5A"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "FREQUENCY:SOURCE V,1"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "MEASURE:ITEM:PRESET DEFAULT1"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   WRT$ = "MEASURE:FORMAT BINARY"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   FOR I = 1 TO 500000: NEXT I

   WRT$ = "STATUS:FILTER1 FALL"
   CALL IBWRT(dvm%, WRT$)
   IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

   FOR I% = 1 TO 10
        WRT$ = "STATUS:EESR?"
        CALL IBWRT(dvm%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

        RD$ = SPACE$(10)
        CALL IBRD(dvm%, RD$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd Error")

        WRT$ = "COMMUNICATE:WAIT 1"
        CALL IBWRT(dvm%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

        WRT$ = "MEASURE:VALUE?"
        CALL IBWRT(dvm%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt Error")

      'read measurement data.
         RD$ = SPACE$(512)
         CALL IBRD(dvm%, RD$)
         IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd Error")

        N = 0
        FOR J = 7 TO 58 STEP 4
               P$ = MID$(RD$, J + 3, 1): SP = CVI(P$ + CHR$(0))
               Q$ = MID$(RD$, J + 2, 1): SQ = CVI(Q$ + CHR$(0))
               R$ = MID$(RD$, J + 1, 1): SR = CVI(R$ + CHR$(0))
               T$ = MID$(RD$, J + 0, 1): SS = CVI(T$ + CHR$(0))
               T$ = RIGHT$("0" + HEX$(SS), 2) + RIGHT$("0" + HEX$(SR), 2) + R
IGHT$("0" + HEX$(SQ), 2) + RIGHT$("0" + HEX$(SP), 2)
               FOR K = 1 TO 8
                      A$(K) = MID$(T$, K, 1)
                      IF A$(K) = "0" THEN b$(K) = "0000"
                      IF A$(K) = "1" THEN b$(K) = "0001"
                      IF A$(K) = "2" THEN b$(K) = "0010"
                      IF A$(K) = "3" THEN b$(K) = "0011"
                      IF A$(K) = "4" THEN b$(K) = "0100"
                      IF A$(K) = "5" THEN b$(K) = "0101"
                      IF A$(K) = "6" THEN b$(K) = "0110"
                      IF A$(K) = "7" THEN b$(K) = "0111"
                      IF A$(K) = "8" THEN b$(K) = "1000"
                      IF A$(K) = "9" THEN b$(K) = "1001"
                      IF A$(K) = "A" THEN b$(K) = "1010"
                      IF A$(K) = "B" THEN b$(K) = "1011"
                      IF A$(K) = "C" THEN b$(K) = "1100"
                      IF A$(K) = "D" THEN b$(K) = "1101"
                      IF A$(K) = "E" THEN b$(K) = "1110"
                      IF A$(K) = "F" THEN b$(K) = "1111"
               NEXT K
               b$ = b$(1) + b$(2) + b$(3) + b$(4) + b$(5) + b$(6) + b$(7) + b$(8)
               U = 0: E = 0: F = 0
               U = VAL(LEFT$(b$, 1))
               E$ = MID$(b$, 2, 8)
               FOR L = 0 TO 7
                      E = E + (2 ^ L) * VAL(MID$(E$, (8 - L), 1))
               NEXT L
               W$ = MID$(b$, 10, 23)
               FOR M = 1 TO 23
                      F = F + (2 ^ (-M)) * VAL(MID$(W$, M, 1))
               NEXT M
               F = F + 1
               DT(N) = ((-1) ^ U) * (2 ^ (E - 127)) * F
               IF DT(N) < 1E-12 THEN DT(N) = 0
               N = N + 1
```

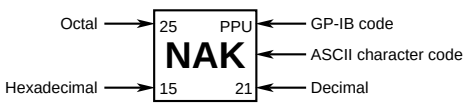
```
        NEXT J

        PRINT "MEASURE DATA"
        PRINT "ELEMENT1 : ", DT(0), DT(1), DT(2)
        PRINT "ELEMENT2 : ", DT(3), DT(4), DT(5)
        PRINT "ELEMENT3 : ", DT(6), DT(7), DT(8)
        PRINT "SUM      : ", DT(9), DT(10), DT(11)
        PRINT "FREQUENCY: ", DT(12)

    NEXT I%

'   Call the IBONL function to disable the hardware and software.
    CALL IBONL(dvm%, 0)

