TA220
Digital Jitter Meter
USER'S MANUAL

YOKOGAWA
Yokogawa Electric Corporation

IM 704610-01E
2nd Edition

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Foreword

Thank you for purchasing the YOKOGAWA TA220 Digital Jitter Meter. This user's manual contains useful information about the functions and operating procedures of the instrument as well as precautions that should be observed during use. To ensure proper use of the instrument, please read this manual thoroughly before beginning operation. After reading this manual, keep it in a convenient location for quick reference in the event a question arises.
There are two manuals for the TA220 including this one. If the option function is installed, please read both manuals.

Manual Title	Manual No.	Description
TA220 Digital Jitter Meter User's Manual	IM 704610-01E	This manual. Explains all functions and operating procedures of the TA220 excluding the option function.
TA220 Digital Jitter Meter Option Function User's Manual	IM 704610-51E	Explains the operating procedures of the TA220 option function.

Notes

- The contents of this manual are subject to change without prior notice as a result of improvements in the instrument's performance and functions. Display contents illustrated in this manual may differ slightly from what actually appears on your screen.
- 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 nearest YOKOGAWA representative as listed on the back cover of this manual.
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Revisions

1st Edition: July 2004
2nd Edition: January 2005

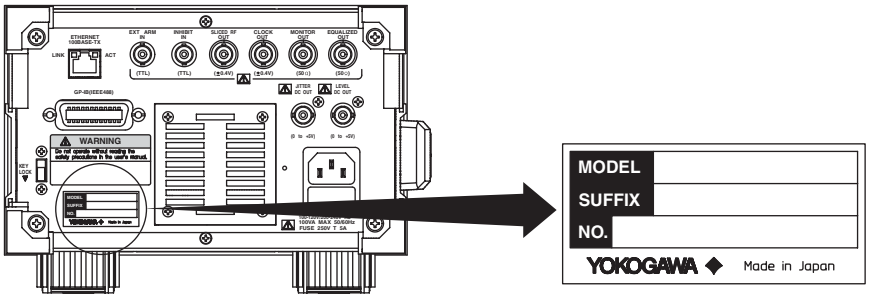
2nd Edition : January 2005 (YK)

Checking the Contents of the Package

Unpack the box and check the contents before operating the instrument. If some items are missing or otherwise inconsistent with the contents description, please contact your dealer or nearest YOKOGAWA representative.

TA220

Check that the model name and suffix code given on the name plate on the rear panel match the ones you ordered.



Model and Suffix Code

Model	Suffix	Specification
704610	100–240 VAC	
Equalizer	-BDS	Conventional equalizer for BD (the -BDS equalizer specification will be discontinued in December, 2004, upon release of -BD1).
	-BD1	Conventional equalizer for BD, D-to-C high speed calculation, D-to-C jitter measurement excluding 2T
Power cord	-D	UL/CSA standard power cord (Part No.: A1006WD) [Maximum rated voltage: 125 V; Maximum rated current: 7 A]
	-F	VDE standard power cord (Part No.: A1009WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A]
	-Q	BS standard power cord (Part No.: A1054WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A]
	-R	AS standard power cord (Part No.: A1024WD) [Maximum rated voltage: 240 V; Maximum rated current: 10 A]
	-H	GB standard power cord (Part No.: A1064WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A]
Option*	/LEQ	Limit equalizer for BD

* For information on the option, see the TA220 Digital Jitter Meter Option Function User's Manual (IM 704610-51E). Also, the option cannot be selected for products with suffix code -BDS.

NO. (Instrument Number)

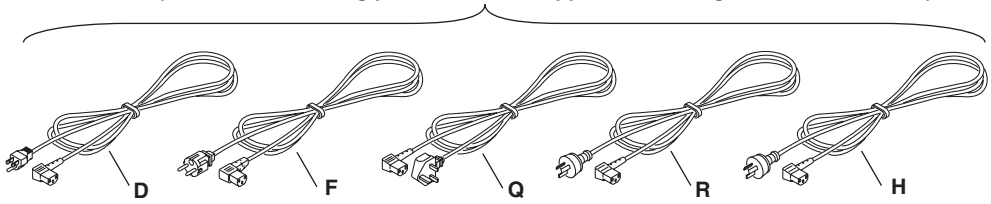
When contacting the dealer from which you purchased the instrument, please give them the instrument number.

Standard Accessories

The following accessories are included in the package.

Part Name	Model/Part Number	Qty.	Notes
Power cord	One of the following power cords is included according to the suffix code on the previous page.		
Spare fuse for power supply	A1114EF	1	250 V, 5 A, time lag Installed in the main unit fuse holder
Rubber feet	A9088ZM	2	Two rubber feet in one set
User's manual	IM704610-01E	1	This manual
Option function user's manual	IM704610-51E	1	Included for instruments with the option installed

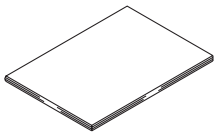
Power cord (One of the following power cords is supplied according to the suffix codes.)



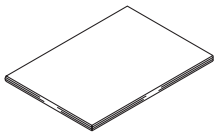
Spare fuse for power supply A1114EF 1 piece

Rubber feet A9088ZM 2 sheets

User's manual IM704610-01E



Option function user's manual IM704610-51E



Optional Accessories (Sold Separately)

The following optional accessories are also available.

Name	Model	Lot Qty.	Description
Power fuse	A1114EF	2	250 V, 5 A, time lag
150-MHz probe	700998	1	Input resistance: 10 MΩ, length: 1.5 m (10:1 and 1:1 switching type)
BNC cable	366924	1	BNC-BNC, length: 1m
BNC cable	366925	1	BNC-BNC, length: 2 m
Rack mount kit	751533-E3	1	For EIA single mount
Rack mount kit	751534-E3	1	For EIA dual mount
Rack mount kit	751533-J3	1	For JIS single mount
Rack mount kit	751534-J3	1	For JIS dual mount

Safety Precautions

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

The instrument is marked with the following symbols.


Danger. Refer to the user's manual. This symbol appears on dangerous locations on the instrument which require special instructions for proper handling or use. The same symbol appears in the corresponding place in the manual to identify those instructions.


Alternating current

ON (power)


OFF (power)


In-position of a bistable push control


Out-position of a bistable push control

Make sure to take the following precautions. Failure to take these precautions might result in injury or death of personnel.

WARNING

- **Use the Correct Power Supply**
  Before connecting the power cord, ensure that the source voltage matches the rated supply voltage of the instrument and that it is within the maximum rated voltage of the provided power cord.
- **Use the Correct Power Cord and Plug**
  To prevent the possibility of electric shock or fire, be sure to use the power cord supplied by YOKOGAWA. The main power plug can only be plugged into an outlet with a protective grounding terminal. Do not disable the protection feature of the instrument by using an extension cord without protective grounding.
- **Connect the Protective Grounding**
  Make sure to connect the protective grounding to prevent electric shock before turning ON the power. The power cord included with this instrument is a 3-prong cord with a grounding wire. Connect the power cord to a 3-prong AC outlet with a protective grounding terminal.
- **Do Not Impair the Protective Grounding**
  Never cut off the internal or external protective grounding wire or disconnect the wiring from the protective grounding terminal. Doing so creates a potential shock hazard.
- **Do Not Operate with Defective Protective Grounding or Fuse**
  Never operate the instrument if you suspect the protective grounding or fuse might be defective. Make sure to check them before operation.
- **Use the Correct Fuse**
  To prevent fire, make sure to use fuses of the specified rating for voltage, current, and type. Make sure to turn OFF the instrument and unplug the power cord before replacing the fuse. Never short the fuse holder.
- **Do Not Operate Near Flammable Materials**
  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 Use When Removed from the Case**
  The cover should be removed by qualified personnel only. There are some areas inside the instrument with high voltages.
- **Ground the Instrument before Making External Connections**
  Connect the protective grounding before connecting to the item under measurement or external control circuits. Also, If you need to touch the circuit with your hand, first cut the power to the circuit and confirm that it contains no voltage. To prevent the possibility of electric shock or an accident, connect the ground of the probe and input connector to the ground of the item being measured.

Conventions Used in This Manual

Safety Markings

The following markings are used in this manual.

Improper handling or use can lead to injury to the user or damage to the instrument. This symbol appears on the instrument to indicate that the user must refer to the user's manual for special instructions. The same symbol appears in the corresponding place in the user's manual to identify those instructions. In the manual, the symbol is used in conjunction with the word "WARNING" or "CAUTION."

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

CAUTION Describes precautions that should be observed to prevent minor or moderate injury, or damage to the instrument.

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

Headings Used for Descriptions of Operations

On pages that describe the operating procedures in Chapter 3 through 12, the following headings and symbols are used to distinguish the procedures from their explanations.

Procedure This subsection contains the operating procedure used to carry out the function described in the current chapter. All procedures are written with inexperienced users in mind; experienced users may not need to carry out all the steps.

Explanation This subsection provides a detailed explanation of the settings introduced in the procedure and their restrictions. A detailed description of the function is not provided. For a detailed description of the function refer to chapter 2.

Terms Used in Explanations of Procedures

Keys and Rotary Knob

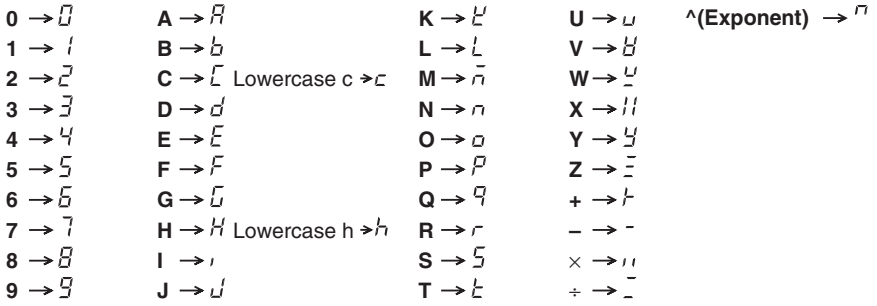
Bold characters used in the Procedure sections indicate that the panel keys or rotary knob are used to execute the operation being described.

SHIFT+Panel Key

SHIFT+key means you will press the SHIFT key to turn ON the green indicator that is located above the SHIFT key and then press the panel key. The functions marked in purple above the panel keys are activated when the SHIFT key is pressed.

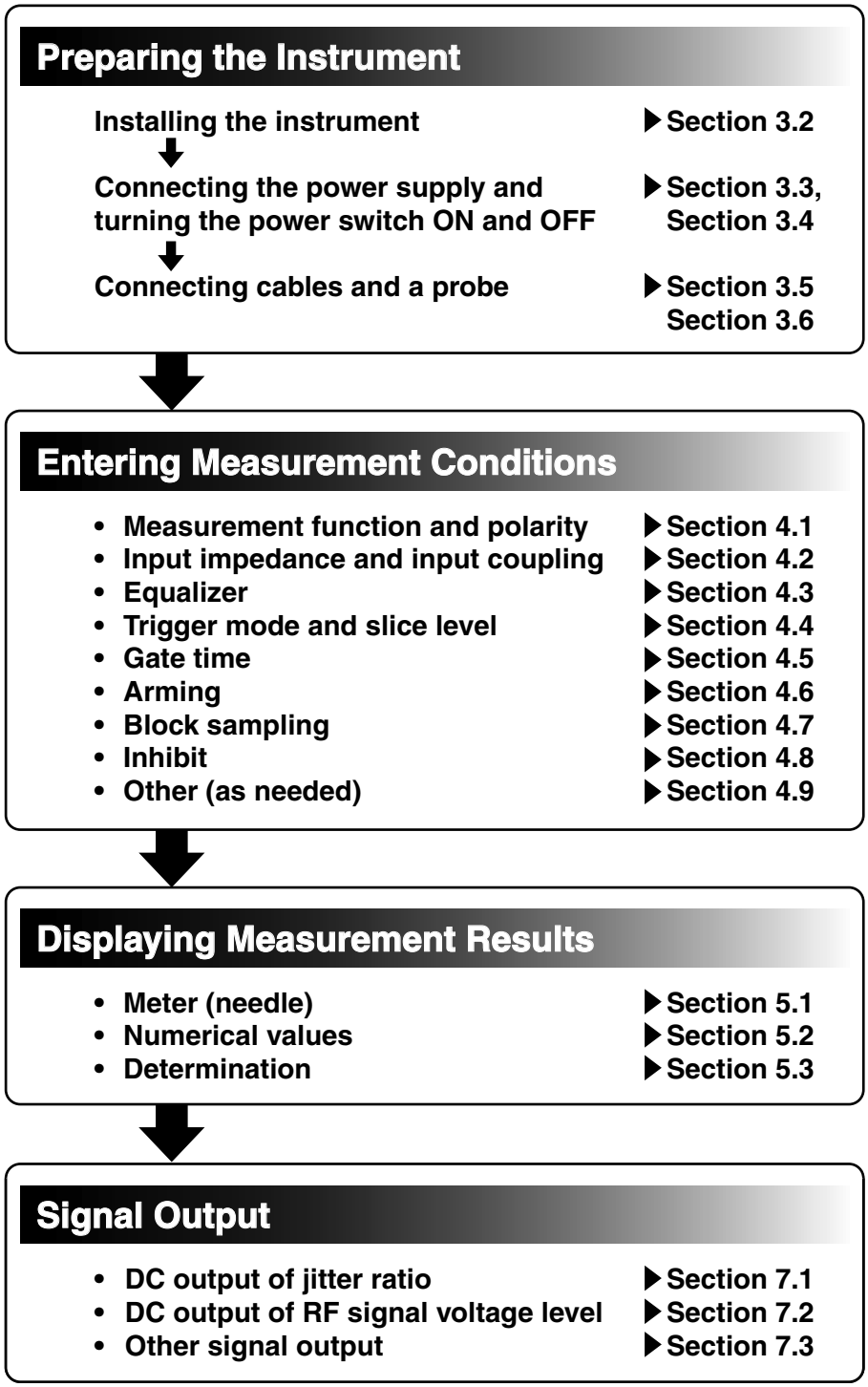
Digital Numbers and Characters

Since the instrument's red-colored display is a 7-segment LED, it displays numbers, alphabetical characters, and mathematical operators in a simplified form as shown below. (Some characters are not used at all by the instrument.)



Flowchart of Operation

The figure below is provided to familiarize the first-time user with the general flow of the TA220 operation. For a more detailed description of each item, see the relevant section.



Contents

Chapter 6 Storing and Recalling Setup Information

Chapter 7 Signal Output

Chapter 8 GP-IB Communications

Chapter 9 Ethernet Communications

Chapter 10 Communication Command

1.1 Front and Rear Panels

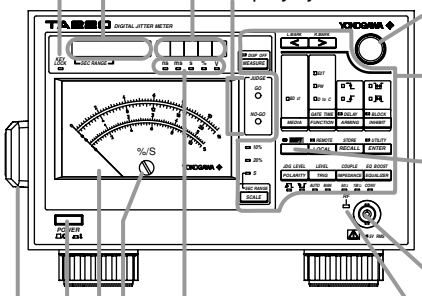
Front Panel

KEY LOCK indicator
Illuminates when key lock is ON. -> (section 11.4)

Display 2 (dot matrix green LED display)
Displays entered or selected numerical settings and other setting items.

Display 1 (7-segment red LED display)
Displays entered or selected numerical settings and other setting items.

Determination indicator
Displays jitter ratio determination results. -> (section 5.3)



Rotary knob
Use to enter or select numerical settings and other setting items.

Keys
Keys that are pressed first when entering a setting. Press a key to display the corresponding selection menu. -> (section 1.2)

SHIFT key
Pressing the SHIFT key causes the SHIFT lamp above the key to illuminate, indicating that the instrument has entered SHIFT mode. The functions marked in purple above the panel keys are activated when the SHIFT key is pressed.

Measurement input terminal (RF input)
Terminal for connecting the RF signal measurement cable. -> (section 3.5)

RF indicator
Illuminates when a trigger activates during measurement of RF signals.

Unit indicator
An LED illuminates to indicate the units for the measured value or setting value being displayed.
-> (sections 5.1 and 5.2)

Adjustment trimmer
Use to adjust the zero position of the needle. -> (section 12.3)

Meter
Needle indicates measured results. -> (sections 5.1 and 12.3)

Power switch -> (section 3.4)

Handle
Use to lift or carry the instrument. -> (section 3.1)

Rear Panel

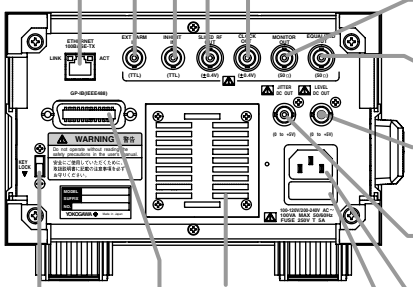
Ethernet port -> (section 9.2)

External arming signal input terminal ⚠
Accepts input of external arming signals. -> (section 4.6)

Inhibit signal input terminal ⚠
Accepts input of inhibit signals. -> (section 4.8)

Data signal output terminal ⚠
Outputs RF signals in binary. -> (section 7.3)

Clock signal output terminal ⚠
Outputs the clock signal regenerated by the PLL circuit. -> (section 7.3)



RF signal monitor output terminal ⚠
Outputs the RF signals input to the measurement input terminal as-is.
-> (section 7.3)

Equalized RF signal monitor output terminal ⚠
If the equalizer is activated, the equalized RF signal is output. -> (section 7.3)

Voltage level DC output terminal ⚠
Outputs the RF signals input to the measurement input terminal as DC signals. -> (section 7.2)

Jitter ratio DC output terminal ⚠
Outputs the jitter ratio as a DC signal. -> (section 7.1)

Power connector ⚠ -> (section 3.3)

Power fuse ⚠ -> (section 12.8)

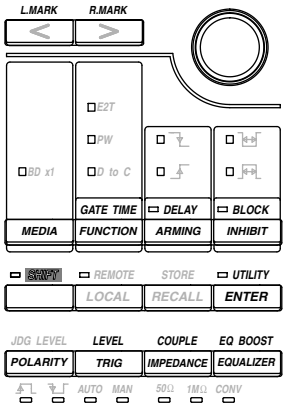
Vent holes
-> (section 3.2)

GP-IB connector -> (section 8.3)

KEY LOCK switch
Used to turn the key lock ON and OFF. -> (section 11.4)

1.2 Keys

Measurement Condition Settings



SHIFT+< (L.MARK) key and SHIFT+> (R.MARK) key -> section 4.1
When using the measurement function PW, these key combinations are used to set the upper and lower limits of the pulse width to be measured.

MEDIA key -> sections 12.4
Press this key during self testing to execute the LED test.

FUNCTION key -> sections 4.1 and 12.4
Selects a measurement function. Also, you can press this key during self testing to execute the keyboard test.

SHIFT+FUNCTION (GATE TIME) key -> section 4.5
Sets the gate time.

ARMING key -> sections 4.6 and 12.4
Selects either auto arming or external arming. Also, you can press this key during self testing to execute the meter test.

SHIFT+ARMING (DELAY) key -> section 4.6
Sets the arming delay when external arming is selected.

INHIBIT key -> sections 4.8 and 12.4
Sets inhibit. Also, you can press this key during self testing to execute the board test.

SHIFT+INHIBIT (BLOCK) key -> section 4.7
Sets up block sampling.

POLARITY key -> section 4.1
Selects the polarity of the signal to be measured.

TRIG key -> section 4.4
Selects the trigger mode.

SHIFT+TRIG (LEVEL) key -> section 4.4
Sets the slice level.

IMPEDANCE key -> section 4.2
Selects the input impedance of the measurement input terminal.

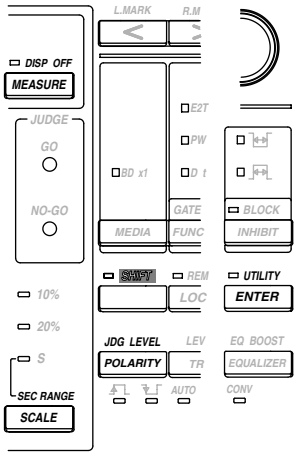
SHIFT+IMPEDANCE (COUPLE) key -> section 4.2
Selects the input coupling of the measurement input terminal.

EQUALIZER key -> section 4.3
Equalizes the amplitude of the RF signals input to the measurement input terminal.