END
```

Appendix 2.6 ASCII Character Code

ASCII character codes are given below.

	0	1	2	3	4	5	6	7
0	0 **NUL** 0 0	20 **DEL** 10 16	40 0 **SP** 20 32	60 16 **0** 30 48	100 0 **@** 40 64	120 16 **P** 50 80	140 0 **‘** 60 96	160 16 **p** 70 112
1	1 GTL **SOH** 1 1	21 LLO **DC1** 11 17	41 1 **!** 21 33	61 17 **1** 31 49	101 1 **A** 41 65	121 17 **Q** 51 81	141 1 **a** 61 97	161 17 **q** 71 113
2	2 **STX** 2 2	22 **DC2** 12 18	42 2 **”** 22 34	62 18 **2** 32 50	102 2 **B** 42 66	122 18 **R** 52 82	142 2 **b** 62 98	162 18 **r** 72 114
3	3 **ETX** 3 3	23 **DC3** 13 19	43 3 **#** 23 35	63 19 **3** 33 51	103 3 **C** 43 67	123 19 **S** 53 83	143 3 **c** 63 99	163 19 **s** 73 115
4	4 SDC **EOT** 4 4	24 DCL **DC4** 14 20	44 4 **$** 24 36	64 20 **4** 34 52	104 4 **D** 44 68	124 20 **T** 54 84	144 4 **d** 64 100	164 20 **t** 74 116
5	5 PPC **ENQ** 5 5	25 PPU **NAK** 15 21	45 5 **%** 25 37	65 21 **5** 35 53	105 5 **E** 45 69	125 21 **U** 55 85	145 5 **e** 65 101	165 21 **u** 75 117
6	6 **ACK** 6 6	26 **SYN** 16 22	46 6 **&** 26 38	66 22 **6** 36 54	106 6 **F** 46 70	126 22 **V** 56 86	146 6 **f** 66 102	166 22 **v** 76 118
7	7 **BEL** 7 7	27 **ETB** 17 23	47 7 **’** 27 39	67 23 **7** 37 55	107 7 **G** 47 71	127 23 **W** 57 87	147 7 **g** 67 103	167 23 **w** 77 119
8	10 GET **BS** 8 8	30 SPE **CAN** 18 24	50 8 **(** 28 40	70 24 **8** 38 56	110 8 **H** 48 72	130 24 **X** 58 88	150 8 **h** 68 104	170 24 **x** 78 120
9	11 TCT **HT** 9 9	31 SPD **EM** 19 25	51 9 **)** 29 41	71 25 **9** 39 57	111 9 **I** 49 73	131 25 **Y** 59 89	151 9 **i** 69 105	171 25 **y** 79 121
A	12 **LF** A 10	32 **SUB** 1A 26	52 10 ***** 2A 42	72 26 **:** 3A 58	112 10 **J** 4A 74	132 26 **Z** 5A 90	152 10 **j** 6A 106	172 26 **z** 7A 122
B	13 **VT** B 11	33 **ESC** 1B 27	53 11 **+** 2B 43	73 27 **;** 3B 59	113 11 **K** 4B 75	133 27 **[** 5B 91	153 11 **k** 6B 107	173 27 **{** 7B 123
C	14 **FF** C 12	34 **FS** 1C 28	54 12 **,** 2C 44	74 28 **<** 3C 60	114 12 **L** 4C 76	134 28 **** 5C 92	154 12 **l** 6C 108	174 28 **|** 7C 124
D	15 **CR** D 13	35 **GS** 1D 29	55 13 **-** 2D 45	75 29 **=** 3D 61	115 13 **M** 4D 77	135 29 **]** 5D 93	155 13 **m** 6D 109	175 29 **}** 7D 125
E	16 **SO** E 14	36 **RS** 1E 30	56 14 **.** 2E 46	76 30 **>** 3E 62	116 14 **N** 4E 78	136 30 **^** 5E 94	156 14 **n** 6E 110	176 30 **~** 7E 126
F	17 **SI** F 15	37 **US** 1F 31	57 15 **/** 2F 47	77 UNL **?** 3F 63	117 15 **O** 4F 79	137 UNT **_** 5F 95	157 15 **o** 6F 111	177 **DEL (RUBOUT)** 7F 127
	Address Command	Universal Command	Listener Address		Talker Address		Second Command	

Example



Appendix 2.7 Communication Error Messages

Error messages related to the 488.2 communication mode are given below.

- When servicing is required, contact your nearest YOKOGAWA representative, listed on the back cover of this manual.
- The following error messages are displayed when a communication command is received in 488.2 communication mode. For a description of errors which occur in a mode other than the 488.2 communication mode or occur when a panel key is pressed, refer to Section 16.2, "Error Codes and Corrective Actions".

Errors in communication command (100 to 199)

Error in communication command

Code	Message	Action Reference	Page
102	Syntax error	Incorrect syntax	Appendix 2.2, Appendix 2.3
103	Invalid separator	Insert a comma between data items to separate them.	App 2-3
104	Data type error	Refer to pages App 2-6 to 2-7 and enter using the correct data format.	App 2-6, App 2-7