SHIFT+EQUALIZER (EQ BOOST) key -> section 4.3
Sets the boost amount of the equalizer.

SHIFT+ENTER (UTILITY) key -> section 4.9
Use to enter PLL hold, D-to-C high speed calculation (not available for products with suffix code -BDS), AGC, and DC clamp settings.

Displaying Measurement Results



MEASURE key -> sections 5.1 to 5.2
Changes the displayed measured result.

SHIFT+MEASURE (DISP OFF) key -> section 5.2
Turns OFF displays 1 and 2 (for numerical values) and the unit indicator.

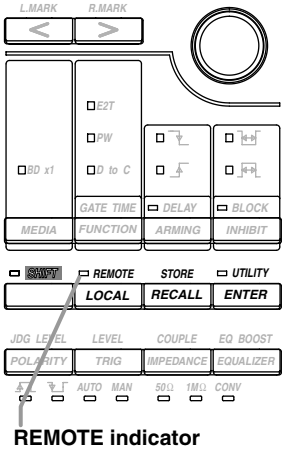
SCALE key -> section 5.1
Selects the scale of the meter.

SHIFT+SCALE (SEC RANGE) key -> section 5.1
Selects the time range for the scale when the units of time for the meter scale are set to "s".

SHIFT+POLARITY (JDG LEVEL) key -> section 5.3
Sets the determination level when performing determination on the jitter ratio and displaying the result as GO or NO-GO.

SHIFT+ENTER (UTILITY) key -> section 5.2
Selects the measured result displayed using the MEASURE key.

Storing/Recalling Setup Information, Signal Output, Communications, and Other Functions



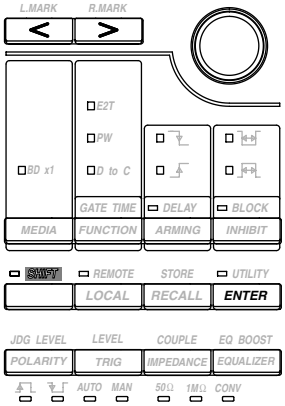
RECALL key -> section 6.2
Recalls setup info stored in the internal memory, and replaces with the current settings.

SHIFT+RECALL (STORE) key -> section 6.1
Stores setup information to the internal memory.

SHIFT+ENTER (UTILITY) key -> chapter 7 and sections 8.4, 9.3, 11.2, and 11.3
Use to set signal output, select the communication interface, enter a GP-IB address or TCP/IP setting, confirm the MAC address, set the timeout time, initialize settings, set the brightness, and display version information.

LOCAL key -> sections 8.2, 9.1, and 12.5
Returns the instrument from remote mode (when the REMOTE indicator above the LOCAL key is illuminated) to local mode. Also, you can press this key when in maintenance mode to execute calibration.

Common Operations

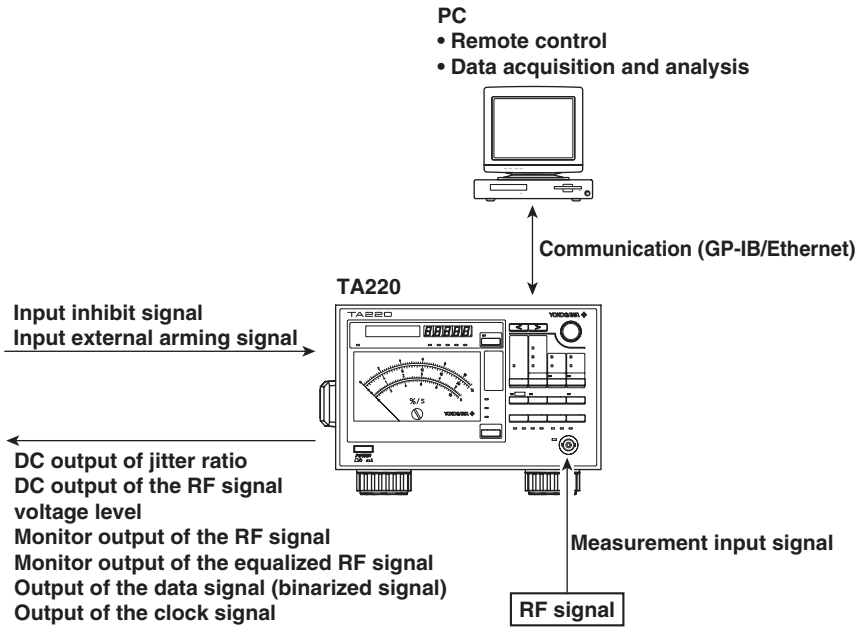


< > keys
Moves the selected digit when entering a value using the rotary knob and changes the setting item.

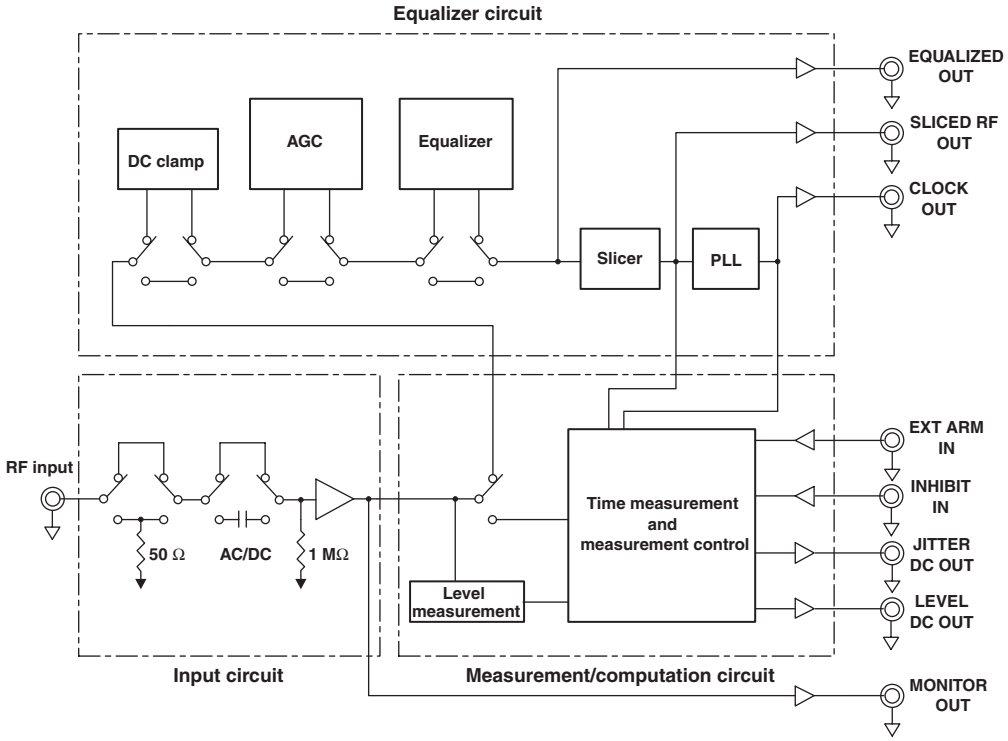
ENTER key
When changing the selection item and entering a setting for Display 1 in the Utility menu, pressing this key causes Display 1 to blink, indicating that the rotary knob and or < > keys can be used to select the setting item for editing. If you press this key again while Display 1 is blinking, it stops blinking and you can then edit the item.

2.1 System Configuration and Block Diagram

System Configuration



Block Diagram



The TA220 is a jitter measuring instrument that utilizes signal processing circuits (auto slicer, equalizer, and PLL) for support of the Blu-ray Disk standard (hereinafter, BD) of next-generation high precision optical discs. When BD-standard RF signals are input to the instrument, the PLL circuit regenerates the clock signal enabling measurement of the data to clock (D-to-C) jitter.

The RF signals input to the measurement input terminal (RF input) are routed through the input circuit at the selected input coupling and input impedance, and are passed to the measurement/computation circuit via a buffer amplifier. At the same time, signals passing through the input circuit are output from the RF signal monitoring output terminal (MONITOR OUT) on the rear panel.

The amplitude of the signals coming from the input circuit is measured by the level measurement circuit. The measured amplitude values are processed by the computation circuit and are sent to Display 1 (the 7-segment red LED) for display. These amplitude values can also be converted to DC voltages between 0 and 5 V, and output from the voltage level DC output terminal (LEVEL DC OUT) on the rear panel.

The RF signals passing through the input circuit are routed to the equalizer circuit if the equalizer circuit is selected. Otherwise, they are sent directly to the measurement/computation circuit.

When the equalizer circuit is selected, the RF signals pass through the DC clamp circuit (DC clamp), AGC amplifier (AGC), and variable boost equalizer circuits (equalizer), and are converted to binary values by the autoslice (slicer) circuit. Binarized data signals are input to the PLL circuit (PLL), and the clock signal is regenerated. Data and clock signals are input to the measurement/computation circuit where the D-to-C time (phase difference) is measured and jitter values are calculated. RF signals prior to binarization that are processed in the equalizer are output from the equalized RF signal monitoring output terminal (EQUALIZED OUT) on the rear panel, or, data signals and clock signals are output from the data signal output terminal (SLICED RF OUT) and clock signal output terminal (CLOCK OUT) on the rear panel, respectively.

The DC clamp circuit function is used to stabilize input RF signals with DC components such as can occur with mirror portions of discs. This circuit temporarily adjusts the low-band cutoff frequency from 10 kHz to 3 MHz, thereby quickly attenuating the fluctuating DC component. The DC clamp circuit is active during the inhibit period.

The variable boost equalizer circuit has the equalizing characteristics shown by the transfer function below, and the characteristics of a 3rd order Bessel LPF (lowpass filter, 3 dB attenuation point 30 MHz) connected in cascade. You can set the difference in gain at 100 kHz and 16.5 MHz as the boost amount.

$$H(z)=1/2\{-k+(1+k)z^{-1}+(1+k)z^{-2}-kz^{-3}\}$$

The autoslice circuit consists of a first order integration feedback circuit. It uses a function that superimposes DC voltage on the slice level, and you can change the slice level when the RF signal is binarized.

In the measurement/computation circuit, signal acquisition is controlled according to external arming and inhibit signals (EXT ARM and INHIBIT), time measurement and computation is performed on the acquired data, and jitter, jitter ratio, and average values are calculated. The results are shown by the meter needle and the value displayed on Display 1. In addition, the jitter ratio can also be converted to a DC voltage between 0 and 5 V, and output from the jitter ratio DC output terminal (JITTER DC OUT) on the rear panel.

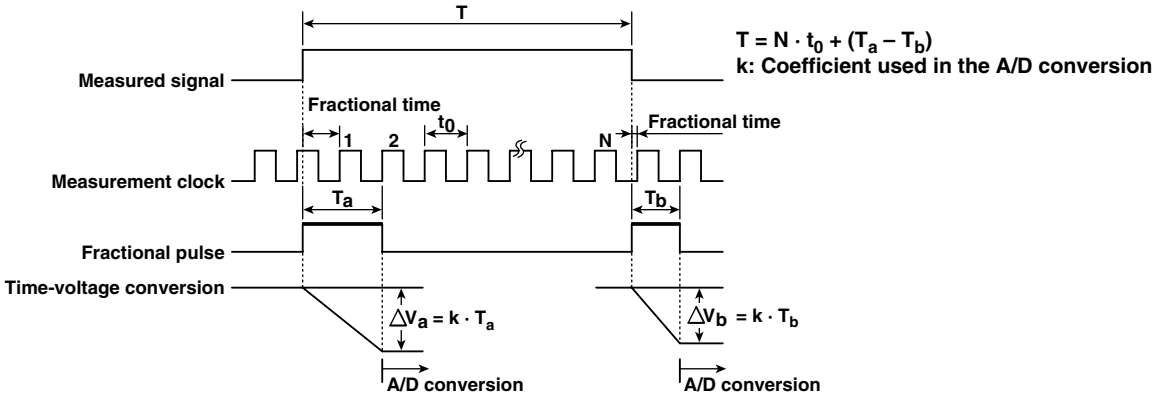
2.2 Measurement Principle

Example with Pulse Width Measurement

A time shorter than the period of the measurement clock is called the fractional time. In general, since the measured signal and the measurement clock are not synchronized, fractional time exists both at the beginning and at the end of measurements. This instrument generates a “fractional pulse” which is a pulse signal equal to the sum of the fractional time and one period of the measurement clock. Given pulse width T of the measured signal, measurement clock period t_0, and fractional pulse times T_a and T_b, pulse width T can be divided into integer multiples of the measurement clock time N times t_0 and fractional pulse times T_a and T_b as follows:

$T = N \bullet t_0 + (T_a - T_b)$

The instrument converts the fractional pulse times on the starting and ending sides (T_a and T_b) to voltage values. By then converting those voltages to digital values using 7-bit A/D conversion, the fractional pulse widths can be measured at time resolutions of approximately 100 ps per 1LSB. T is determined by substituting the measured fractional pulse times with T_a and T_b in the equation above.



2.3 Measurement Functions (Measurement Items)

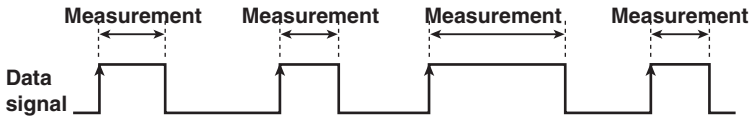
Pulse Width Jitter <<For procedures, see section 4.1>>

Pulse Width Measurement

You can measures the pulse width from the rising edge of the slope* to the next falling edge of the slope (positive side) or from the falling edge of the slope to the next rising edge of the slope (negative side) of the data signal.

* The slope of a signal is its movement from a low level to a high level (rising), or from a high level to a low level (falling).

Example of positive side pulses



Jitter σ, Jitter Ratio σ/T, and Average Value

A histogram (frequency distribution) is created from multiple pulse widths within a specified range (see “Upper and Lower Limits of the Pulse Width” on page 2-6), and the standard deviation σ of the values making up the histogram is calculated. This standard deviation σ is the pulse width jitter. The percentage calculated when dividing the standard deviation σ by the difference T in the upper and lower limits of the pulse width is called the pulse width jitter ratio. The time-averaged value of the measured pulse width signal is the pulse width average value (AVE).

• Pulse width jitter

$$AVE = \sum_{i=1}^{n} (X_i \times P_i)$$

• Pulse width jitter ratio

$$\sigma = \sqrt{\sum_{i=1}^{n} \{(X_i - AVE)^2 \times P_i\}}$$

• Pulse width average value

$$\frac{\sigma}{T} \times 100(\%)$$

n: Number of bins (histogram lines) of the histogram
X_i: Class value of each bin
P_i: Relative frequency
(Ratio of frequency X_i of a single bin with respect to the total number of samples)

T: Difference between the upper and lower limit of the pulse width.

Note

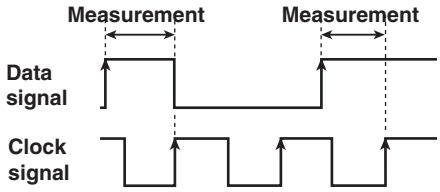
By switching the displayed numerical value (see section 5.2) and making queries through communication commands (see section 10.2.2) you can obtain statistical values other than the jitter, jitter ratio, and average value.

D-to-C Jitter <<For procedures, see section 4.1>>

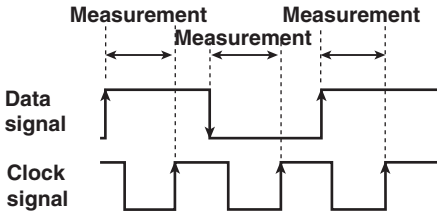
Measuring Phase Difference

You can measure the phase (time) difference from the rising (or falling) slope of the data signal to the first rising slope of the clock signal.

- **Example 1**
  Data signal slope: rising
  Clock signal slope: rising



- **Example 2**
  Data signal slope: both rising and falling
  Clock signal slope: rising



Jitter σ, Jitter Ratio σ/T, and Average Value

A histogram (frequency distribution) is determined from multiple measured values of phase difference, and the standard deviation σ from the histogram is calculated. This standard deviation σ is the D-to-C jitter. The D-to-C jitter ratio is derived as a percentage by dividing the standard deviation σ by the period T of the clock signal. The time-averaged value of the measured phase difference signal is the D-to-C average value AVE.

• D-to-C average value

$$AVE = \sum_{i=1}^{n} (X_i \times P_i)$$

• D-to-C jitter

$$\sigma = \sqrt{\sum_{i=1}^{n} \{(X_i - AVE)^2 \times P_i\}}$$

• D-to-C jitter ratio

$$\frac{\sigma}{T} \times 100(\%)$$

n: Number of bins (histogram lines) of the histogram
X_i: Class value of each bin
P_i: Relative frequency
(Ratio of frequency Xi of a single bin with respect to the total number of samples)

T: Period of the clock signal
(differs depending on the signal being measured since it is measured at the same time as the data signal)

Regenerating the Clock Signal

The clock signal that is necessary in measuring the D-to-C jitter can be regenerated by the PLL circuit of the instrument. D-to-C jitter measurements are carried out using the regenerated clock signal. You can display the period T of the regenerated clock signal.

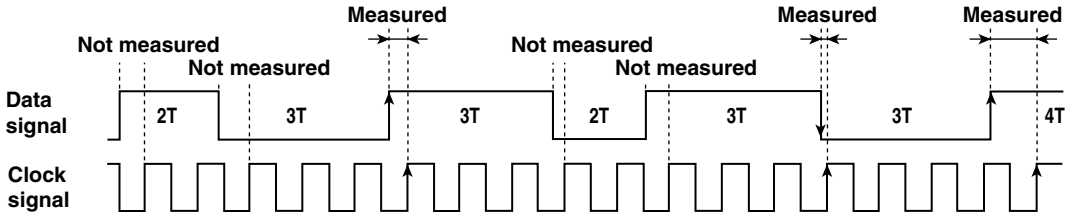
Note

By switching the displayed numerical values (see section 5.2) and making queries through communication commands (see section 10.2.2), you can obtain statistical values other than the jitter, jitter ratio, and average value.

D-to-C Jitter Excluding 2T <For the setup procedure, see section 4.1>

This is one of the functions available for measuring D-to-C jitter. D-to-C jitter is measured, excluding the phase difference of data signals having pulse widths of two times the clock signal period (2T) or less. When the pulse width of the data signal is 2T or less, the phase difference before and after that data signal is not measured.
The method for determining the jitter σ, jitter ratio σ/T, and average value is the same as that for normal D-to-C jitter.
D-to-C jitter excluding 2T cannot be measured by products with suffix code -BDS.

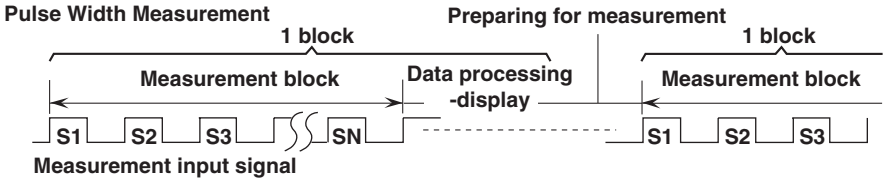
Example
Slope of the data signal: Both rising and falling
Slope of the clock signal: Rising



2.4 Measurement Conditions

Measurement Block

The TA220 repeats a three-part process of measurement, data processing, and display. The smallest unit that is measured during the first part of this process is called a measurement block. In the figure below, N is the number of samples (number of data) acquired in a single pass of the process, and the measurement, data processing, and display of these samples is considered to be one block of measurement. The range of measured blocks is specified by the gate time described below.



Upper and Lower Limits of the Pulse Width <<For procedures, see section 4.1>>

Optical disc signals are pulse signals having time widths that are integer multiples of a reference item width T (for example, 2T–14T, etc.). The pulses can experience variations (jitter), such that for example a 3T pulse signal may include time widths of 2.9T or 3.1T. You can specify to measure only pulse signals within a certain range of these variations (for example a range from 2.5T to 3.5T).

Input Impedance <<For procedures, see section 4.2>>

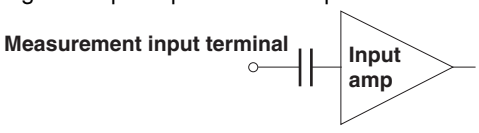
To attenuate the measured signal and reduce distortions, you must adjust to the output impedance of the signal under test. You can select an input impedance for the measurement input terminal of 50 Ω or 1 MΩ.

Input Coupling <<For procedures, see section 4.2>>

Measurement of only the amplitude (AC component) of the measurement input signal or only signals superimposed with a specific DC voltage is simplified by removing the DC component of the signal. There are also times when you wish to measure the input signal without removing the DC component. In these cases, you can change the input coupling setting and apply the signal to the input amp. The following types of input coupling are available.

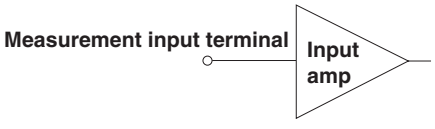
AC

Input is passed through a capacitor, removing the DC component. This coupling should be used when measuring only the amplitude of the signal, or when measuring only signals superimposed with a specific DC voltage.



DC

Inputs the signal directly. Use this setting if you wish to measure the entire input signal (DC component and AC component).

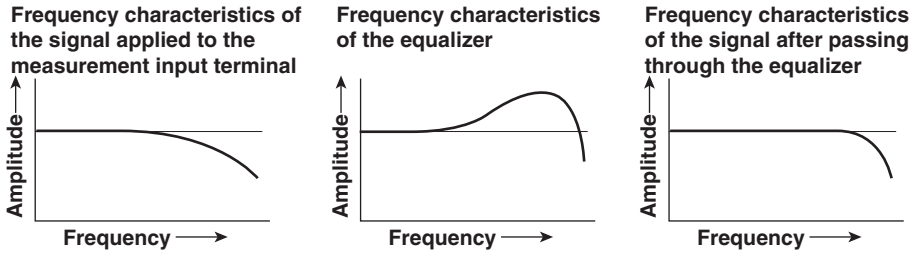


Note

When the equalizer is ON, the signal is AC-coupled through the cutoff frequency of 10 kHz inside the equalizer regardless of the above coupling setting.

Equalizing RF Signals (Equalizer) <<For procedures, see section 4.3>>

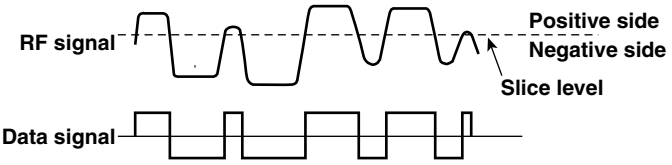
You can equalize the signal amplitude in the high frequency region. The signal amplitude in the high frequency region attenuates due to the frequency characteristics of the optical pickup. By passing the RF signal that is applied to the measurement input terminal through the equalizer, you can obtain a signal that has frequency characteristics that do not attenuate up to the high frequency region (better frequency characteristics than the optical pickup).



Binarization of the RF Signal

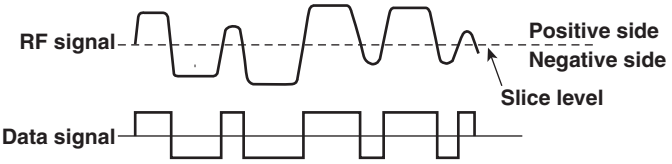
The signal used to measure the pulse width and phase difference is a data signal binarized from the RF signal applied to the measurement input terminal. Using the slicer of the TA220, the RF signal is binarized by setting the portion of the signal that is greater than the given slice level* to the positive side and the portion that is less than the slice level to the negative side.

* The slice level changes depending on the trigger mode setting. For information on setting the trigger mode and slice level, see “Trigger Mode and Slice Level” below.



Auto Slice

To correct the asymmetrical signal waveforms typical of optical disks, a slice level is automatically detected such that the time ratio of the positive and negative sides of the RF signal is 50%. The RF signal is binarized using the detected slice level. The auto slice function operates when the trigger mode is set to “auto mode” or “auto + manual mode” as described below.

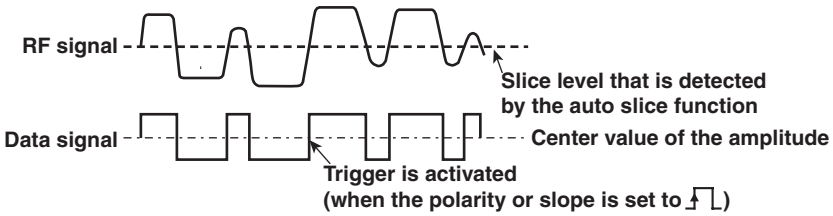


Trigger Mode and Slice Level <<For procedures, see section 4.4>>

When measuring the pulse width or phase difference of a single pulse, you can select the level of the data signal at which to make the measurement (activate the trigger). Slice level refers to the signal level used to binarize the RF signal.

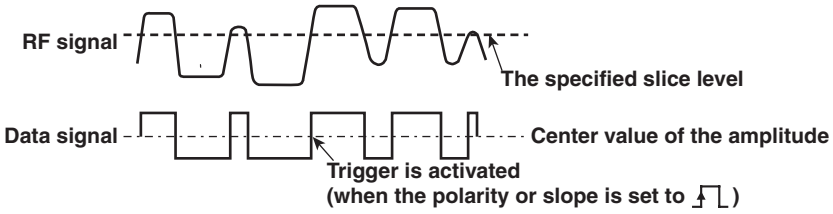
Auto mode

The RF signal is binarized using the slice level that is detected by the auto slice function.



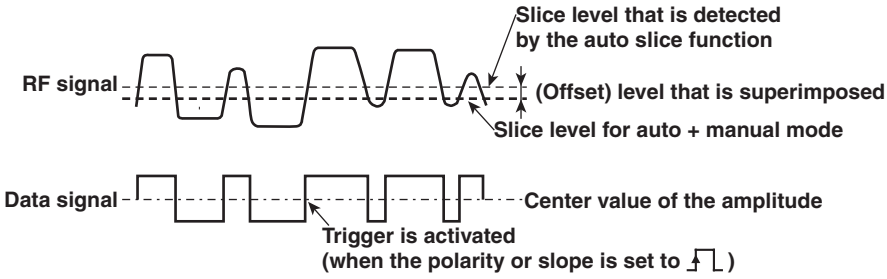
Manual mode

The RF signal is binarized using a specified slice level.



Auto + manual mode

The RF signal is binarized using the slice level detected with the auto slice function superimposed by a specified offset slice level. The offset level that is superimposed is set separately from the slice level of the manual mode described above.



Gate Time <<For procedures, see section 4.5>>

You can set the time (gate time) during which the measured values of pulse width and phase difference are stored in the acquisition memory.

Arming <<For procedures, see section 4.6>>

Arming refers to the cue used to start the measurement. As opposed to a trigger, which refers to the cue used to measure the pulse width or phase difference of each pulse, arming refers to the starting point of the measurement of a set of pulse widths or phase differences used to derive the jitter.

Auto Arming (Internal Arming)

The internal signal of the TA220 is the arming source. Arming is the cue used to start the first measurement (the first trigger).

External Arming

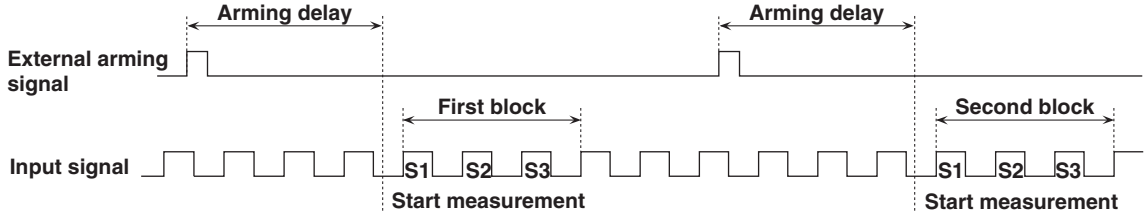
Arming is activated when an external signal (arming source) is applied to the external arming input terminal. You can also select whether the rising or falling edge is used to activate the arming.

Arming Delay

When using external arming, you can delay the start of the measurement by a given amount of time (delay time) after arming occurs.

Block Sampling <<For procedures, see section 4.7>>

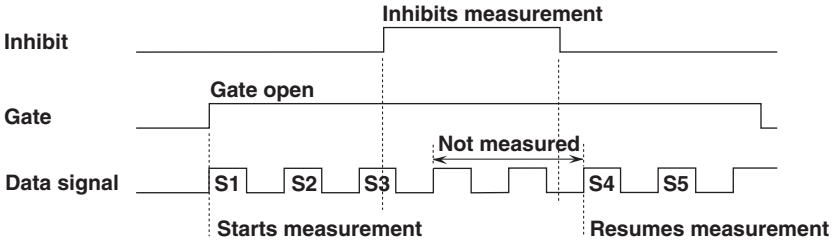
Repeating one block of measurement a specified number of times is called block sampling. With block sampling, all data collected after performing one block of measurement a specified number of repetitions is processed and displayed together. Block sampling measurement is available when external arming is active.



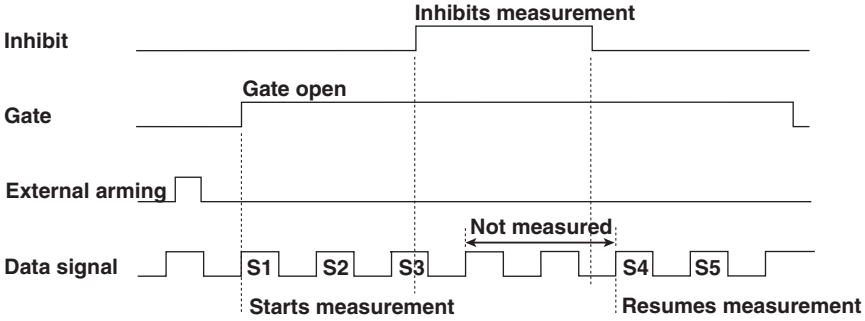
Inhibit <<For procedures, see section 4.8>>

You can inhibit measurements by applying an external signal to the inhibit signal input terminal. This is possible even while the gate is open or during measurement after arming activation. You can also select which polarity of the signal, positive or negative, is used to inhibit measurements. The relation between the inhibit signal, gating, and arming for pulse width jitter measurement is indicated below.

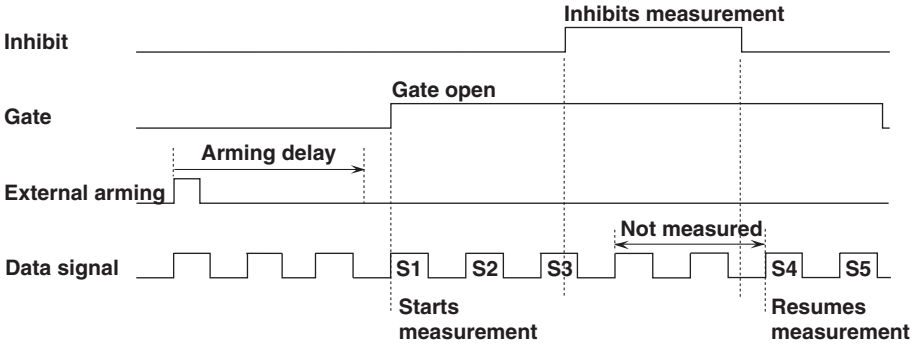
Relation between the Inhibit Signal and Gating



Relation between the Inhibit Signal, Gating, and External Arming



Relation between the Inhibit Signal, Gating, External Arming, and Arming Delay



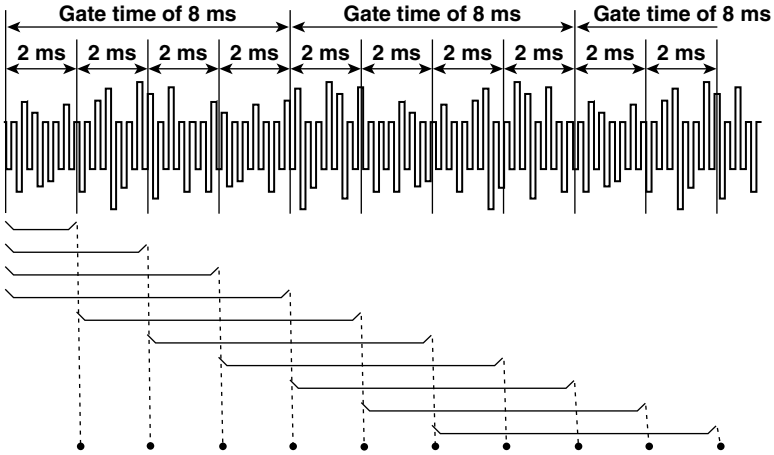
PLL Hold <<For procedures, see section 4.9>>

The PLL hold function maintains the frequency of the clock signal regenerated in the PLL circuit when Inhibit is active. If RF signals whose clock signals cannot be regenerated in the PLL circuit are input to the measurement input terminal when Inhibit is active, once Inhibit is cleared, if a normal RF signal whose clock signal can be regenerated in the PLL circuit is then introduced, the clock signal will be generated normally.

D-to-C High Speed Calculation <For the setup procedure, see section 4.9>

With normal D-to-C jitter measurement, when this function is enabled the measured D-to-C jitter is updated every 2 ms rather than being updated according to a specified gate time. For example, if the gate time is set to 8 ms, the measured values of the measurement clock delimited every 2 ms as in the figure below is moving-summed over an 8-ms time range, and the results are updated every 2 ms.

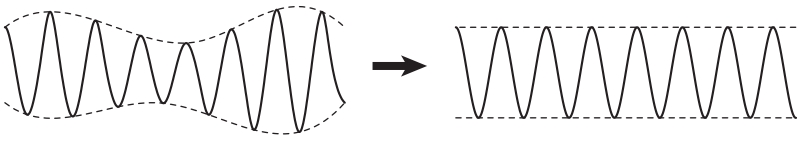
The D-to-C high speed calculation function is not available on products with suffix code -BDS.



Outputs the moving-summed result every 2 ms.
The summing time is the same as the gate time.

AGC (Automatic Gain Control Amplifier) <<For procedures, see section 4.9>>

If undulations occur in the signal amplitude envelope, the signal can be applied to an AGC circuit to normalize the fluctuations in the amplitude thereby improving the accuracy of jitter measurements.



DC Clamp <<For procedures, see section 4.9>>

If RF signals with temporarily changing DC components are applied to the measurement input terminal when Inhibit is active, the DC clamp function can be used to quickly attenuate the changed portion of the DC components. The low-band cutoff frequency in the equalizer circuit is changed from 10 kHz to 3 MHz, the changed portion of the DC component is immediately attenuated, and regeneration of the clock signal by the PLL circuit is maintained.

2.5 Display

Meter Display <<For procedures, see section 5.1>>

The TA220 indicates the jitter and jitter ratio on the analog meter.

Jitter Ratio Indication

The jitter ratio of the selected measurement function is indicated on the analog meter. You can select a scale for the meter of 10% or 20%. The indication range is 0% to 11% for the 10% scale and 0% to 22% for the 20% scale.

Jitter Indication

The jitter of the selected measurement function is indicated on the analog meter. The scale is marked in units of time (seconds) on the bottom of the meter. You can switch the range of the scale from 0.5 ns to 5.0 μs. The range is shown on Display 2.

Display of Numerical Values and Characters

The TA220 displays numerical values and alphabetical characters such as the jitter, jitter ratio, average value, specified value, error code, and firmware version on Display 1 or Display 2.

Numerical Display of Measured Results <<For procedures, see section 5.2>>

Measured results (the jitter ratio, jitter, and average value) are displayed numerically on Display 1. Display 1 is a red 7-segment LED. Display 1 is used for settings, error codes, and the firmware version.

Character and Numerical Display of Setting Parameters and Values

Setting parameters are shown using alphabetical characters on Display 2. Display 2 is a green dot matrix LED. For certain setting parameters, you can display the numerical measured result on Display 1 while simultaneously displaying a setting parameter and setting value on Display 2.

Turning OFF Numerical/Character Display <<For procedures, see section 5.2>>

If you are distracted by the changing jitter ratio, jitter, or average values, or blinking setting values, you can turn both Display 1 and Display 2 OFF.

Determination Display of Jitter Ratio <<For procedures, see section 5.3>>

You can set the determination level for the jitter ratio and display determination results as GO or NO-GO. The GO indicator illuminates in green when the jitter ratio is less than or equal to the determination level, and the NO-GO indicator illuminates in red when the jitter ratio exceeds the determination level. If a clock signal can not be regenerated by the PLL circuit during D-to-C measurement, both GO and NO-GO indicators illuminate in green and red respectively.

2.6 Signal Output

DC Output of the Jitter Ratio <<For procedures, see section 7.1>>

DC Output of the Jitter Ratio

The jitter ratio of the selected measurement function can be linearly converted to DC voltage (0 to 5 V) and output from the jitter ratio DC output terminal on the rear panel. You can also change the jitter ratio that corresponds to 0 V and 5 V.

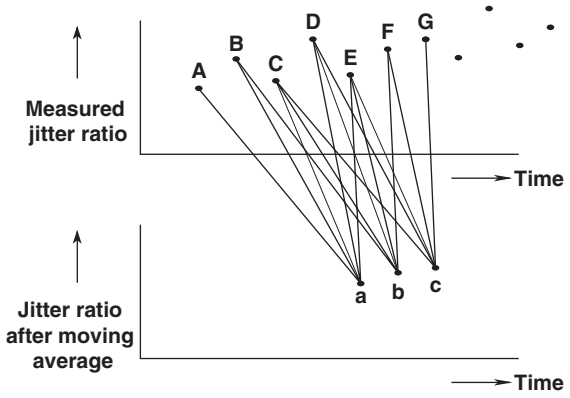
Jitter Ratio Determination Output

You can specify the determination level in terms of a jitter ratio and output 5 VDC from the jitter ratio DC output terminal when the data signal is less than or equal to the determination level, and 0 VDC when it is greater than the determination level.

DC Output Filter

This filter takes the moving average of the measured jitter ratio. When the DC output fluctuates due to instability in the measured jitter, this function suppresses the degree of fluctuation. You can set the number of measured values (average coefficient) to be averaged in the range from 1 to 10. The moving-averaged jitter ratio is shown on the numerical display and analog meter, and sent to DC output.

When the average coefficient is set to 5



Jitter Ratio Correction Coefficients

The specified jitter ratio can undergo 1st order correction per the specified correction coefficients. Two correction coefficients can be specified, α (slope) and β (offset value). The jitter is the value obtained by multiplying the corrected jitter ratio by time T (see section 2.3). The corrected jitter and jitter ratio are shown on the numerical display and analog meter, and sent to DC output.

Jitter Ratio Correction Equation

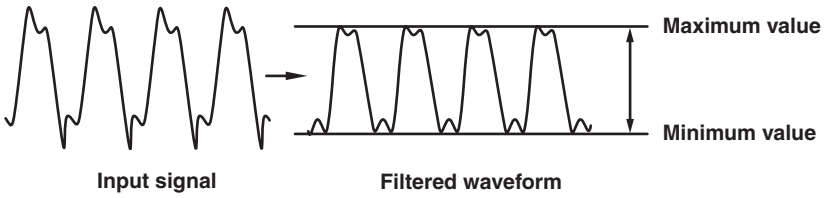
$J_c = \alpha J_m + \beta$

J_c: corrected jitter ratio, J_m: uncorrected jitter ratio

Measurement of the RF Signal Voltage Level and DC Output of the Voltage Level <<For procedures, see 7.2 section >>

Voltage Level Measurement

RF signals input to the amplitude measurement circuit pass through a filter than removes noise and overshoot. Next, the A/D converter in the amplitude measurement circuit measures the maximum and minimum values of the input signal, and the difference between the two is taken as the RF signal's voltage level.



Voltage Level Display

When RF signal voltage measurement is ON, you can switch the display to view the measured numerical voltage level values on the same display.

DC Output of Voltage Levels

The voltage level of the RF signal can be linearly converted to DC voltage (0 to 5 V) and output from the voltage level DC output terminal on the rear panel. You can also change the RF signal voltage level that corresponds to the 0 and 5 V levels.

Voltage Level Determination Output

The upper and lower limits of the determination range can be set according to the RF signal voltage levels so that 5 VDC is output when the signal falls between the upper and lower limits, and 0 VDC is output when the upper limit is exceeded or the lower limit is not reached.

DC Output Filter for Voltage Levels

A moving average can be taken of the RF signal voltage levels. When the DC output fluctuates due to instability in the RF signal voltage levels, this function suppresses the degree of fluctuation. You can set the number of measured values (average coefficient) to be averaged in the range from 1 to 10. The operation is the same as that of the jitter ratio DC output filter on the previous page.