105	GET not allowed	GET is not supported as a response . to an interface message	—
108	Parameter not allowed	Check the number of parameters.	App 2-6, Appendix 2.3
109	Missing parameter	Enter required parameters.	App 2-6, Appendix 2.3
111	Header separator error	Insert a space between the header and the data to separate them.	App 2-3
112	Program mnemonic too long	Check the mnemonic (a character string consisting of letters and numbers).	Appendix 2.3
113	Undefined header	Check the header.	Appendix 2.3
114	Header suffix out of range	Check the header.	Appendix 2.3
120	Numeric data error	Numeric value must be preceded by a mantissa for <NRf> format.	App 2-6
123	Exponent too large	Use a smaller exponent for <NR3> format.	App 2-6, Appendix 2.3
124	Too many digits	Limit the number of digits to 255 or less.	App 2-6, Appendix 2.3
128	Numeric data not allowed	Enter in a format other than <NRf> format.	App 2-6, Appendix 2.3
131	Invalid suffix	Check the unit for <Voltage> and <Current>.	App 2-7
134	Suffix too long	Check the unit for <Voltage> and <Current>.	App 2-7
138	Suffix not allowed	No units are allowed other than <Voltage> and <Current>.	App 2-7
141	Invalid character data	Enter one of the character strings in {...|...|...}.	Appendix 2.3
144	Character data too long	Check the spelling of the character strings in {...|...|...}.	Appendix 2.3
148	Character data not allowed	Enter in a format other than in {...|...|...}.	Appendix 2.3
150	String data error	<Character string> must be enclosed by double quotation marks or single quotation marks.	App 2-7
151	Invalid string data	<Character string> is too long or contains characters which cannot be used.	Appendix 2.3

Code	Message	Action Reference	Page
158	String data not allowed	Enter in a data format other than <Character string>.	Appendix 2.3