Monitor Output of RF Signals <<For procedures, see section 7.3>>

You can output the RF signals applied to the measurement input terminal as-is from the RF signal monitor output terminal on the rear panel.

Monitor Output of Equalized RF Signals <<For procedures, see section 7.3>>

If the equalizer is activated, the equalized RF signal is output. When AGC is ON, the RF signal passes through the AGC circuit before being output. When AGC is OFF and the equalizer is not activated, the signal bypasses the AGC and equalizer circuits.

Data Signal Output <<For procedures, see section 7.3>>

You can output the data signal obtained by slicing and binarizing the RF signal from the data signal output terminal on the rear panel.

Clock Signal Output <<For procedures, see section 7.3>>

You can output the clock signal regenerated by the PLL circuit from the clock signal output terminal on the rear panel.

2.7 Other Functions

Storing and Recalling Setup Information <<For procedures, see chapter 6>>

Up to seven sets of setup information can be stored in the internal non-volatile memory. You can also recall the stored setup information and change the settings.

Communication Using Commands (GP-IB or Ethernet) <<For procedures, see chapters 8 and 9, and the explanation of commands in chapter 10>>

The TA220 comes standard with GP-IB and Ethernet interfaces. You can output the jitter or jitter ratio of the selected measurement function to a PC or control the TA220 from an external controller.

Backing Up of Setup Information <<For procedures, see section 11.1>>

The setup information is stored using a lithium battery. When the power switch is turned ON, the TA220 starts measurement using the settings that existed immediately before the power switch was turned OFF. If the setup information can no longer be stored due to a dead lithium battery, the TA220 is reset to the factory default settings.

Initializing Setup Information <<For procedures, see section 11.2>>

The following two methods are available for initializing setup information on the instrument.

- Initialization to factory default settings
- Initialization of all setup information except the following.
  Network related set up information
  Setup information stored to the internal memory
  Digital display (green) brightness setting

Digital Display (Green) Brightness Setting <<For procedures, see section 11.3>>

You can change the brightness of Display 2.

Key Lock <<For procedures, see section 11.4>>

You can disable the front panel key operation.

Adjusting the Zero Position of the Needle <<For procedures, see section 12.3>>

You can adjust the zero position of the needle.

Self Test <<For procedures, see section 12.4>>

If you are in doubt as to whether the instrument has malfunctioned, you can run a self test before contacting a YOKOGAWA dealer. You can check things such as the keys, rotary knob, indicator, meter, and boards.

Calibration <<For procedures, see section 12.5>>

Using the internal calibration signal, the offset voltage of the input amplifier and the conversion coefficient of the time-voltage converter can be calibrated.

Version Display <<For procedures, see section 12.7>>

The firmware version (ROM version) of the TA220 can be displayed.

Detection of a Cooling Fan Malfunction

The condition of the cooling fan is monitored at all times. If the fan stops, error code 906 is shown on the display. If this occurs, immediately turn OFF the power. If you continue to use the instrument, a warning is given approximately every ten seconds by displaying the error code until the cooling fan recovers.

3.1 Handling Precautions

Safety Precautions

Symbols Used on This Instrument

When using the instrument for the first time, make sure to read the “Safety Precautions” given on pages iv and v.

Do Not Remove the Cover from the Instrument

Do not remove the instrument case. Some parts of the instrument use high voltages, which are extremely dangerous. For internal inspection or adjustment, contact your nearest YOKOGAWA dealer.

Cut the Power in Case of Irregularity

If there are any symptoms of trouble such as strange smells or smoke coming from the instrument, turn the power OFF immediately, and remove the power cord from the outlet. If such an irregularity occurs, contact your YOKOGAWA dealer.

Turn OFF the Instrument If the Cooling Fan Stops

If error code 906 appears on the display, the cooling fan is stopped. Immediately turn OFF the power switch. From the rear panel, check for and remove any foreign object that may be obstructing the cooling fan. If error message 906 appears when you turn ON the power switch again, it is probably a malfunction. Contact your YOKOGAWA dealer.

Handle the Power Cord Correctly

Nothing should be placed on top of the power cord. The power cord should also be kept away from any heat sources. When unplugging the power cord from the outlet, never pull by the cord itself. Always hold and pull by the plug. If the power cord is damaged, check the part number indicated on page ii and purchase a replacement.

General Handling Precautions

Do Not Place Objects on Top of the Instrument

Never place any objects containing water on top of the instrument. Doing so can lead to malfunction.

Do Not Apply Physical Shock or Vibration to the Instrument

Do not apply physical shock or vibration to the instrument. Doing so can lead to malfunction. Take extra caution because the built-in meter is sensitive to vibration and shock. In addition, applying shock to the input terminal or the connected cable can cause electrical noise to enter the instrument.

Keep Electrically Charged Objects Away from the Instrument

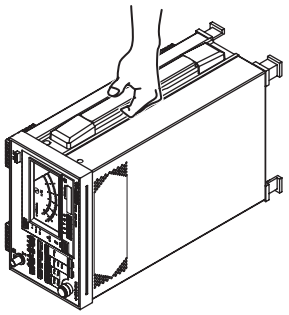
Do not bring charged objects near the input connector. Doing so could cause damage to the instrument's internal circuitry.

Unplug During Periods of Extended Non-Use

When not using the instrument for a long period of time, turn OFF the power switch and remove the power cord from the outlet.

Moving the Instrument

Remove the power cord and all connected cables before moving the instrument. The instrument weighs approximately 5 kg. Always carry the instrument carefully by the handle (as shown below) when moving it.



Clean the Instrument Properly

When wiping off dirt from the case or operation panel, turn OFF the power switch and remove the power cord from the outlet. Then, gently wipe with a soft dry clean cloth. Do not use chemicals such as benzene or thinner, since these may cause discoloring and deformation. Do not bring charged objects near the signal terminals.

3.2 Installing the Instrument

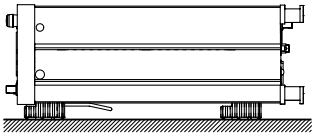
Installation Position

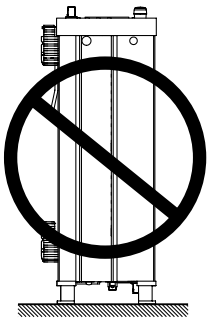
WARNING

To avoid the possibility of fire, never use the instrument with the rear panel facing down. There are vent holes for the cooling fan on the rear panel. Placing the instrument with the rear panel down can cause a fire when the instrument malfunctions. If you must use the instrument with the rear panel down, place a metal plate or a flame-resistive barrier (grade UL94 V-1 or higher) beneath the instrument.

- Place the instrument on a flat, even surface as shown in the figure below.
- If you are installing the instrument on a slippery surface, attach the rubber feet (two pieces, included in the package) to the hind feet.

Place the instrument on a flat, even surface.





Note

- The specification of the meter presumes that the TA220 is installed horizontally and that the meter is in the vertical position. The specifications of the meter cannot be satisfied when the instrument is installed with the rear panel down.
- It is possible to install the TA220 with the stand in the upright position. Please note that the instrument specifications are based on horizontal placement. When using the stand, pull the stand forward until it locks (perpendicular to the bottom surface of the instrument). If you are not using the stand, return it to the original position while pressing the leg section of the stand inward.

Installation Location and Environment

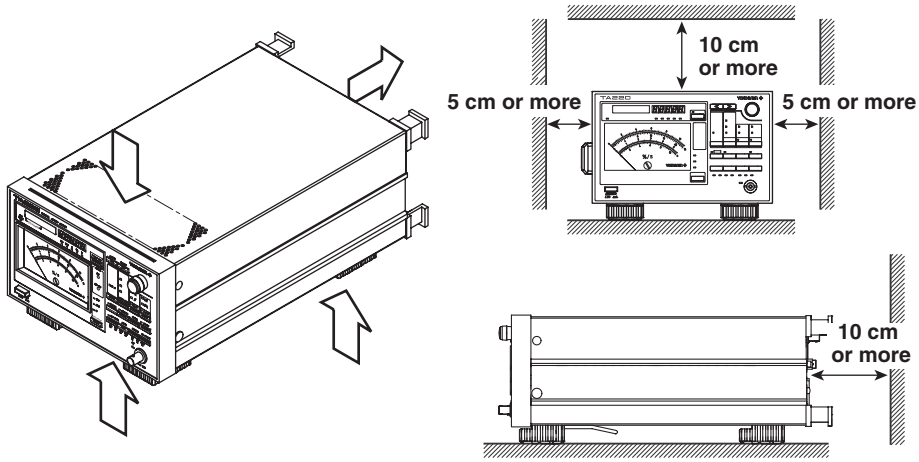
The instrument must be installed where the following conditions are met.

Orientation and Stability

Install the instrument in a stable, horizontal place. Accurate measurements may be hindered if the instrument is used in an unstable place or tilted position.

Ventilation

Inlet holes are located on the top and bottom of the instrument. In addition, there are vent holes for the cooling fan on the rear panel. To prevent internal overheating, allow for enough space around the instrument (see the figure below) and do not block the vent holes.



Ambient Temperature and Humidity

Use the instrument in the following environment.

- Ambient temperature: 5 to 40°C
  However, in order to obtain highly accurate measurements, operate the instrument in the 23 ±5°C temperature range.
- Ambient humidity: 20% to 80% RH
  No condensation should be present. However, in order to obtain highly accurate measurements, operate the instrument in the 50 ±10% RH range.

Note

Condensation may occur if the instrument is moved to another place where the ambient temperature is higher, or if the temperature changes rapidly. In this case, let the instrument adjust to the new environment for at least an hour before using it.

Do Not Install the Instrument in Any of the Following Places

- In direct sunlight or near heat sources
- Where an excessive amount of soot, steam, dust, or corrosive gases are present
- Near strong magnetic field sources
- Near high voltage equipment or power lines
- Where the level of mechanical vibration is high
- On an unstable surface

Storage Locations

When storing the TA220, avoid the following locations:

- A place with a relative humidity of 80% or more
- In direct sunlight
- Where the temperature rises above 60°C
- Near high sources of heat or humidity
- Where the level of vibration is high
- Where corrosive or explosive gas is present
- Where an excessive amount of soot, dust, salt, and iron are present
- Near locations where water, oil, or chemicals can splatter.

It is recommended that you store the instrument in an environment of 5 to 40°C, 20 to 80% RH whenever possible.

Rack Mounting

When rack mounting the TA220, use the rack mount kit that is sold separately. For the procedure on attaching the TA220 to a rack, see the User's Manual included in the rack mount kit.

Name	Model	Description
Rack mount kit	751533-E3	For EIA single mount
Rack mount kit	751534-E3	For EIA dual mount
Rack mount kit	751533-J3	For JIS single mount
Rack mount kit	751534-J3	For JIS dual mount

3.3 Connecting the Power Supply

Before Connecting the Power Supply

Follow the warnings below to avoid electric shock or damage to the instrument.

WARNING

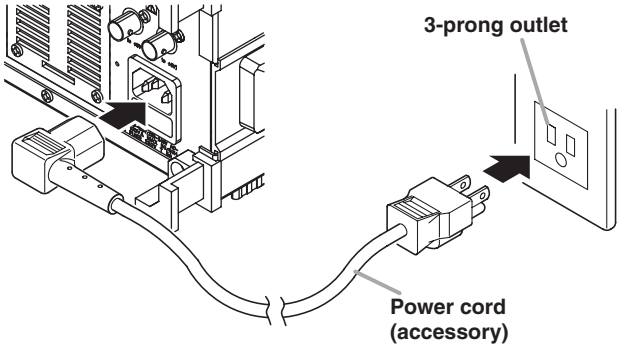
- Before connecting the power cord, ensure that the source voltage matches the rated supply voltage of the instrument and that it is within the maximum rated voltage of the provided power cord.
- Check that the power switch of the instrument is turned OFF before connecting the power cord.
- To prevent the possibility of electric shock or fire, be sure to use the power cord for the instrument that was supplied by YOKOGAWA.
- Make sure to connect protective grounding to prevent electric shock. Connect the power cord of the adapter to a three-prong power outlet that has a protective grounding terminal.
- Do not use an extension cord that does not have a protective grounding wire. The protective features of the instrument will be rendered ineffective.
- Use an AC outlet that complies with the power cord provided and securely connect the protective grounding. Do not use the instrument if no such compatible power outlet and proper protective grounding are available.

Connecting the Power Cord

1. Check that the power switch is turned OFF.
2. Connect the power cord plug to the power connector on the rear panel.
3. Plug the other end of the power cord into a power outlet that satisfies the conditions below. Use a 3-prong power outlet equipped with protective grounding.

Item	Description
Rated supply voltage*	100 to 120 VAC, 200 to 240 VAC
Permitted supply voltage range	90 to 132 VAC, 180 to 264 VAC
Rated power supply frequency	50/60 Hz
Allowable power supply frequency variation	48 to 63 Hz
Maximum power consumption	150 VA

* The TA220 can use a 100-V or a 200-V power supply. Check that the voltage supplied to the TA220 is less than or equal to the maximum rated voltage of the provided power cord (see page ii) before using it.



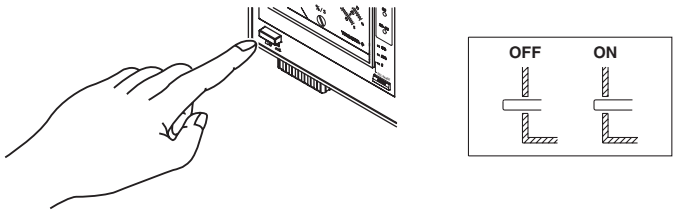
3.4 Turning the Power Switch ON and OFF

To Be Checked before Turning the Power ON

- Is the instrument properly installed?: Section 3.2, “Installing the Instrument”
- Is the power cord properly connected?: Section 3.3, “Connecting the Power Supply”

Location of the Power Switch and ON/OFF Operation

The power switch is located at the lower left corner of the front panel. The power switch is a push button. Press once to turn it “ON” and press again to turn it “OFF.”



Power Up Operation

When the power switch is turned ON, a test program is launched automatically and the model name and results of each test are displayed on Display 2 (model name -> EQ board -> MEMORY -> ETHER, and so on). If the test program finishes successfully, the instrument enters measurement mode. The setup conditions are restored to the ones that existed immediately before the power switch was turned OFF after the previous session.

Note

If the TA220 does not operate as described above when the power switch is turned ON, turn OFF the power switch and check the following points:

- That the power cord is securely connected.
- That the supply voltage from the power outlet is correct -> See section 3.3.
- That the power fuse has not blown -> See section 12.8.
- That, if necessary, the setup information on the instrument is initialized. Two initialization methods can be used. -> See section 11.2.

If the instrument still fails to power up when the power switch is turned ON after checking these points, the instrument is most likely malfunctioning. Contact your nearest YOKOGAWA dealer for repairs.

To Make Accurate Measurements

To ensure accurate measurements, check the installation conditions indicated in section 3.2, then allow the instrument to warm up for at least thirty minutes after the power switch is turned ON.

Shutdown Operation

The setup information that exists immediately before the power switch is turned OFF is stored. This holds true also when the power cord becomes unplugged. Please note that measured results will not be saved.

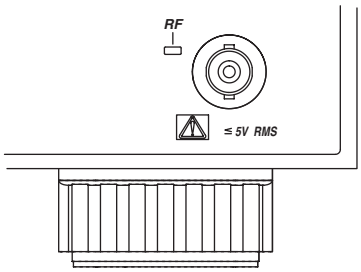
Note

The lithium battery that is used to store the setup information has a limited life span. When the voltage level of the lithium battery drops below a given level, error code 909 appears on the display when the power switch is turned ON. If the error code appears frequently, the lithium battery must be replaced quickly. The user cannot replace the battery. Contact your nearest YOKOGAWA dealer. For the life span of the battery, see section 12.9.

3.5 Connecting Cables and a Probe

Location of the Measurement Input Terminal

The signal input terminal is located at the lower right section of the front panel. Connect a cable or a probe with a BNC connector. You can select an input impedance for the instrument's measurement input terminal of 1 MΩ or 50 Ω (see section 4.2). Therefore you should choose a cable or probe that matches the impedance setting you entered.



Signal Input Terminal Specifications

Item	Description
Connector type	BNC
Number of channels	1 (RF input)
Input impedance	Select 1 MΩ // 20 pF (typical value*), or 50 Ω.
Maximum input voltage	5 Vrms
Ground	Connect to the case ground

* The typical value is a representative or standard value. It is not strictly guaranteed.

CAUTION

Do not apply a voltage that exceeds the maximum input voltage to the input terminal. Doing so can cause damage to the input section.

Note

When connecting the probe for the first time, perform phase correction of the probe according to the description given in section 3.6. Failure to do so will cause unstable gain across different frequencies, thereby preventing correct measurement. Phase correction of the probe must be performed if either the probe or the TA220 is altered.

3.6 Correcting the Probe Phase

Items Required

The following items are required.

Calibration Signal

Frequency	1 kHz
Voltage (waveform amplitude)	1 V_{p-p}
Waveform type	Square wave
Output impedance	1 MΩ
Recommended signal	Probe compensation signal of the Digital Oscilloscope DL1740 (YOKOGAWA)

Waveform Monitor

Frequency characteristics	DC to 100 MHz (–3 dB point)
Input coupling	DC
Input Impedance	50 Ω
Recommended device	DL1740 Digital Oscilloscope (Yokogawa Corp.)

The connection procedure and operation when the recommended signal is connected to the recommended instruments are described below.

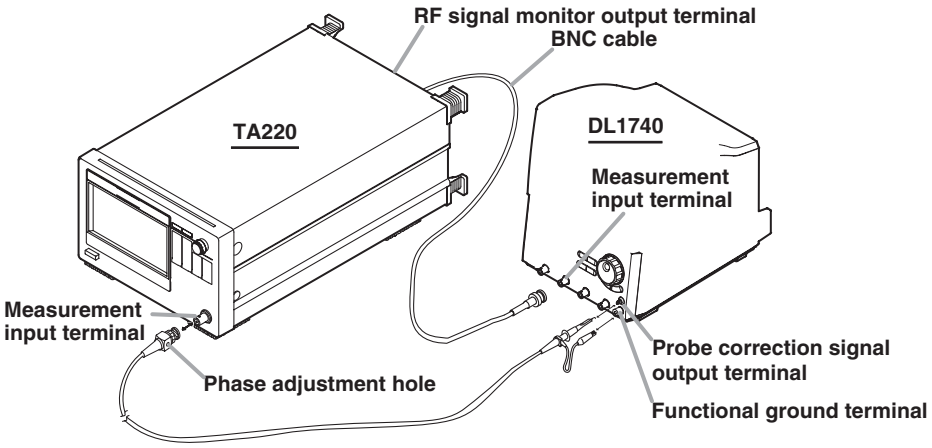
Device Connections

CAUTION

- Do not apply a voltage that exceeds the maximum input voltage to the input terminal. This may cause damage to the input section.
- Do not short or apply an external voltage to the probe compensation signal output terminal of the DL1740, or the RF signal monitor output terminal of the TA220. This may cause damage to the internal circuitry.

Check that the TA220 and DL1740 are turned OFF and connect them as shown in the figure.

1. Connect a BNC cable from the RF signal monitor output terminal on the rear panel of the TA220 to the measurement input terminal of the DL1740.
2. Connect the BNC end of the probe that is to be phase corrected to the measurement input terminal on the front panel of the TA220.
3. Connect the other end of the probe to the probe compensation signal output terminal of the DL1740 and the ground wire to the functional ground terminal.



Procedure

1. Turn ON the TA220 and DL1740.
2. Set the input impedance of the DL1740 to 50 Ω. For the procedure, see the DL1740 User's Manual.
3. Turn OFF the equalizer of the TA220 (see section 4.3).
4. Set the waveform acquisition conditions of the DL1740 so that approximately two periods of the waveform can be viewed in their entirety.
5. Insert a flat-head screwdriver to the phase adjustment hole of the probe and turn the variable capacitor to make the waveform displayed on the waveform monitor a correct rectangular wave (see explanation).