161	Invalid block data	<Block data> is not allowed.	—
168	Block data not allowed	<Block data> is not allowed.	—
171	Invalid expression	Equation is not allowed.	Appendix 2.3
178	Expression data not allowed	Equation is not allowed.	Appendix 2.3
181	Invalid outside macro definition	Does not conform to the macro function specified in IEEE488.2	—

Error in communications execution (200 to 299)

Error in communication execution

Code	Message	Action Reference	Page
221	Setting conflict	Check the relevant setting.	Appendix 2.3
222	Data out of range	Check the setting range.	Appendix 2.3
223	Too much data	Check the data byte length.	Appendix 2.3
224	Illegal parameter value	Check the setting range.	Appendix 2.3
241	Hardware missing	Check availability of options.	—
260	Expression error	Equation is not allowed.	—
270	Macro error	Does not conform to the macro function specified in IEEE488.2	—
272	Macro execution error	Does not conform to the macro function specified in IEEE488.2	—
273	Illegal macro label	Does not conform to the macro function specified in IEEE488.2	—
275	Macro definition too long	Does not conform to the macro function specified in IEEE488.2	—
276	Macro recursion error	Does not conform to the macro function specified in IEEE488.2	—
277	Macro redefinition not allowed	Does not conform to the macro function specified in IEEE488.2	—
278	Macro header not found	Does not conform to the macro function specified in IEEE488.2	—

Error in communications query (400 to 499)

Error in communication Query

Code	Message	Action Reference	Page
410	Query INTERRUPTED	Check transmission/reception order.	App 2-3
420	Query UNTERMINATED	Check transmission/reception order.	App 2-3
430	Query DEADLOCKED	Limit the length of the program message including <PMT> to 1024 bytes or less.	App 2-4
440	Query UNTERMINATED after indefinite response	Do not enter any query after `*IDN?` and `*OPT?`.	—

Error in Execution (800 to 899)

Error in Execution

Code	Message	Action Reference	Page
813 to 819	Invalid operation	For the lower 2 digits of the error code, refer to Section 16.2, "Error Codes and Corrective Actions".	—
830	Internal memory access error	For the lower 2 digits of the error code, refer to Section 16.2, "Error Codes and Corrective Actions".	—
841 to 848	Integrator execute error	For the lower 2 digits of the error code, refer to Section 16.2, "Error Codes and Corrective Actions".	—

Error in System Operation (912)

Error in System Operation

Code	Message	Action Reference	Page
912	Fatal error in Communication-driver	Servicing is required.	—

Other errors (350, 390)

Code	Message	Action Reference	Page
350	Queue overflow	Queue overflow Read the error queue.	App 2-52
390	Overrun error (RS-232-C only)	Reduce the baud rate.	15-12

Note

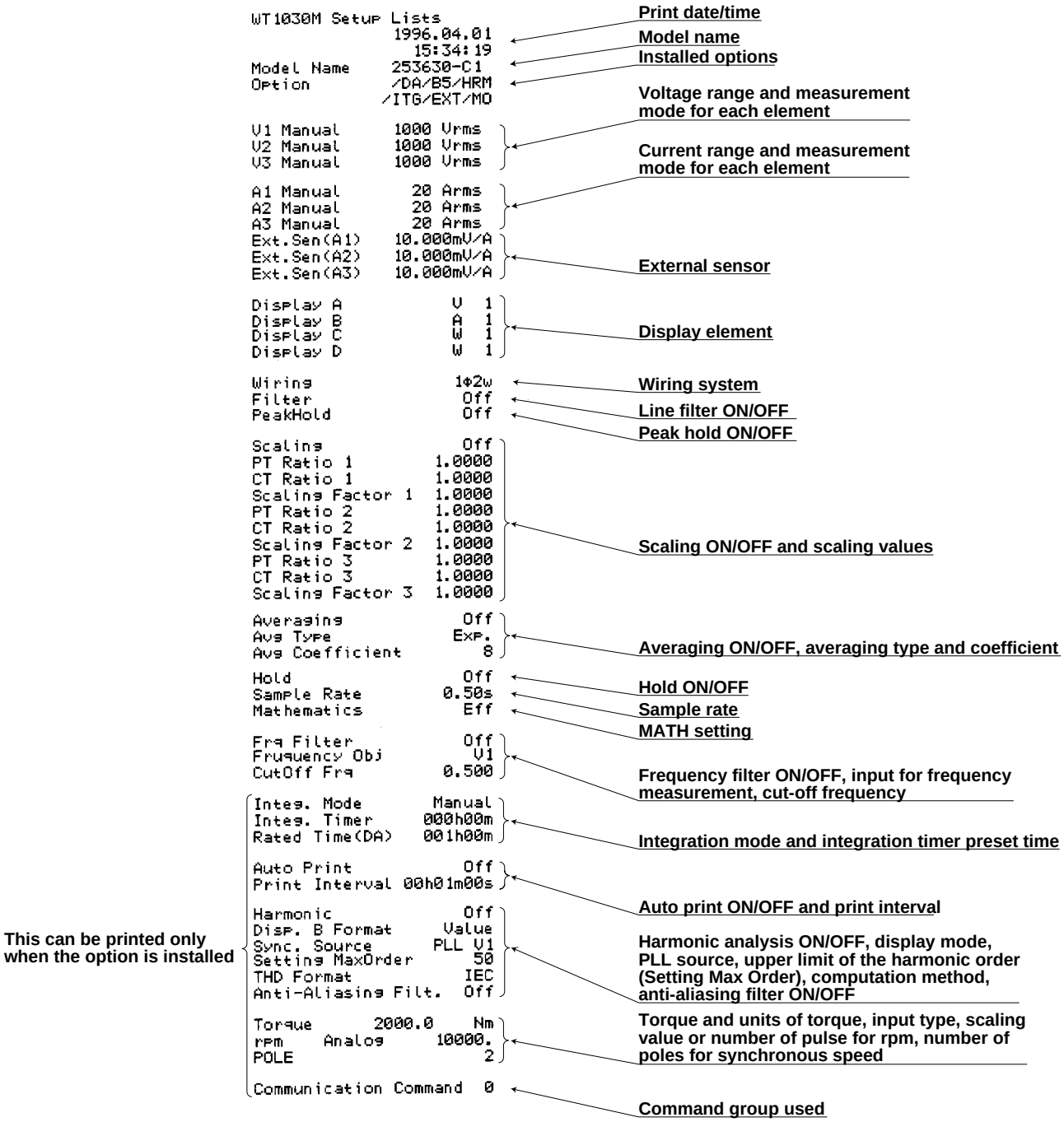
- Code 350 occurs when the error queue is full up. This message is output only for the `STATus:ERRor?` query and is not displayed on the screen.

Appendix 3 Print Examples

The print examples given below may differ from the actual print outputs.

Panel Set-up Information

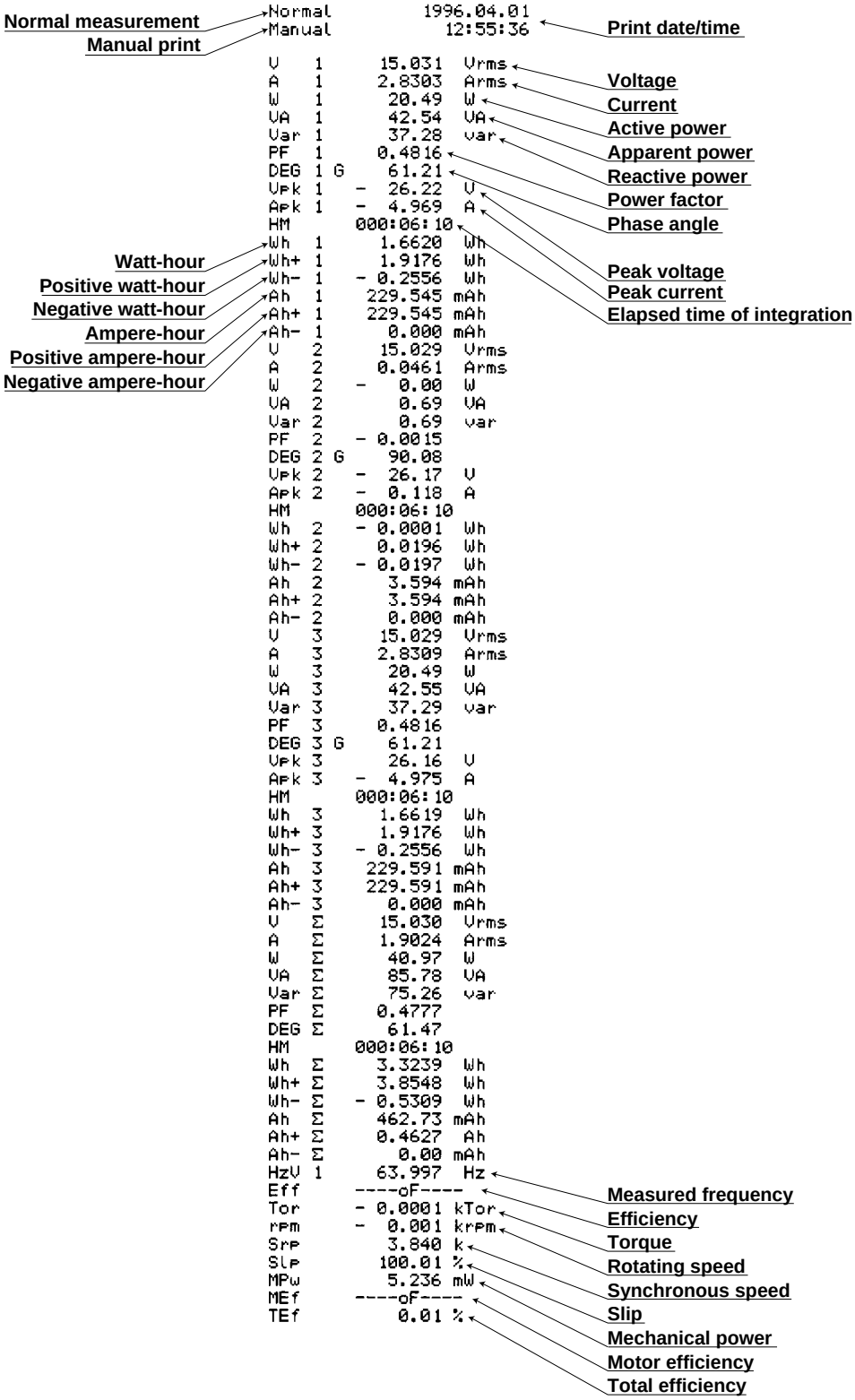
The following example shows the default settings (factory settings).



This can be printed only when the option is installed

Output Items for Normal Measurement

The following example shows output items when "ALL" is selected for the built-in printer output type. The number to the right of each output item indicates the element no.

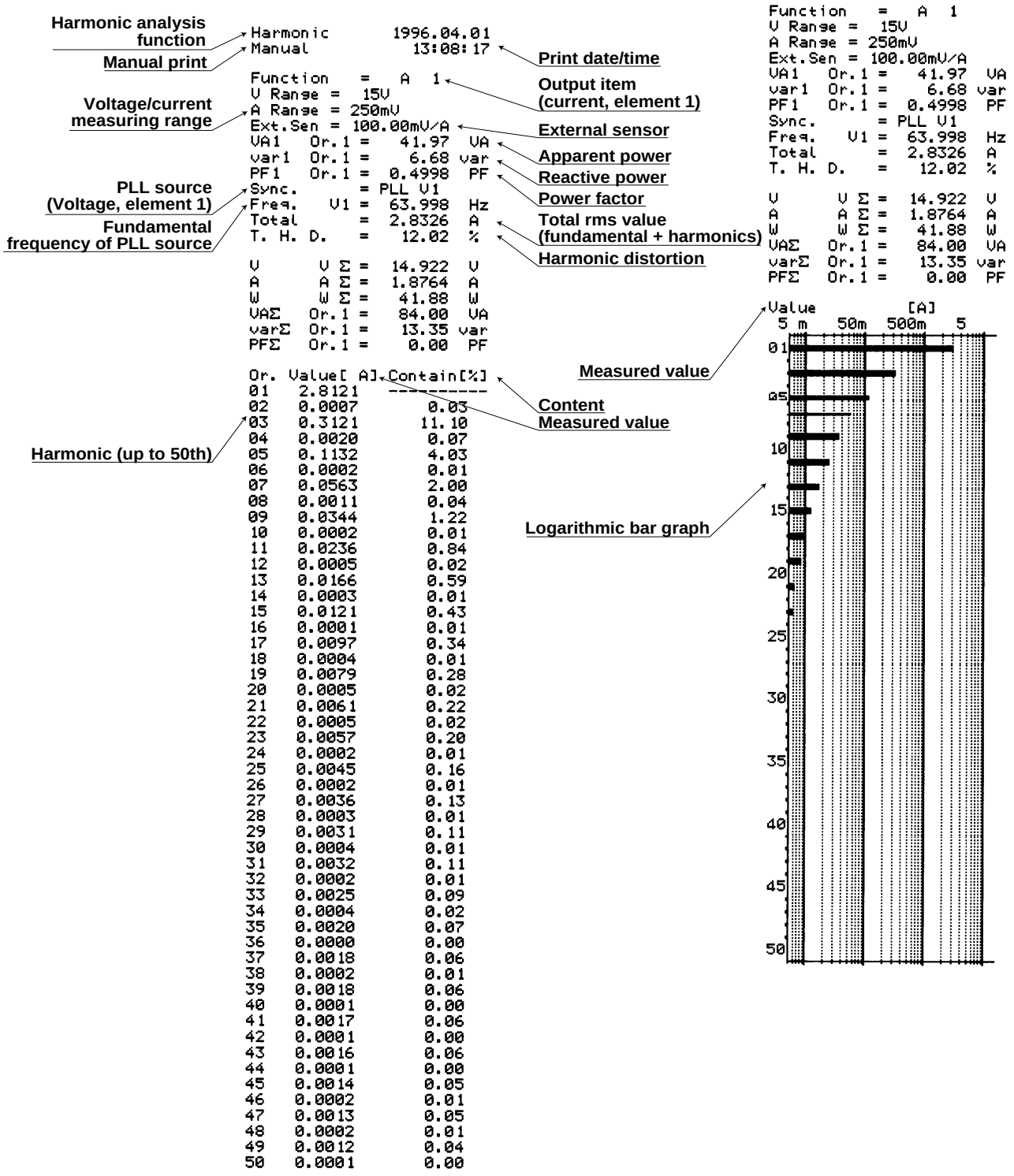