Explanation

The Necessity of Phase Correction of the Probe

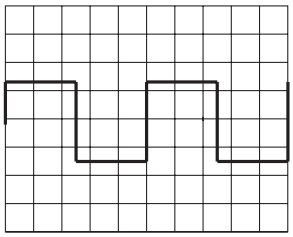
If the input capacity of the probe is not within the adequate range, the gain across different frequencies will not be uniform. Consequently, a correct waveform cannot be input to the measurement circuit of the TA220. The input capacity of each probe is not necessarily all the same. Therefore, the probe has a variable capacitor (trimmer) that allows the input capacity to be adjusted. This adjustment is called phase correction. When using the probe for the first time, make sure to perform phase correction. The appropriate input capacitance varies depending on the input connector of the instrument. Therefore, phase correction must also be performed when the connected instrument is changed.

Calibration Signal

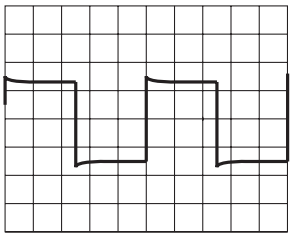
Waveform type	Square wave
Frequency	1 kHz
Voltage	1 Vp-p

Differences in the waveform due to the phase correction of the probe

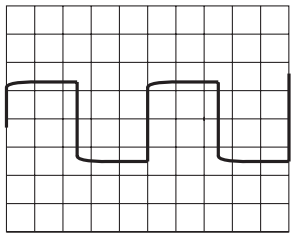
Correct waveform



Over compensated (the gain in the high frequency region is up)

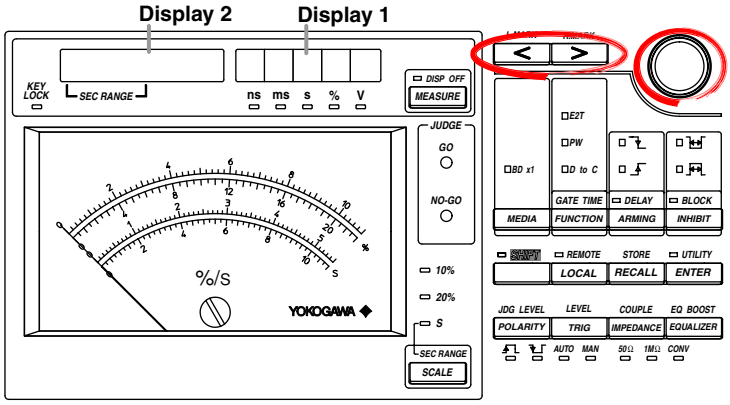


Under compensated (the gain in the high frequency region is low)



3.7 Entering Numerical Values

Procedure



1. Confirm that Display 1 or 2 is displaying numerical values, and that only one of the digits of the displayed values is blinking.
2. Press an **arrow** (< or >) key to select the digit you wish to change. The numerical value or underbar at the selected digit blinks.
3. Turn the **rotary knob** to set the value within the range of each item. As the value of the selected digit is increased, the next higher digit is also increased accordingly. Likewise, as the value of the selected digit is decreased, the next lower digit is also decreased accordingly.

Explanation

You can set the numerical value within the range of each item. You can confirm that the TA220 is ready to accept numerical values when a single digit of the numerical value on the display is blinking.

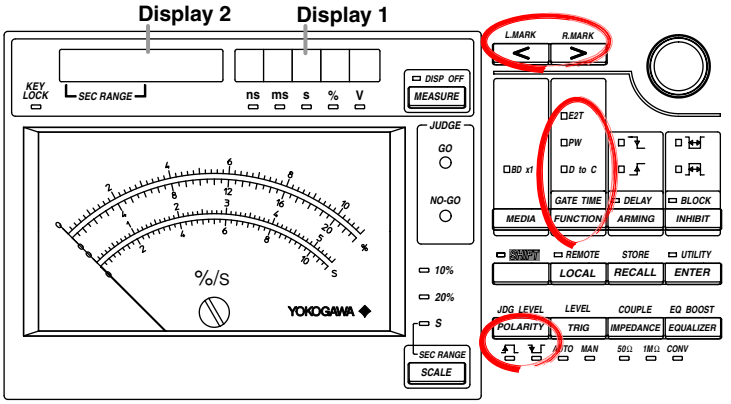
Note

You can reset the specified numerical value to the initial value (factory default setting). For details, see section 11.2.

4.1 Selecting the Measurement Function and Polarity

<<For a functional description, see section 2.3>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Selecting Data-to-Clock Phase Difference Jitter or Data-to-Clock Phase Difference Jitter Excluding 2T

1. Press **FUNCTION**, then select D-to-C or E2T. The D-to-C or E2T indicator illuminates.
   - If you select D-to-C, the normal data-to-clock phase difference jitter will be measured.
   - If you select E2T, the data-to-clock phase difference jitter excluding 2T will be measured. E2T cannot be selected on products with suffix code -BDS.

Selecting the Polarity

2. Press **POLARITY** and select ⌐¯, ¯¬, or both ⌐¯ and ¯¬. The indicator of the selected item illuminates.

Selecting the Pulse Width Jitter

1. Press **FUNCTION** and select PW. The PW indicator illuminates.

- **Selecting the Polarity**

2. Press **POLARITY** and select ⌐¯, ¯¬, or both and . The indicator of the selected item illuminates.

- **Setting the Upper and Lower Limit of the Pulse Width to be Measured**

3. Press **SHIFT+< (L.MARK)**. L.Marker appears in Display 2, and the pulse width lower limit appears in Display 1.
4. Use **rotary knob & < >** to set the lower limit of the pulse width to be measured.
5. Press **SHIFT+< (R.MARK)**. R.Marker appears in Display 2, and the pulse width upper limit appears in Display 1.
6. Use **rotary knob & < >** to set the upper limit of the pulse width to be measured.

Explanation

You can select the measurement function (measurement parameter). For each function, you can select the polarity of the signals to measure.

Data-to-Clock Phase Difference (D-to-C) Jitter or Data-to-Clock Phase Difference (E2T) Jitter Excluding 2T

You can set the item to be measured as either the phase difference jitter between the measurement input signal (RF signal) and clock signal (D-to-C), or the phase difference jitter* between the measurement input signal excluding 2T and clock signal (E2T). The clock signal used is the one regenerated from the RF signal inside the instrument.

* E2T cannot be selected on products with suffix code -BDS.

Polarity

You can select which polarity of RF data signals to measure.

- : The rising slope becomes the phase difference jitter measurement starting point.
- : The falling slope becomes the phase difference jitter measurement starting point.
- and : The rising and falling slopes alternately become the starting point for phase difference jitter measurement.

Pulse Width (PW) Jitter

You can select to measure the pulse width jitter in the measurement input signal (RF signal).

- **Polarity**
  You can select which polarity of signals to measure.
  - : Measures the positive side (from the rising slope to the next falling slope) of the pulse width.
  - : Measures the negative side (from the falling slope to the next rising slope) of the pulse width.
- **Upper and Lower Limit of the Pulse Width to be Measured**
  The limit values can be set in the following range when the measurement function is set to pulse width jitter.
  Setting range for pulse width lower limit: 0.00 to 998.99 ns (in steps of 0.01 ns)
  Setting range for pulse width upper limit: 1.00 to 999.99 ns (in steps of 0.01 ns)
  The minimum difference (in time) between the upper and lower limit is 1 ns. If the lower limit is set equal to or higher than the upper limit (or vice versa), the upper limit is automatically raised to 1 ns above the lower limit (or vice versa).

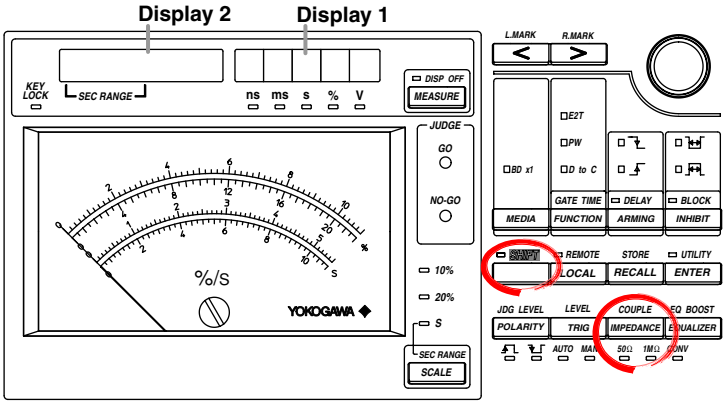
Note

- Setup information (measurement conditions) can be saved for each measurement function. However, the key lock ON/OFF setting (see section 11.4), communication settings (see chapters 8 and 9), and other global settings are always the same regardless of the function.
- The clock signal used is the one regenerated from the RF signal inside the instrument. The frequency range of the regenerated clock signal is 66 MHz±3%.
- If the clock cannot be regenerated by the PLL circuit (PLL unlock), the meter needle goes beyond the scale line that indicates the maximum value of each scale, and the characters “unLoC” appear on Display 1. The jitter ratio output and determination output (see section 7.1) are 5 V and 0 V respectively.

4.2 Selecting the Input Impedance and Input Coupling

<<For a functional description, see section 2.4>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Selecting the Input Impedance

Press **IMPEDANCE**, and select 50 Ω or 1 MΩ. The indicator of the selected item illuminates.

Selecting the Input Coupling

1. Press **SHIFT+IMPEDANCE (COUPLE)**. Couple appears in Display 2, and dC or AC appears in Display 1.
2. Turn the **rotary knob** to select dC or AC.

Explanation

Input Impedance

You can select an input impedance for the measurement input terminal of 50 Ω or 1 MΩ.

Input Coupling

You can select an input coupling for the measurement input terminal of DC or AC.

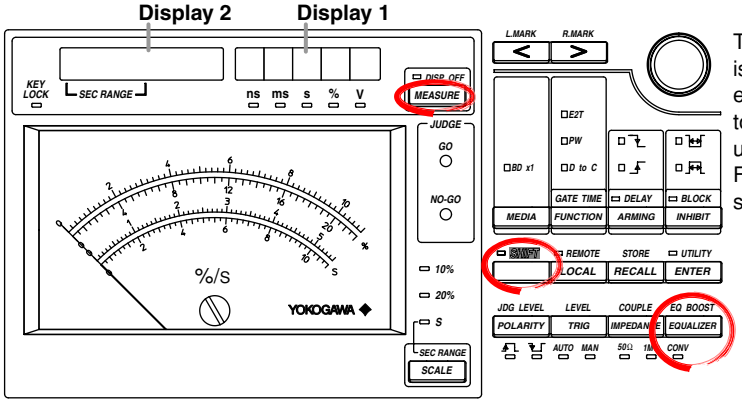
Note

The frequency characteristics differ depending on the input impedance and input coupling setting. For information on the frequency characteristics, see section 13.1.

4.3 Equalizer Settings

<<For a functional description, see section 2.4>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Turning the Conventional Equalizer ON and Setting the Boost Amount

(For information on the limit equalizer option, see the option function user's manual (IM 704610-51E).

- **Procedure A**
  1. Press the **EQUALIZER** and select CONV. The CONV indicator illuminates.
  2. Press **SHIFT+EQUALIZER (EQ BOOST)**. ConBoost (or EQ Boost for products with suffix code -BDS) appears in Display 2, and the setting value appears in Display 1.
  3. Use **rotary knob & < >** to set the boost amount.

- **Procedure B**

  To enter the boost amount using the procedure below, you must turn display of Disp EQ ON when selecting numerical value display (see section 5.2).

  You can set the boost amount while viewing the measured jitter ratio on Display 1.
  1. Press **MEASURE** to display the EQ in Display 2.
  2. Press **EQUALIZER** and select CONV. The CONV indicator illuminates. At the same time, the boost amount is shown on Display 2.
  3. Use **rotary knob & < >** to set the boost amount.

Turning the Equalizer OFF

Press **EQUALIZER**. The illuminated indicator turns off.

Explanation

When the equalizer is turned ON (CONV), you can equalize the signal amplitude in the high frequency range. You can make more accurate measurements by equalizing the RF signal input to the measurement input terminal.

Boost Amount (Amplification) of the Conventional Equalizer

The boost amount can be set in the following range when the equalizer is set to CONV.
Setting range: 3.0 to 9.0 dB (in steps of 0.1 dB)

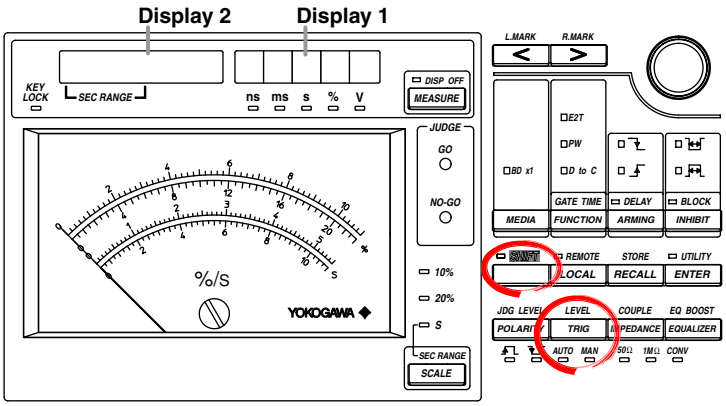
Note

- The frequency characteristics of the internal equalizer circuit of the TA220 conform to Part 1 Ver. 1.0 of the Blu-ray Disc standard (1 ¥ speed).
- For information on the limit equalizer option, see the option function user's manual (IM 704610-51E). The limit equalizer cannot be selected as an option for products with suffix code -BDS.

4.4 Setting the Trigger Mode and Slice Level

<<For a functional description, see section 2.4>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Selecting the Trigger Mode

1. Press **TRIG** and select AUTO, MAN, or AUTO and MAN. The indicator of the selected item illuminates. If you selected MAN or AUTO and MAN, proceed to step 2.

Setting the Slice Level

2. Press **SHIFT+TRIG (LEVEL)**. TrigLv. appears in Display 2, and the setting value appears in Display 1.
3. Use **rotary knob & < >** to set the slice level.

Explanation

When measuring the pulse width or phase difference of a single pulse, you can select the level of the data signal at which to make the measurement (activate the trigger). Slice level refers to the signal level used to binarize the RF signal, and this slice level is used to activate the trigger.

Trigger Mode and Slice Level

- **AUTO (auto mode)**
  The RF signal is binarized using the slice level that is detected by the auto slice circuit. For information about the auto slice function, see section 2.4.

- **MAN (manual mode)**
  The slice level can be set in the range below when the trigger mode is set to Manual. The RF signal is binarized using the specified slice level.
  - When the measurement function is set to PW (pulse width), AGC is OFF (see section 4.9), and the equalizer is OFF:
    Setting range: –2.000 to 2.000 V (in steps of 1 mV)
  - Other than the above:
    Setting range: –1000 to 1000 (in steps of 1)

- **AUTO and MAN (Auto + Manual Mode)**
  The RF signal is binarized using the slice level obtained by superimposing a given offset level to the slice level that is detected by the auto slice function. The offset level is a separate level from the slice level of manual mode in the previous section, and when the trigger mode is set to auto + manual, the following range applies.
  Setting range: –1000 to 1000 (in steps of 1)

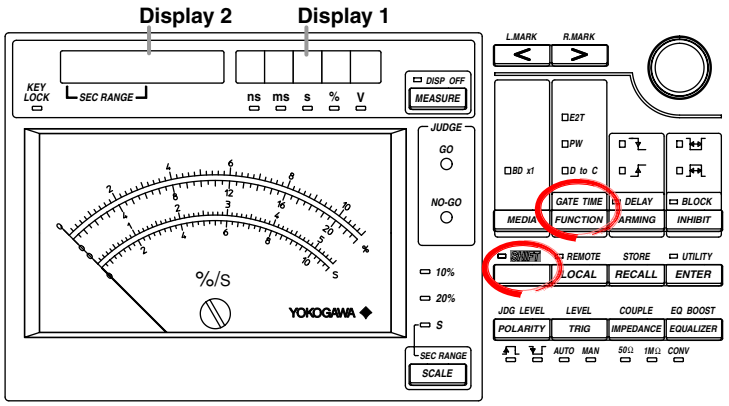
Note

- When the measurement function is PW, AGC is OFF, and the equalizer is OFF, if the slice level set in manual mode exceeds 1 V (or is less than –1 V), it will change to 1000 (or –1000) when AGC or the equalizer are turned ON.
- When the measurement function is PW, AGC is OFF, and the equalizer is OFF, you cannot change to a trigger mode other than manual mode. Conversely, even if you set the instrument to a different mode, if the measurement function is then set to PW, and AGC and the equalizer are turned OFF, the trigger mode automatically changes to manual mode.
- The trigger mode is forcibly set to AUTO when the limit equalizer is selected (see the option function user's manual, IM704610-51E). The trigger mode remains the same even if the equalizer is returned to OFF or CONV.

4.5 Setting the Gate Time

<<For a functional description, see section 2.4>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

1. Press **SHIFT+FUNCTION (GATE TIME)**. GateTime appears in Display 2, and the setting value appears in Display 1.
2. Use **rotary knob & < >** to set the gate time.

Explanation

You can set the time (gate time) during which the measured values of pulse width and phase difference are stored in the acquisition memory.

Gate Time

The duration can be set within the following range.

Setting range

When D-to-C high speed calculation (see section 4.9) is OFF:

1 to 1000 ms (in 1 ms steps)

When D-to-C high speed calculation is ON:

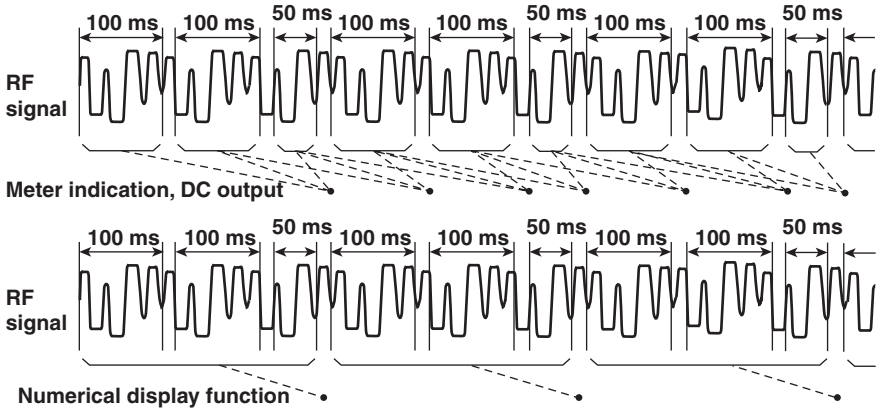
2 to 1000 ms (in 2 ms steps)

Note

Loading the Measured Values When D-to-C High Speed Calculation is OFF

- When the gate time is set between 100 ms and 1000 ms, the measured values are acquired in units of 100 ms. The measured values are acquired so that the sum of the gate times in units of 100 ms add up to the specified gate time, and those values are used to determine the jitter (statistical value). The calculated value is displayed or output as a DC level signal (see section 7.1). Meter indication, numerical display, and DC output are updated as shown below. When measurement is performed only once using the SSTart communication command, if external arming (see section 4.6) is selected, the acquisition is performed all at once without being divided up by the specified gate time in 100 ms units.

Example in which the gate time is set to 250 ms



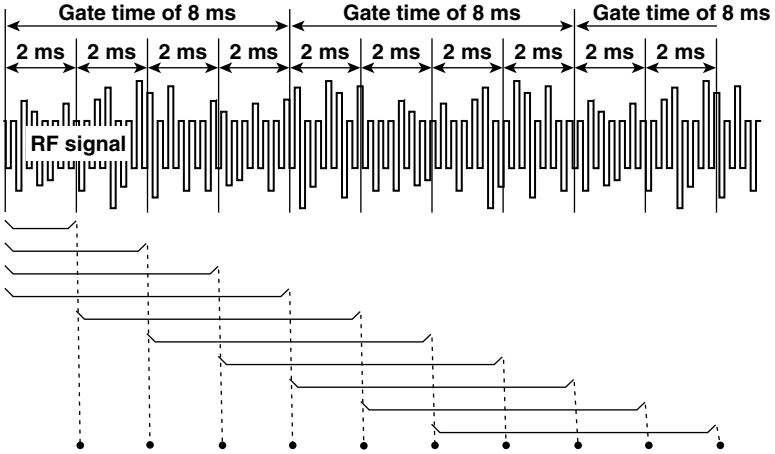
- The setting for the gate time and number of blocks during block sampling is restricted such that maximum number of samples that can be acquired by the instrument is not exceeded. For details, see the Note in section 4.7.

Loading the Measured Values When D-to-C High Speed Calculation is ON

- When D-to-C high speed calculation is ON, the measured values of the measurement clock delimited every 2 ms are moving-summed over the gate time range, and the results are displayed or DC-output (see section 7.1).
  - Meter indication, numeric display, and DC output are updated as shown below.
  - The SSTart and STOP communication commands cannot be executed when D-to-C high speed calculation is ON.

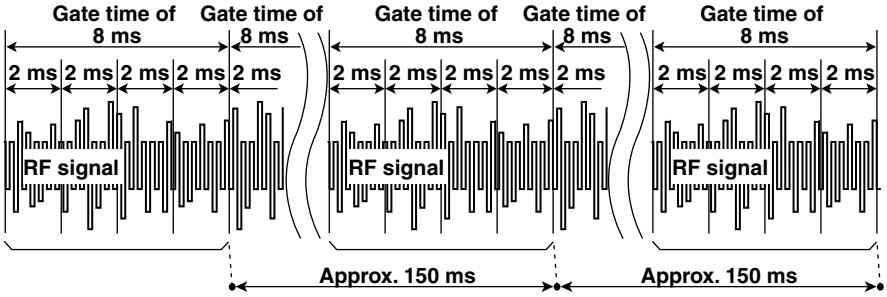
Example of Display/Output Updating When the Gate Time is 8 ms

- **Meter indication and DC output**



Updates the display/output of the moving-summed result every 2 ms.
The summing time is the same as the gate time.

- **Numeric display**



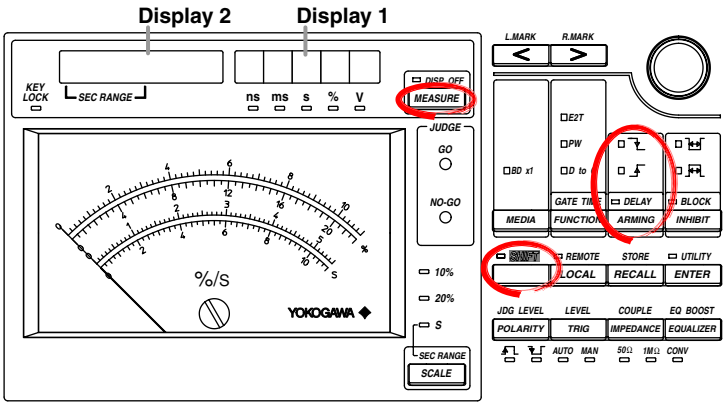
Updates the display of the moving-summed result approximately every 150 ms.
The summing time is the same as the gate time.

- The setting for the gate time and number of blocks during block sampling is restricted such that the maximum number of samples that can be acquired by the instrument is not exceeded. For details, see the Note in section 4.7.

4.6 Setting the Arming

<<For a functional description, see section 2.4>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Selecting Auto Arming (Internal Arming)

Press **ARMING** to turn OFF both the ⌐‾ and ‾⌐ indicators.

Selecting External Arming and Setting the Arming Delay

- **Procedure A**
  1. Press **ARMING** and select ⌐‾ or ‾⌐. The indicator of the selected item illuminates.
  2. Press **SHIFT+ARMING (DELAY)**. ArmDelay appears in Display 2, and the setting value appears in Display 1.
  3. Use **rotary knob & < >** to set the delay time.

- **Procedure B**

  To enter the delay time using the procedure below, you must turn display of DispDly ON when selecting numerical value display (see section 5.2).

  You can set the delay time while viewing the measured jitter ratio on Display 1.
  1. Press **MEASURE** to display Dly in Display 2.
  2. Press **ARMING** and select ⌐‾ or ‾⌐. The indicator of the selected item illuminates. At the same time, the delay time is shown on Display 2.
  3. Use **rotary knob & < >** to set the delay time.

Explanation

Arming refers to the cue used to start the measurement. As opposed to a trigger, which refers to the cue used to measure the pulse width or phase difference of each pulse, arming refers to the starting point of the measurement of a set of pulse widths or phase differences used to derive the jitter.

Auto Arming (Internal Arming)

If you turn OFF both the ⌐ and ¬ indicators, auto arming is activated. The internal signal of the TA220 is the arming source. Arming is the cue used to start the first measurement (the first trigger).

External Arming

Arming is activated when an external signal (arming source) is applied to the external arming input terminal.

- **Slope**
  - ⌐: Arming is activated on the rising slope of the external arming signal.
  - ¬: Arming is activated on the falling slope of the external arming signal.
- **Arming Delay**

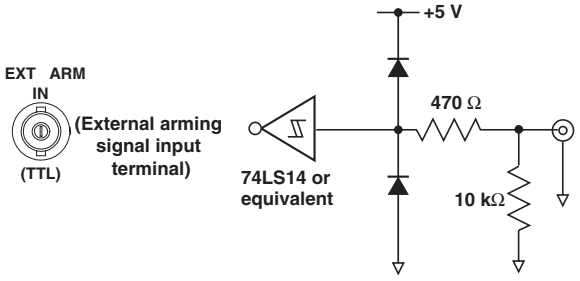
  When using external arming, set the delay time of arming in the range shown below.
  Setting range: 0.0 to 100.0 ms (in steps of 0.1 ms)
- **External Arming Signal**

  Input the external arming signal to the terminal labeled “EXT ARM IN” on the rear panel.

Item	Description
Connector type	BNC
Input Impedance	10 kΩ (typical value*)
Input coupling	DC
Input level	TTL level
Allowable input voltage range	–5 to 10 V (DC+ACpeak)
Minimum input pulse width	30 ns

* The typical value is a representative or standard value. It is not strictly guaranteed.

External arming input circuit



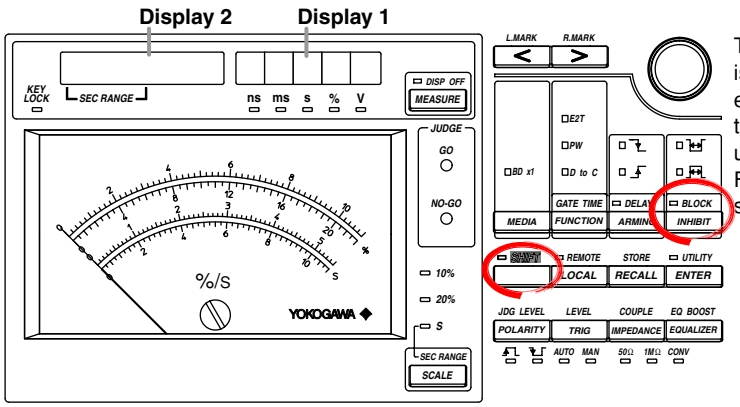
CAUTION

Do not apply a voltage that exceeds the allowable input voltage range to the external arming signal input terminal. This may cause damage to the TA220.

4.7 Block Sampling Settings

<<For a functional description, see section 2.4>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Arming must be set to external arming before carrying out the procedures in this section. For the procedure to set arming, see section 4.6.

1. Press **SHIFT+INHIBIT (BLOCK)**. Block appears in Display 2, and the setting value appears in Display 1.
2. Use **rotary knob & < >** to set the number of blocks. If the number of blocks is set to 2 or more, the BLOCK indicator illuminates.

Explanation

With block sampling, all data collected after performing one block of measurement a specified number of repetitions is processed and displayed together. When using external arming, you can set the number of block in the following range.

Setting range: 1 to 99 (in steps of 1 block)

Note

- During normal measurement, the number of blocks is set to 1. For block sampling measurements other than normal measurement, select a number of blocks of 2 or more.
- The setting for the gate time and number of blocks is restricted such that maximum number of samples that can be acquired by the instrument is not exceeded.
  Conditional expressions
  - **When D-to-C high speed calculation (see section 4.9) is OFF:**
    Gate time × no. of blocks ≤ 5 seconds
  - **When D-to-C high speed calculation is ON: Gate time × no. of blocks ≤ 1 seconds**

Example

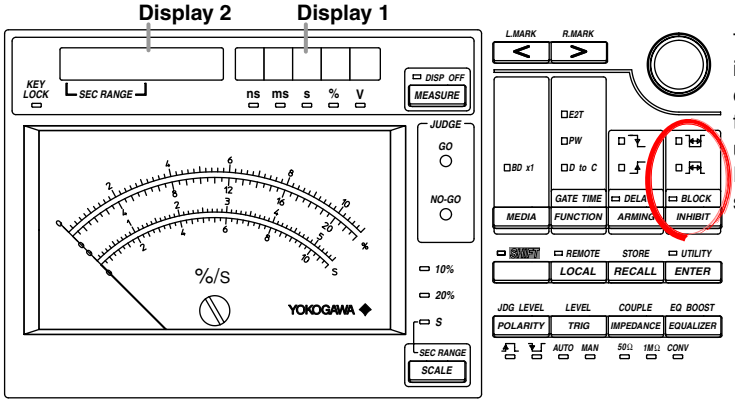
Gate time	Measurable no. of blocks When D-to-C high speed calculation is OFF	When D-to-C high speed calculation is ON
1 ms	99	99
10 ms	99	99
50 ms	99	20
100 ms	50	10
500 ms	10	2
1000 ms	5	1

- Once the gate time and number of blocks reaches the limit according to the condition equation above, if the gate time is increased, the setting for the number of blocks is automatically adjusted. For example, when D-to-C high speed calculation is OFF, and when the gate time starts out at 50 ms and the number of blocks is 99, if the gate time is increased to 500 ms, the number of blocks automatically changes to 10. However, if the gate time is then returned to 50 ms, the number of blocks stays at 10.
- If the gate time is decreased and the measurable number of blocks increases, the setting for the number of blocks is not automatically increased. To manually increase the number of blocks, perform the procedure described in this section.

4.8 Setting Inhibit

<<For a functional description, see section 2.4>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Turning Inhibit ON and Selecting the Polarity

Press **INHIBIT** and select ⌐↔L or ⌐↔⌐. The indicator of the selected item illuminates and inhibit is turned ON.

Turning Inhibit OFF

Press **INHIBIT** to turn OFF both the ⌐↔L and ⌐↔⌐ indicators. Inhibit is turned OFF.

Explanation

You can inhibit measurements by applying an external signal (inhibit signal) to the inhibit signal input terminal. This is possible even while the gate is open or during measurement after arming activation.

Polarity

- ⌐↔L: Inhibits measurements while a positive signal is being input.
- ⌐↔⌐: Inhibits measurements while a negative signal is being input.

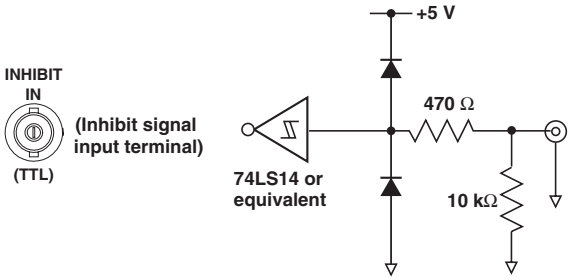
Inhibit Signal

Input the inhibit signal to the connector labeled INHIBIT IN on the rear panel.

Item	Description
Connector type	BNC
Input Impedance	10 kΩ (typical value*)
Input coupling	DC
Input level	TTL Level
Allowable input voltage range	–5 to 10 V (DC+ACpeak)
Minimum input pulse width	30 ns

* The typical value is a representative or standard value. It is not strictly guaranteed.

Inhibit input circuit



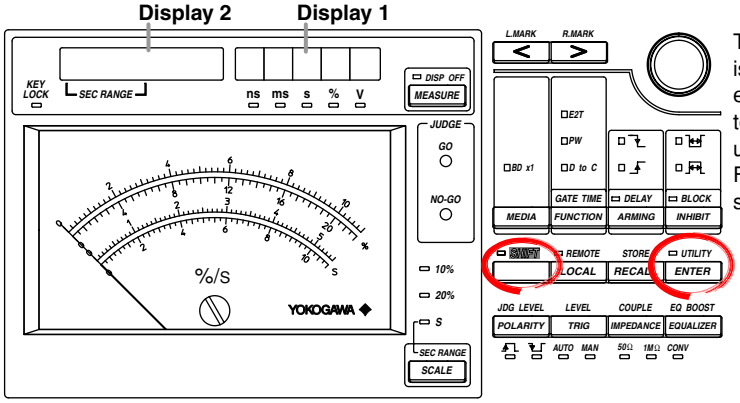
CAUTION

Do not apply a voltage that exceeds the allowable input voltage range to the inhibit signal input terminal. This may cause damage to the TA220.

4.9 Other Functions

<<For a functional description, see section 2.4>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

1. Press **SHIFT+ENTER (UTILITY)**. The Utility menu is shown on Display 2.
2. Turn the **rotary knob** to display Meas in Display 2.
3. Press **>**. PLLhold, D-Ccalc, AGC, or DCclamp is displayed.
   - When the limit equalizer is selected (see the option function user's manual, IM704610-51E), the PLLhold and DCclamp items are not displayed.
   - D-Ccalc is not displayed on products with suffix code -BDS.

Turning PLL Hold ON and OFF

4. Turn the **rotary knob** to select PLLhold.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Turn the **rotary knob** to select on or oFF.
7. Press **ENTER**.

Turning D-to-C High Speed Calculation ON and OFF

(D-Ccalc cannot be turned ON or OFF on products with suffix code -BDS.)

4. Turn the **rotary knob** to select D-Ccalc.
5. Press **>** (or **ENTER**). Display1 blinks.
6. Turn the **rotary knob** to select H-on (ON) or H-oFF (OFF).
7. Press **ENTER**.

Turning AGC ON and OFF

4. Turn the **rotary knob** to select AGC.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Turn the **rotary knob** to select on or oFF.
7. Press **ENTER**.

Turning DC Clamp ON and OFF

4. Turn the **rotary knob** to select DCclamp.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Turn the **rotary knob** to select on or oFF.
7. Press **ENTER**.

Explanation

You can choose to turn the PLL hold function, D-to-C high speed calculation, AGC circuit, or DC clamp function ON or OFF.

PLL Hold

The PLL hold function maintains the frequency of the clock signal regenerated in the PLL circuit when Inhibit is active. If RF signals whose clock signals cannot be regenerated in the PLL circuit are input to the measurement input terminal when Inhibit is active, once Inhibit is cleared, if a normal RF signal whose clock signal can be regenerated in the PLL circuit is then introduced, the clock signal will be generated normally. With PLL hold turned ON, when Inhibit is turned ON and an inhibit signal is input, the PLL hold function activates at the same time.

D-to-C High Speed Calculation

You can update the measured D-to-C jitter values every 2 ms. The measured values of the measurement clock delimited every 2 ms is moving-summed over the gate time range, and the results are updated every 2 ms. The D-to-C high speed calculation function is not available on products with suffix code -BDS.

AGC

If undulations occur in the signal amplitude envelope, the signal can be applied to the AGC circuit to normalize the fluctuations in the amplitude.

DC Clamp

If RF signals with temporarily changing DC components are applied to the measurement input terminal when Inhibit is active, the DC clamp function can be used to quickly attenuate the changed portion of the DC components. The changed portion of the DC component is immediately attenuated, and regeneration of the clock signal by the PLL circuit is maintained. With DC clamp turned ON, when Inhibit is turned ON and an inhibit signal is input, the DC clamp function activates at the same time.

Note

When the limit equalizer is selected (see the option function user's manual, IM704610-51E), the PLLhold and DCclamp functions are not available. The limit equalizer cannot be selected as an option for products with suffix code -BDS.

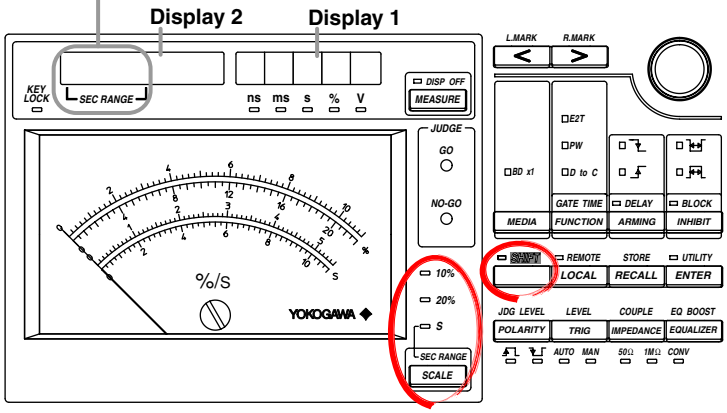
5.1 Meter Display

<<For a functional description, see section 2.5>>

Procedure

Displaying the Time Range

If you press the SCALE key and select s, the units of jitter displayed on the meter are set to units of time (ns or μs). In this case, the specified time range (SEC RANGE) is displayed here.



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Displaying the Jitter Ratio and Selecting the Scale

Press **SCALE** to select 10% or 20%. The needle moves according to the selected scale. The jitter ratio can be read on the upper scale of the meter (%).

Displaying the Jitter and Selecting the Time Range

1. Press **SCALE** to select s.
2. Press **SHIFT+SCALE (SEC RANGE)**. The currently set time range is displayed in the SEC RANGE area of Display 2.
3. Turn the **rotary knob** to select the time range. The selected time range is applied to the lower scale (s) on the meter, and the needle moves according to the new range. The jitter can be read on the lower scale of the meter (s).

Explanation

The TA220 continuously takes measurements when the power is turned ON. The meter needle indicates the jitter ratio or jitter of the measurement function that was selected in section 4.1.

Jitter Ratio Scale

You can select the 10% or 20% scale for the jitter ratio on the upper scale of the meter.

- 10%
  The scale line is written every 0.2%. The needle is capable of indicating a jitter ratio of up to 11%.
- 20%
  The scale line is written every 0.5%. The needle is capable of indicating a jitter ratio of up to 22%.

Jitter Scale

The lower scale on the meter (s) is used as the jitter scale.

Time Range

When the scale units for the meter are set to s, you can select a time range from the following.

0.5 n, 1.0 n, 5.0 n, 10 n, 50 n, 0.1 μ, 0.5 μ, 1.0 μ, 5.0 μ

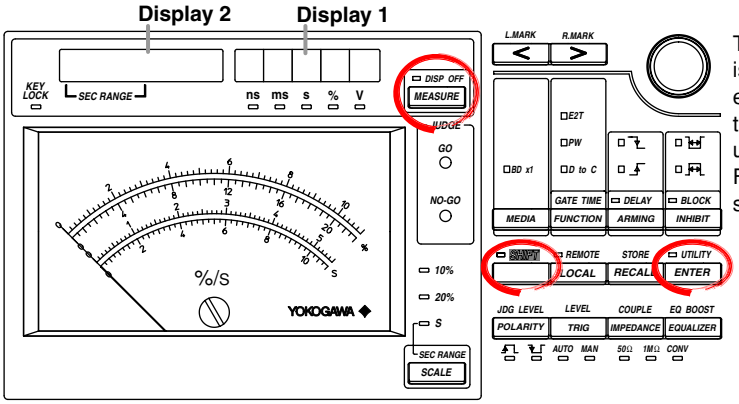
Note

- The shortest period of jitter than can be measured by the instrument is 50 ms (or 2 ms when D-to-C high speed calculation is ON). The meter needle may not respond to all changes in the measured value.
- If the jitter or jitter ratio exceeds the maximum value of each scale, the meter needle goes beyond the scale line that indicates the maximum value of each scale.
- If the trigger is not activated on the input signal and measurements cannot be made, the meter needle goes off the scale beyond the scale line that indicates the maximum value of each scale.
- If the clock cannot be regenerated by the PLL circuit during D-To-C measurement (unLoC is displayed on Display 1), the meter needle goes beyond the scale line that indicates the maximum value of each scale. The jitter ratio output and determination output (see section 7.1) are 5 V and 0 V respectively.

5.2 Turning Numerical Value Display and/or Character Display ON and OFF

<<For a functional description, see section 2.5>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Switching the Numerical Value Display

Press **MEASURE** to change the numerical value displayed in Display 1. Display 2 shows the parameter whose value is displayed in Display 1.

Lv is displayed when measurement of the RF signal voltage level is turned ON (see 7.2 section).

Selecting Numerical Value Display

You can select an item to be displayed when changing the display according to the procedure above ("Switching the Numerical Value Display").