```
Normal          1996.04.01
Manual            12:55:36
V    1     15.031  Vrms
A    1     2.8303  Arms
W    1      20.49  W
VA   1      42.54  VA
Var  1      37.28  var
PF   1     0.4816
DEG  1 G     61.21
Vpk  1   -  26.22  V
Apk  1   -  4.969  A
HM       000:06:10
Wh   1      1.6620  Wh
Wh+  1      1.9176  Wh
Wh-  1   - 0.2556  Wh
Ah   1    229.545 mAh
Ah+  1    229.545 mAh
Ah-  1      0.000 mAh
V    2     15.029  Vrms
A    2     0.0461  Arms
W    2   -   0.00  W
VA   2       0.69  VA
Var  2       0.69  var
PF   2   - 0.0015
DEG  2 G     90.08
Vpk  2   -  26.17  V
Apk  2   -  0.118  A
HM       000:06:10
Wh   2   - 0.0001  Wh
Wh+  2     0.0196  Wh
Wh-  2   - 0.0197  Wh
Ah   2      3.594 mAh
Ah+  2      3.594 mAh
Ah-  2      0.000 mAh
V    3     15.029  Vrms
A    3     2.8309  Arms
W    3      20.49  W
VA   3      42.55  VA
Var  3      37.29  var
PF   3     0.4816
DEG  3 G     61.21
Vpk  3      26.16  V
Apk  3   -  4.975  A
HM       000:06:10
Wh   3      1.6619  Wh
Wh+  3      1.9176  Wh
Wh-  3   - 0.2556  Wh
Ah   3    229.591 mAh
Ah+  3    229.591 mAh
Ah-  3      0.000 mAh
V    Σ     15.030  Vrms
A    Σ     1.9024  Arms
W    Σ      40.97  W
VA   Σ      85.78  VA
Var  Σ      75.26  var
PF   Σ     0.4777
DEG  Σ      61.47
HM       000:06:10
Wh   Σ      3.3239  Wh
Wh+  Σ      3.8548  Wh
Wh-  Σ   - 0.5309  Wh
Ah   Σ     462.73 mAh
Ah+  Σ     0.4627  Ah
Ah-  Σ       0.00 mAh
HzV  1     63.997  Hz
Eff      ----oF----
Tor      - 0.0001 kTor
rpm      -  0.001 krpm
Srp         3.840 k
Slp       100.01 %
MPw         5.236 mW
MEf      ----oF----
TEf          0.01 %
```

Print Examples for Harmonic Analysis

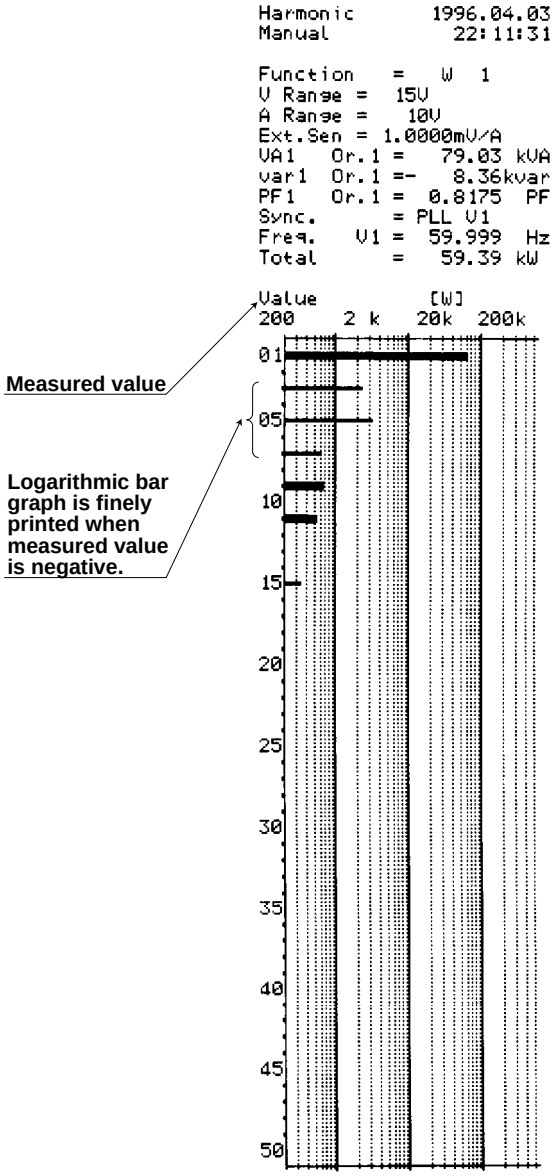
Output item: A(current)
Element 1
(Measured current and distortion are printed in numeric.)

Output item: G - A (current in graph)
Element 1
(Measured current is printed in graph.)



Output item: Σ - P (active power in graph)

Element 1 (Measured active power is printed in graph.)

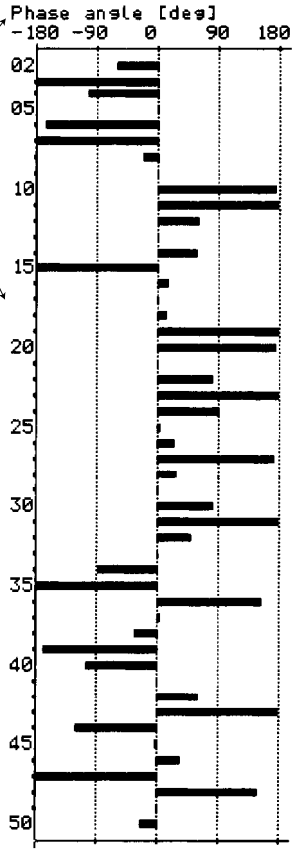


Output item: DEG (phase angle)
Element 1 (Phase angle is printed in numeric.)

Output item: G-Yd (phase angle of voltage)
Element 1 (Phase angle is printed in graph.)

```
Harmonic        1996.04.01
Manual            13:12:13

Function    =    DEG1
V Range =   15V
A Range = 250mV
Ext.Sen = 100.00mV/A
VA1    Or.1 =    41.91  VA
var1   Or.1 =     6.66 var
PF1    Or.1 =   0.5004  PF
deg1   Or.1 =     0.00 deg
Sync.       = PLL V1
Freq.    V1 =  63.990  Hz
Fundamental=G  59.97 deg

V       V Σ =   14.922  V
A       A Σ =   1.8735  A
W       W Σ =    41.99  W
VAΣ    Or.1 =    83.87  VA
varΣ   Or.1 =    13.33 var
PFΣ    Or.1 =     0.00  PF

Or.   V [deg]     A [deg]
02 -   61.99    - 160.24
03 -  179.99      179.76
04 -  103.81      125.94
05      0.02        0.28
06 -  165.95    - 110.47
07 -  179.88      179.77
08 -   21.12       58.27
09      0.04        0.74
10    175.69    - 127.09
11    179.85    - 179.14
12     62.70    - 147.45
13      0.46    -   0.52
14     59.98    - 130.56
15 -  179.56      178.88
16     17.82       51.86
17 -    0.26    -   1.05
18     14.73    - 148.97
19    178.54    - 179.42
20    176.48      19.99
21      1.00        0.25
22     81.07    - 121.06
23    179.45    - 175.66
24     90.28    - 157.99
25      4.08    -   0.51
26     26.40    - 163.80
27    172.60    - 173.70
28     28.19    -   8.59
29      1.01    -   1.43
30     81.98    -  10.21
31    179.85      177.34
32     49.07       65.38
33      0.29    -   4.51
34 -   88.11    -  69.95
35 -  178.89    - 177.62
36    153.45      19.24
37      4.57        0.50
38 -   35.30    -  19.95
39 -  169.46      168.74
40 -  105.90       98.93
41      0.73    -   2.33
42     61.06       30.75
43    179.21    - 178.57
44 -  121.66      123.47
45 -    3.93        0.91
46     34.80      176.36
47 -  179.79      170.83
48    147.23    -  94.53
49      0.38    -   1.53
50 -   25.51       24.32
```

```
Function    = V deg1
V Range =   15V
A Range = 250mV
Ext.Sen = 100.00mV/A
VA1    Or.1 =    41.91  VA
var1   Or.1 =     6.66 var
PF1    Or.1 =   0.5004  PF
deg    Or.1 =     0.00 deg
Sync.       = PLL V1
Freq.    V1 =  63.990  Hz
Fundamental=G  59.97 deg

V       V Σ =   14.922  V
A       A Σ =   1.8735  A
W       W Σ =    41.99  W
VAΣ    Or.1 =    83.87  VA
varΣ   Or.1 =    13.33 var
PFΣ    Or.1 =     0.00  PF
```



Output item (phase angle, element 1)

Output item (phase angle of current, element 1)

Phase angle between fundamentals of voltage and current

Phase angle of each harmonic in relation of fundamental of voltage

Phase angle of each harmonic in relation of fundamental of current

Phase angle

deg (bar graph)

Index

A

B

C

D

E

F

G

H

I

K

L

M

N

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P

Q

R

S

T

U

V

W

Z