1. Press **SHIFT+ENTER (UTILITY)**. The Utility menu is shown on Display 2.
2. Turn the **rotary knob** to display Display in Display 2.
3. Press **>**. Disp σ/T, Disp σ, DispAVE, DispT, DispSnU, DispSnL, DispEQ, or DispDly is displayed.
4. Turn the **rotary knob** to select Disp σ/T, Disp σ, DispAVE, DispT, DispSnU, DispSnL, DispEQ, or DispDly.
5. Press **>** (or ENTER). Display 1 blinks.
6. Turn the **rotary knob** to select on or oFF.

Turning OFF Display of Numerical Values and Characters

Press **SHIFT+MEASURE (DISP OFF)**. The DISP OFF indicator illuminates, and numerical values and alphabetical characters are no longer displayed on Display 1 and Display 2.

Turning ON Display of Numerical Values and Characters

The DISP OFF indicator illuminates. Numerical values and alphabetical characters are still not displayed, but if you press **SHIFT+MEASURE (DISP OFF)**, the DISP OFF indicator goes out, and numerical values are displayed.

Explanation

The TA220 continuously makes measurements when the power is turned ON. The meter needle indicates the jitter ratio or jitter of the measurement function that was selected in section 4.1, and the numerical value is displayed in Display 1.

Switching the Numerical Value Display

You can switch the parameter whose numerical value is displayed in Display 1. Display 2 shows the parameter whose value is displayed in Display 1. The parameters you can select from are those whose display property is set to ON in "Numerical Value Display Parameters" below (σ/T, σ, AVE, T, SuU, SnL, EQ, and Dly).
"Lv (voltage level)" can also be displayed when measurement of the RF signal voltage level is turned ON (see 7.2 section).

Numerical Value Display Parameters

You can select an item to be displayed from among the following when changing the display according to the procedure above ("Switching the Numerical Value Display"). You can turn the display property of each parameter ON or OFF. However, if display is turned ON for only one parameter, it cannot be turned OFF.

Displayed Characters	Display Contents
Dispσ/T	Jitter ratio (see section 2.3)
Disp σ	Jitter (see section 2.3)
DispAVE	Jitter average (see section 2.3)
Disp T	When the measurement function is set to pulse width Difference between the upper and lower limit of the pulse width set in section 4.1 When the measurement function is set to D-to-C Period of the clock signal
DispSnU	Of the ten digits expressing the number of samples, the value of the upper five digits
DispSnL	Of the ten digits expressing the number of samples, the value of the lower five digits
Disp EQ	Equalizer boost amount (Display 2) and jitter ratio (Display 1)
DispDly	Arming delay time (Display 2) and jitter ratio (Display 1)

* The number of data sampled in order to measure the jitter ratio and jitter.

Turning Display of Numerical Values and Characters ON and OFF

If you are distracted by the changing jitter ratio, jitter, or average values, or blinking setting values, you can turn the display of numerical values and alphabetical characters, as well as the units indicator on Display 1 and Display 2 OFF all at once.

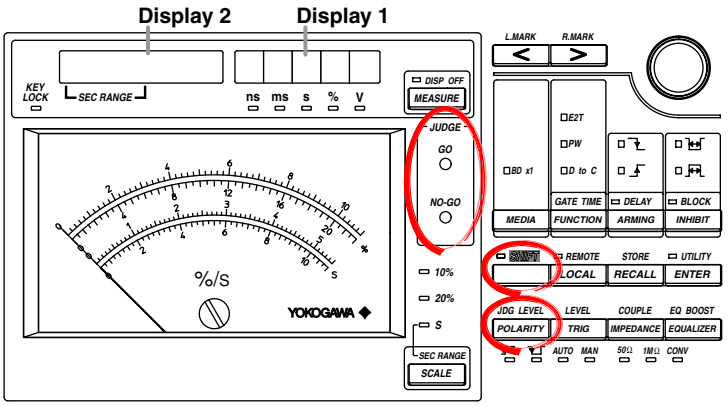
Note

- Even when the numerical display is turned OFF, the display shows the setup values when setting the TA220. For the setup procedures of each type, see the corresponding sections in chapter 4. Error code and version information is still displayed even if numerical value display is turned OFF.
- If the numerical value to be displayed cannot be obtained, Display 1 shows "- - - - -" (bar).
- If the clock cannot be regenerated by the PLL circuit during D-To-C measurement (PLL unlock), unLoC is displayed on Display 1. The jitter ratio output and determination output (see section 7.1) are 5 V and 0 V respectively.
- If the average coefficient for the DC output filter (see section 7.1) or the jitter ratio correction coefficient (see section 7.1) is something other than the default value, the letter F is displayed in inverse video on Display 2 to the left of the characters indicating which parameter is being displayed (except when equalizer boost amount EQ and arming delay time Dly are displayed).

5.3 Displaying the Jitter Ratio Determination

<<For a functional description, see section 2.5>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Setting the Jitter Ratio Determination Level

1. Press **SHIFT+POLARITY (JDG LEVEL)**. DC JdgLv appears in Display 2, and the setting value appears in Display 1.
2. Use **rotary knob & < >** to set the determination level.

Displaying Determination Results

The determination result is displayed in the JUDGE area on the front panel. When the jitter ratio is less than or equal to the determination level set in step 2, the green GO indicator illuminates. When the jitter ratio exceeds the determination level set in step 2, the red NO-GO indicator illuminates. If a clock signal can not be regenerated by the PLL circuit during D-to-C measurement, both GO and NO-GO indicators illuminate in green and red respectively.

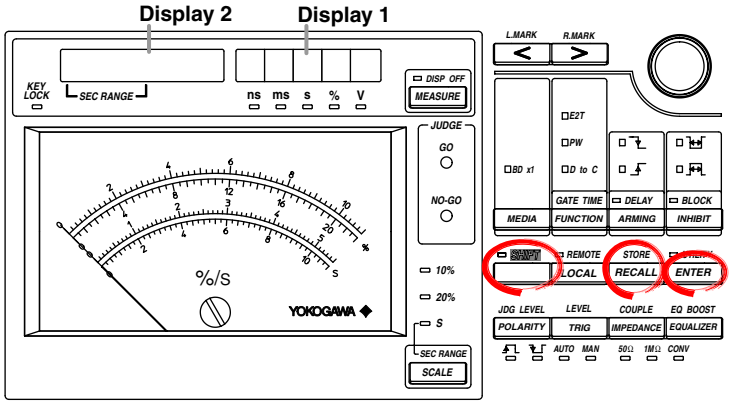
Explanation

You can set the determination level for the jitter ratio and display determination results in the JUDGE area of the front panel. The GO indicator illuminates in green when the jitter ratio is below the determination level, and the NO-GO indicator illuminates in red when the jitter ratio exceeds the determination level. The determination level specified here also applies to the determination level of the jitter ratio determination output (section 7.1). You can set the determination level in the range shown below.

Setting range: 0.00 to 25.00% (in steps of 0.01%)

6.1 Storing Setup Information

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Selecting the Memory Number

1. Press **SHIFT+RECALL (STORE)**. Store appears in Display 2, and the memory number of the store destination appears in Display 1.
2. Turn the **rotary knob** to select the memory number.

Executing the Store

3. Press **ENTER**. The word donE is displayed for approximately one second, and the setup information is stored. When the storing operation is finished, the display once again shows measured results.

Explanation

Information That Is Stored

All settings other than communication related settings are stored to the internal memory.

Number of Sets That Can Be Stored

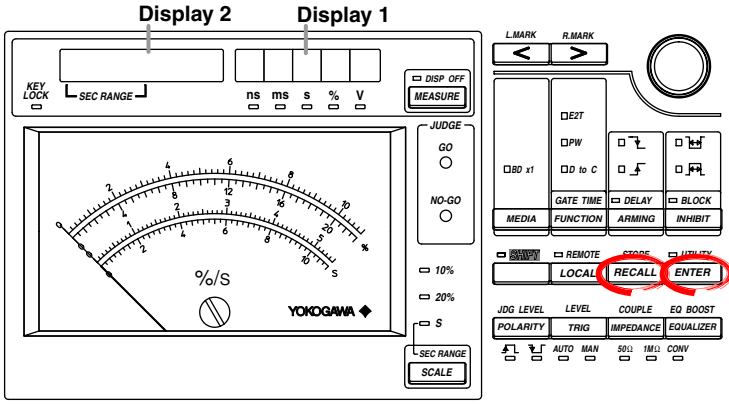
The number of sets that can be stored (memory numbers) is seven, from 0 to 6.

Note

If you initialize all setup information of the TA220 to factory default settings (see section 11.2), the stored setup information is also initialized. The setup information of all seven sets is reset to the factory default condition.

6.2 Recalling Setup Information

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Selecting the Memory Number

1. Press **RECALL**. Recall appears in Display 2, and the memory number of the recall source appears in Display 1.
2. Turn the **rotary knob** to select the memory number.

Executing the Recall

3. Press **ENTER**. The word donE is displayed for approximately one second, and the setup information is recalled. Then, the measurement is started using the recalled setup information.

Explanation

Setup Information That Is Recalled

The setup information that is stored at the specified preset number is recalled, and the current settings are replaced with this information. If no setup information is stored in the internal memory of the specified memory number, the factory default settings are recalled.

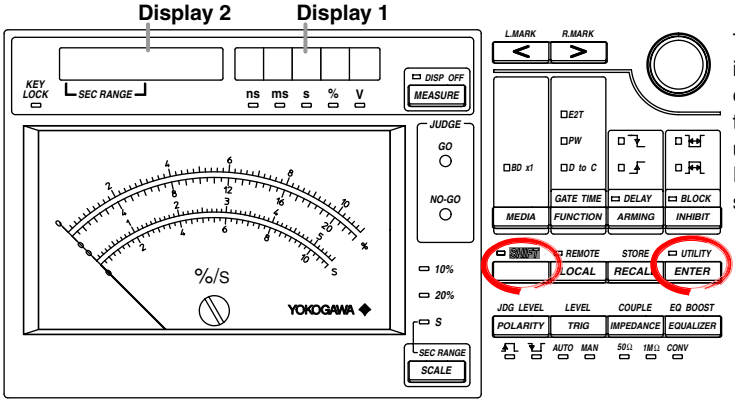
Number of Sets That Can Be Recalled

The number of sets that can be recalled (memory numbers) is seven from 0 to 6.

7.1 DC Output of Jitter Ratio

<<For a functional description, see section 2.6>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

You must connect a BNC cable from the jitter ratio DC output terminal (JITTER DC OUT) on the rear panel of the instrument to a monitoring device before outputting DC signals following the procedures in this section.

1. Press **SHIFT+ENTER (UTILITY)**. The Utility menu is shown on Display 2.
2. Turn the **rotary knob** to display DC out in Display 2.
3. Press **>**. DC mode, DCJitHi, DCJitLo, DC ave, Coeff•α, or Coeff•β is displayed.

Selecting the DC Output Mode

4. Turn the **rotary knob** to select DC mode.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Turn the **rotary knob** to select Jitt or JudGE.
7. Press **ENTER**.

   If you select Jitt (jitter ratio DC output), a DC voltage corresponding to the jitter ratio is output from the jitter ratio DC output terminal. If you select JudGE (determination output), a DC voltage of 5 VDC is output from the jitter ratio DC output terminal when the jitter ratio is equal to or below the determination level and 0 VDC when the jitter ratio is above the determination level.

Setting the Jitter Ratio DC Output Range

- **Setting the Upper Limit of the Jitter Ratio DC Output Range**
  4. Turn the **rotary knob** to select DCJitHi.
  5. Press **>** (or **ENTER**). Display 1 blinks.
  6. Use **rotary knob & < >** to set the upper limit.
  7. Press **ENTER**.

- **Setting the Lower Limit of the Jitter Ratio DC Output Range**
  4. Turn the **rotary knob** to select DCJitLo.
  5. Press **>** (or **ENTER**). Display 1 blinks.
  6. Use **rotary knob & < >** to set the lower limit.
  7. Press **ENTER**.

Setting the Jitter Ratio Determination Level

For the procedure for setting the jitter ratio determination level, see section 5.3.

Setting the Average coefficient of the DC Output Filter

4. Turn the **rotary knob** to select DC ave.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Use **rotary knob & < >** to set the average coefficient.
7. Press **ENTER**.

Setting the Jitter Ratio Correction Coefficient

- **Setting the α Coefficient**
  4. Turn the **rotary knob** to select Coeff•α.
  5. Press **>** (or **ENTER**). Display 1 blinks.
  6. Use **rotary knob & < >** to set the correction coefficient α.
  7. Press **ENTER**.
- **Setting the β Coefficient**
  4. Turn the **rotary knob** to select Coeff•β.
  5. Press **>** (or **ENTER**). Display 1 blinks.
  6. Use **rotary knob & < >** to set the correction coefficient β.
  7. Press **ENTER**.

If you press **MEASURE** during entry of settings or upon completion thereof, the settings entered up to that time are applied to the DC output settings, and measurement is restarted.

Explanation

CAUTION

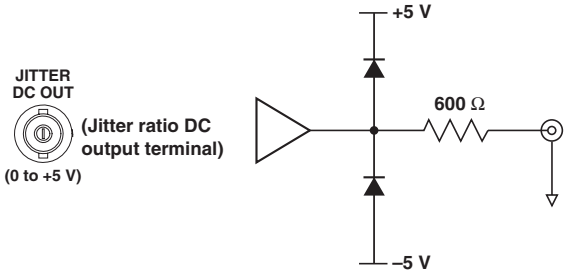
Do not apply external voltage to the output terminal. This may cause damage to the TA220.

DC Output Circuit

Item	Description
Connector type	BNC
Output impedance	600 Ω (typical value*)
Output level	0 to 5 VDC, given that the monitor equipment receives the signal at high impedance (approximately 1 MΩ).

* The typical value is a representative or standard value. It is not strictly guaranteed.

DC output circuit for jitter ratio



Setting Menu for DC Output of the Jitter Ratio

The following setting parameters are available for DC output of the jitter ratio. Use the rotary knob to select the parameter you wish to set. For the procedure for setting the jitter ratio determination level, see section 5.3.

- DC mode: DC output mode
- DCJitHi: Upper limit of the jitter ratio DC output range
- DCJitLo: Lower limit of the jitter ratio DC output range
- DC ave: Average coefficient for the DC output filter
- Coeff•α: Jitter ratio correction coefficient α
- Coeff•β: Jitter ratio correction coefficient β

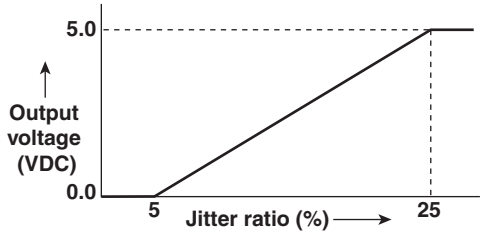
DC Output Mode

You can select whether jitter ratio DC output or determination output is output from the jitter ratio DC output terminal (JITTER DC OUT) on the rear panel.

- **Jitt (Jitter Ratio DC Output)**

  The jitter ratio of the selected measurement function can be converted to DC voltage (0 to 5 V) and output from the jitter DC output terminal on the rear panel. You can specify the jitter ratio that will output 5 V (upper limit) and the jitter ratio that will output 0 V (lower limit), and output DC voltage that is proportional to the jitter ratio. However, if more than 5 V is calculated, 5 V is output. For the setting range of the upper and lower limit, see "Upper and Lower Limit of the Jitter Ratio DC Output Range" below.

  When the upper limit is set to 25% and the lower limit to 5%

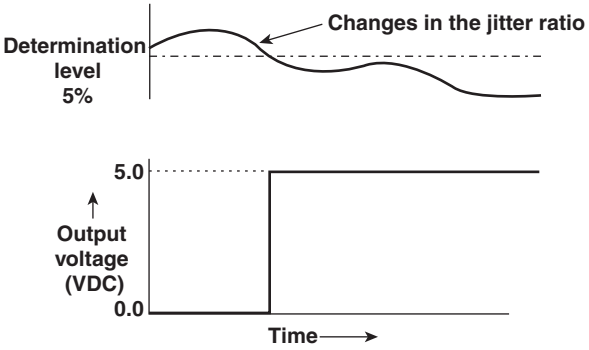


  For information on the update interval of the jitter ratio DC output, see the Note in section 4.5.

- **JudGE (Determination Output)**

  You can judge the measured jitter ratio against a specified value (determination level). If the jitter ratio is less than or equal to the determination level, a DC voltage of 5 VDC is output from the jitter DC output terminal, and 0 VDC is output if the jitter ratio exceeds the determination level. For setting the determination level, see section 5.3.

  When the determination level is set to 5%



Upper and Lower Limit of the Jitter Ratio DC Output Range

You can set the upper and lower limit of the jitter ratio DC output range in the following range. The upper and lower limits correspond to 5 VDC and 0 VDC, respectively.
Setting range: 0.00 to 100.00% (in steps of 0.01%)
The minimum difference (jitter ratio) between the upper and lower limit is 1 ns. If the lower limit is set equal to or higher than the upper limit (or vice versa), the upper limit is automatically raised to 0.01% above the lower limit (or vice versa).

Average Coefficient of the DC Output Filter

You can take the moving average of the jitter ratio that has been measured. When the DC output fluctuates due to instability in the measured jitter ratio, this function suppresses the degree of fluctuation. The jitter ratio that is moving-averaged using the DC output filter is applied to both the jitter ratio output and the DC output. The jitter ratio that is moving-averaged is displayed on the numerical display and analog meter, and sent to DC output. You can set the average coefficient (number of measured values to be averaged) to be used when performing a moving average in the following range.
Setting range: 1 to 10 (in steps of 1)

Jitter Ratio Correction Coefficient

The specified jitter ratio can undergo 1st order correction per the specified correction coefficient. Two correction coefficients can be specified, α (slope) and β (offset value). The jitter is the value obtained by multiplying the corrected jitter ratio by time T (see section 2.3). The corrected jitter and jitter ratio are displayed on the numerical display and analog meter, and sent to DC output. For the correction equation, see section 2.6.
Setting Range

- Correction coefficient α: 0.0001 to 9.9999 (in steps of 0.0001)
- Correction coefficient β: –9.999 to 9.999% (in steps of 0.001%)

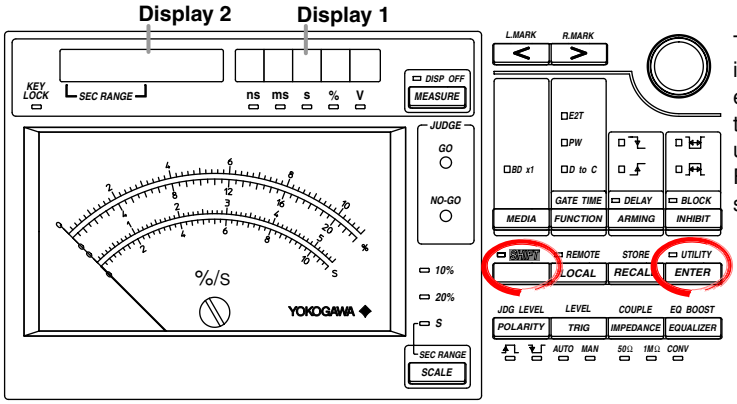
Note

- The DC output is 5 V when the trigger is not activated from the measurement input signal (RF signal) and measurements cannot be made.
- If the clock cannot be regenerated by the PLL circuit during D-to-C jitter measurement (PLL unlock), jitter ratio output and determination output are set to 5 V and 0 V respectively.
- If the average coefficient for the DC output filter or the jitter ratio correction coefficient is something other than the default value, the letter F is displayed in inverse video on Display 2 to the left of the characters indicating which parameter is being displayed (except when equalizer boost amount EQ and arming delay time Dly are displayed).
- When D-to-C high speed calculation is ON (see section 4.9), the jitter ratio that was moving-averaged with the DC output filter is not applied to either the jitter ratio DC output or the judgment output.

7.2 Measurement of the RF Signal Voltage Level and DC Output of the Voltage Level

<<For a functional description, see section 2.6>>

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

You must connect a BNC cable from the voltage level DC output terminal (LEVEL DC OUT) on the rear panel of the instrument to a monitoring device before outputting DC signals following the procedures in this section.

1. Press **SHIFT+ENTER (UTILITY)**. The Utility menu is shown on Display 2.
2. Turn the **rotary knob** to display Level in Display 2.
3. Press **>**. Lv meas, Lv mode, LevelHi, LevelLo, LvJdgHi, LvJdgLo, or Lv ave is displayed.

Turning Voltage Level Measurement ON and OFF

4. Turn the **rotary knob** to select Lv meas.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Turn the **rotary knob** to select on or oFF.
7. Press **ENTER**.

Selecting the Voltage Level DC Output Mode

4. Turn the **rotary knob** to select Lv mode.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Turn the **rotary knob** to select LEVEL or JudGE.
7. Press **ENTER**.

   If you select LEVEL (voltage level), a DC voltage corresponding to the voltage level is output from the voltage level DC output terminal. If you select JudGE (determination output), 5 VDC is output from the DC voltage output terminal when the voltage level is between the upper and lower limit, and 0 VDC is output when the voltage level exceeds upper limit or is less than or equal to the lower limit.

Setting the Voltage Level DC Output Range

- **Setting the Upper Limit of the Voltage Level DC Output Range**
  4. Turn the **rotary knob** to select LevelHi.
  5. Press **>** (or **ENTER**). Display 1 blinks.
  6. Use **rotary knob & < >** to set the upper limit.
  7. Press **ENTER**.

- **Setting the Lower Limit of the Voltage Level DC Output Range**
  4. Turn the **rotary knob** to select LevelLo.
  5. Press **>** (or **ENTER**). Display 1 blinks.
  6. Use **rotary knob & < >** to set the lower limit.
  7. Press **ENTER**.

Setting the Voltage Level Determination Range

- **Setting the Upper Limit of the Voltage Level Determination Range**
  4. Turn the **rotary knob** to select LvJdgHi.
  5. Press **>** (or **ENTER**). Display 1 blinks.
  6. Use **rotary knob & < >** to set the upper limit.
  7. Press **ENTER**.

- **Setting the Lower Limit of the Voltage Level Determination Range**
  4. Turn the **rotary knob** to select LvJdgLo.
  5. Press **>** (or **ENTER**). Display 1 blinks.
  6. Use **rotary knob & < >** to set the lower limit.
  7. Press **ENTER**.

Setting the Average Coefficient of the DC Output Filter

4. Turn the **rotary knob** to select Lv ave.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Use **rotary knob & < >** to set the average coefficient.
7. Press **ENTER**.

If you press **MEASURE** during entry of settings or upon completion thereof, the settings entered up to that time are applied to the DC output settings, and measurement is restarted.

Explanation

CAUTION

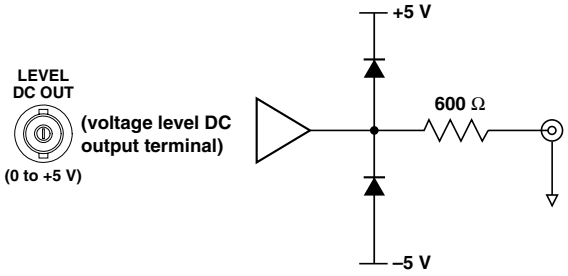
Do not apply external voltage to the output terminal. This may cause damage to the TA220.

DC Output Circuit

Item	Description
Connector type	BNC
Output impedance	600 Ω (typical value*)
Output level	0 to 5 VDC, given that the monitor equipment receives the signal at high impedance (approximately 1 MΩ).

* The typical value is a representative or standard value. It is not strictly guaranteed.

Voltage level DC output circuit



Setting Menu for Voltage Level DC Output

The following setting parameters are available for DC output of the RF signal voltage level. Use the rotary knob to select the parameter you wish to set.

- Lv meas: Turns voltage level measurement ON and OFF
- Lv mode: Selects the voltage level DC output mode
- LevelHi: Sets the upper limit of the voltage level DC output range
- LevelLo: Sets the lower limit of the voltage level DC output range
- LvJdgHi: Sets the upper limit of the voltage level determination range
- LvJdgLo: Sets the lower limit of the voltage level determination range
- Lv ave: The average coefficient for DC output of the voltage level

Turning Voltage Level Measurement ON and OFF

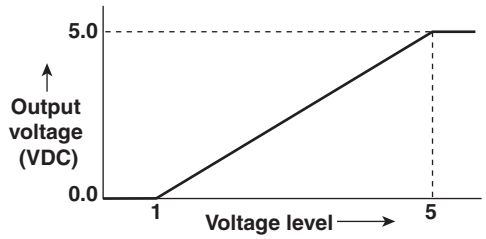
You can select whether or not (ON or OFF) to measure the voltage level of the RF signal. When turned ON, the numerical display of measured results parameter “LV (voltage level)”is added (see section 5.2).

Selecting the Voltage Level DC Output Mode

You can select whether voltage level DC output or determination output is output from the voltage level DC output terminal (LEVEL DC OUT) on the rear panel.

- **LEVEL (Voltage Level DC Output)**
  The voltage level of the RF signal can be converted to DC voltage (0 to 5 V) and output from the voltage level DC output terminal on the rear panel. You can specify the voltage levels that will output 5 V (upper limit) or 0 V (lower limit), and output a DC voltage that is proportional to the voltage level. However, if more than 5 V is calculated, 5 V is output. For the setting range of the upper and lower limit, see "Upper and Lower Limit of the Voltage Ratio DC Output Range" below.

When the upper limit is set to 5 V and the lower limit to 1 V

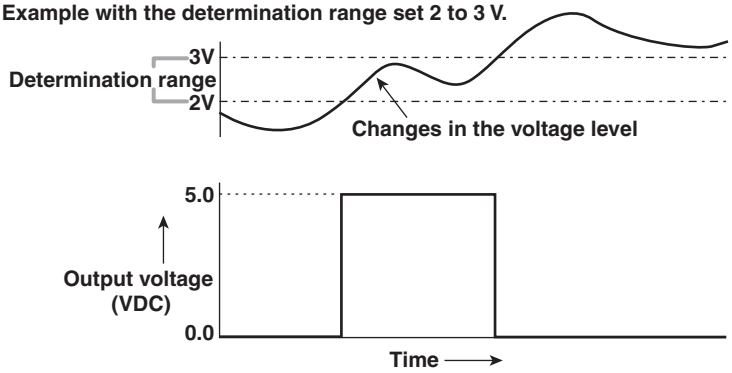


Note

- For information on the update interval of the voltage level DC output, see the Note in section 4.5.
- The voltage level DC output is not available when D-to-C high speed calculation is ON (see section 4.9). The voltage level is always set to 0 V.

- **JudGE (Determination Output)**
  The voltage level of the measured RF signal is determined according to a previously specified determination range. 5 VDC is output from the DC voltage output terminal when the voltage level is between the upper and lower limit of the determination range, and 0 VDC is output when the voltage level exceeds the upper limit or is less than or equal to the lower limit. For the setting range of the upper and lower limit, see "Upper and Lower Limit of the Voltage Ratio Determination Range" below.

Example with the determination range set 2 to 3 V.



Upper and Lower Limit of the Voltage Level DC Output Range

You can set the upper and lower limit of the voltage level DC output range in the following range. The upper and lower limits correspond to 5 VDC and 0 VDC, respectively.

Setting range: 0.00 to 5.000 V (in steps of 0.001 V)

If the lower limit is set equal to or higher than the upper limit (or vice versa), the upper and lower limits are set to the same value.

Upper and Lower Limit of the Voltage Level Determination Range

You can set the upper and lower limit of the voltage level determination range as follows.
Setting range: 0.00 to 5.000 V (in steps of 0.001 V)
If the lower limit is set equal to or higher than the upper limit (or vice versa), the upper and lower limits are set to the same value.

Average Coefficient for DC Output of the Voltage Level

A moving average can be taken of the measured RF signal voltage levels. When the DC output fluctuates due to instability in the measured voltage level, this function suppresses the degree of fluctuation. The voltage level that is moving-averaged using the DC output filter is applied to both the voltage level output and the DC output. The jitter ratio that is moving-averaged is displayed on the numerical display and analog meter, and sent to DC output. You can set the average coefficient (number of measured values to be averaged) to be used when performing a moving average in the following range.
Setting range: 1 to 10 (in steps of 1)

7.3 Outputting Other Signals

CAUTION

Do not apply external voltage to the output terminal. This may cause damage to the TA220.

Connect a BNC cable from the output terminal on the rear panel of the instrument to a monitoring device.

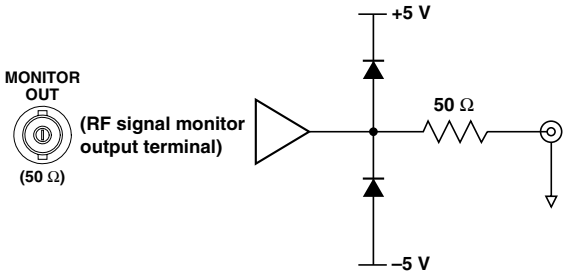
Monitor Output of RF Signals

You can output the RF signals applied to the measurement input terminal as-is from the RF signal monitor output terminal (MONITOR OUT) on the rear panel.

Item	Description
Connector type	BNC
Output impedance	50 Ω (typical value*)
Output level	Approximately one-half of the RF signal (within ±5 V) if the monitor device receives the signal at an impedance of 50 Ω.

* The typical value is a representative or standard value. It is not strictly guaranteed.

RF signal monitor output circuit



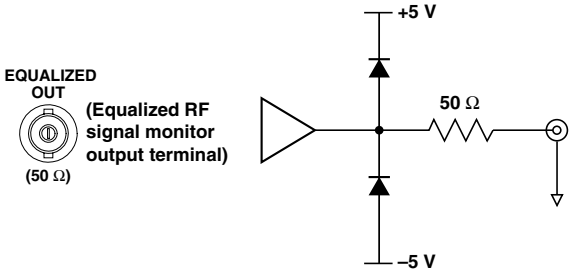
Monitor Output of Equalized RF Signals

When the equalizer is activated, you can output the equalized RF signals from the equalized RF signal monitor output terminal (EQUALIZED OUT) on the rear panel. When AGC is ON, the RF signal passes through the AGC circuit before being output. When AGC is OFF and the equalizer is not activated, the signal bypasses the AGC and equalizer circuits, and is then output.

Item	Description
Connector type	BNC
Output impedance	50 Ω (typical value*)
Output level	When the monitor equipment receives the signal at an input impedance of 50 Ω, the output level is as follows: • Approximately 1/2 the RF signal (within ±5 V) when the equalizer is OFF and AGC is OFF. • Approximately 0.4 Vp-p to 0.7 Vp-p (within ±1 V) when the equalizer is OFF and AGC is ON.

* The typical value is a representative or standard value. It is not strictly guaranteed.

Equalized RF signal monitor output circuit



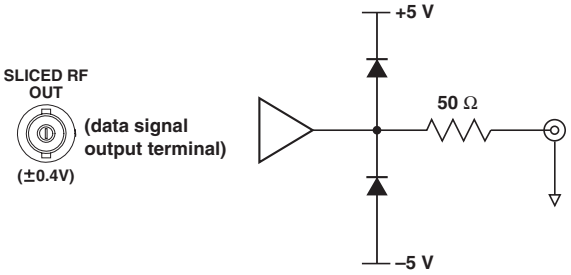
Outputting Data Signals (Binarized Signals)

You can output the data signal obtained through the binarization of the RF signal from the data signal output terminal (SLICED RF OUT) on the rear panel at TTL levels.

Item	Description
Connector type	BNC
Output impedance	50 Ω (typical value*)
Output level	Approximately ±0.4 V if the monitor device receives the signal at an impedance of 50 Ω.

* The typical value is a representative or standard value. It is not strictly guaranteed.

Data signal output circuit



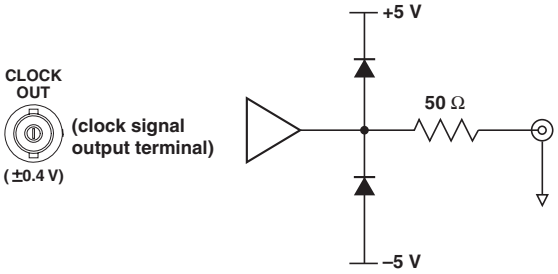
Outputting the Clock Signal

You can output the clock signal regenerated by the PLL circuit from the clock signal output terminal (CLOCK OUT) on the rear panel at TTL levels.

Item	Description
Connector type	BNC
Output impedance	50 Ω (typical value*)
Output level	Approximately ±0.4 V if the monitor device receives the signal at an impedance of 50 Ω.

* The typical value is a representative or standard value. It is not strictly guaranteed.

Clock signal output circuit



8.1 About the IEEE.488.2-1992 Standard

The GP-IB interface for this instrument complies with the IEEE 488.2-1992 standard. This standard requires that the following twenty-three items be included with documentation. Those items are described below.

(1)The subsets of the IEEE 488.1 interface functions that are supported
See "GP-IB Interface Specifications" on page 8-3.

(2)The operation of the device when it is assigned an address outside the 0 to 30 range
The address of this instrument cannot be set to an address outside the 0 to 30 range.

(3)Reaction of the device when the user changes the address
The address is recognized at the moment the address is changed using the Utility menu (see section 8.4). The newly set address is valid until it is changed again.

(4)Device settings at power-up. Commands which can be used at power ON
Basically, the previous settings are used (settings that existed when the power was turned OFF). All commands can be used at power-up.

(5)Message exchange options
(a)Input buffer size
1024 bytes
(b)Queries that return multiple response messages
See section 10.2 for examples with each command.
(c)Queries that create response data when the command syntax is being analyzed
All queries create response data when the command syntax is analyzed.
(d)Queries that create response data during reception
There are no queries in which the response data are created upon receiving a send request from the controller.
(e)Commands that have parameters that restrict one another
See section 10.2 for examples with each command.

(6)Items that include function elements consisting of commands and elements with compound headers
See sections 10.1 and 10.2.

(7)Buffer sizes that affect block data transmission
The buffer size of block data is 64 KB.

(8)A list of program data elements that can be used in equations and their nesting limitations
Equations cannot be used.

(9)Syntax of the responses to queries
See section 10.2 for examples with each command.

(10)Communication between devices that do not follow the response syntax
Not supported.

(11)Size of the response data block
0 to 524284 bytes.

(12)A list of supported common commands
See section 10.2.20, "Common Command Group."

(13)Device condition after a successful calibration
The settings return to the conditions that existed before the calibration, measurements are terminated, and previous measured data are invalidated.

(14)Maximum length of blocks used in the *DDT trigger macro definition
Not supported.

(15)Maximum length of the macro label in the macro definition, maximum length of program data used in the macro definition, and processing when recursion is used in the macro definition.
Macro function not supported.

(16)Reply to the *IDN? query
See section 10.2.20, "Common Command Group."

(17)The size of the storage area for protected user data for *PUD and *PUD? commands
*PUD and *PUD? are not supported.

(18)The length of the *RDT and *RDT? resource names

*RDT and *RDT? are not supported.

(19)The change in the status due to *RST, *LRN?, *RCL, and *SAV

*RST

See section 10.2.20, “Common Command Group.”

*LRN?, *RCL, *SAV

These common commands are not supported.

(20)The extent of the self test using the *TST? command

The self test consists of the same tests that are performed at power-up.

(21)The structure of the extended return status

See section 10.3.

(22)Whether each command is processed in an overlap fashion or sequentially

See section 10.1.6, “Synchronizing with the Controller,” and section 10.2.

(23)The description of the execution of each command

See the functional and procedural explanations in chapters 1 through 7, and 11 through 12.

8.2 GP-IB Interface Functions and Specifications

GP-IB Interface Functions

Listener Function

- This function allows you to perform the same settings that can be carried out using the panel keys (except for turning the power ON/OFF and entering communication settings).
- The instrument can receive commands output from a controller, such as settings and measured data.
- Commands concerning status reports can also be received.

Talker Function

Outputs setup information, measured data, and other information.

Note

Talk-only, listen-only, and controller functions are not available on this instrument.

Switching between Remote and Local

When switching from local to remote mode

Receiving a REN (Remote Enable) message from the controller when the instrument is in local mode causes the instrument to switch to remote mode.

- The REMOTE indicator (see section 1.2) illuminates.
- All keys other than LOCAL are locked.
- The settings that existed in local mode are maintained even when the instrument switches to remote mode.

When switching from remote to local mode

Pressing LOCAL when the instrument is in remote mode causes the instrument to switch to local mode. However, this act is invalid if the instrument has been set to Local Lockout mode (see section 8.5) by the controller.

- The REMOTE indicator turns OFF.
- Key operations are enabled.
- The settings that existed in remote mode are maintained even when the instrument switches to local mode.

GP-IB Interface Specifications

- **Electrical and Mechanical Specifications**
  Conforms to IEEE St'd 488-1978
- **Functional Specifications**
  See chart below
- **Encoding**
  ISO (ASCII)
- **Mode**
  Addressable mode
- **Address Setting**
  A setting between 0 and 30 can be entered for the GP-IB address setting in the Utility menu (see section 8.4).
- **Clear Remote Mode**
  You can press LOCAL to clear remote mode. However, key operation is disabled when under Local Lockout by the controller.

Function	Subset Name	Description
Source handshake	SH1	All functions for sending handshake
Acceptor handshake	AH1	All functions for receiving handshake
Talker	T6	Basic talker function, serial polling, untalk on MLA (My Listen Address), and no talkonly function
Listener	L4	Basic listener function, MTA (my talk address) listener resetting, no listen only function
Service request	SR1	All functions for service request
Remote local	RL1	All functions for remote/ local
Parallel poll	PP0	No parallel poll functions
Device clear	DC1	All functions for device clear
Device trigger	DT1	Full device trigger capability
Controller	C0	No controller functions
Electrical characteristics	E1	Open collector

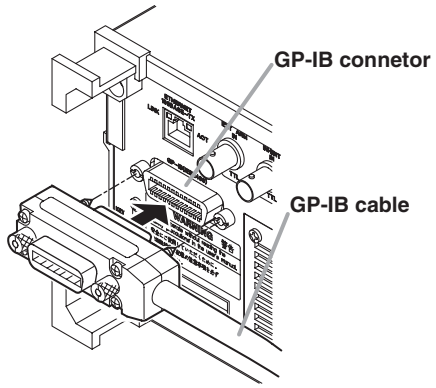
8.3 Connecting the GP-IB Cable

GP-IB Cable

The GP-IB connector of the instrument is a 24-pin connector conforming to the IEEE 488-1978 Standard. Use a GP-IB cable that meets the IEEE 488-1978 standard.

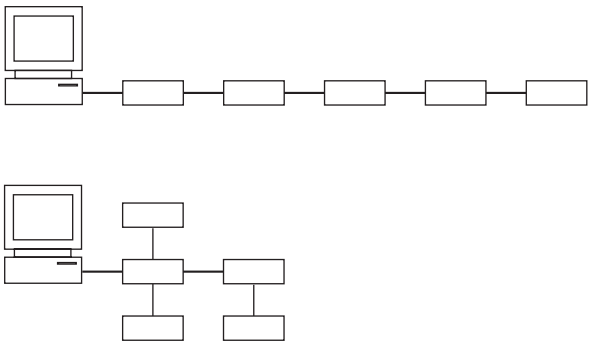
Connections

Connect the cable as shown below.



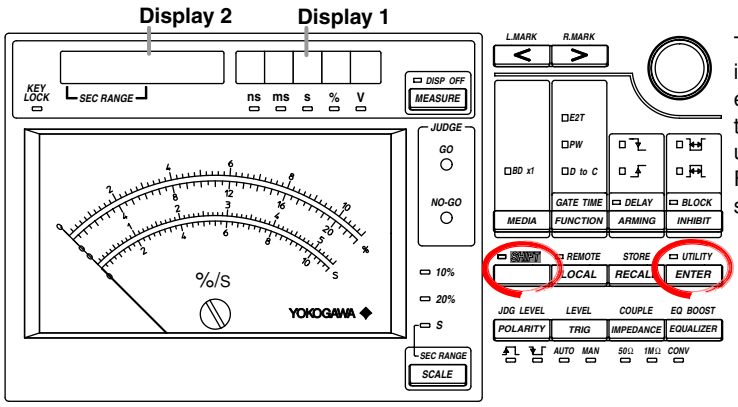
Points to Note When Connecting a Probe

- Firmly tighten the screws on the GP-IB cable's connector.
- Multiple devices can be connected to a single GP-IB system. However, no more than fifteen devices (including the controller) can be connected to a single system.
- When multiple devices are connected, they cannot share the same address.
- Use a cable of two meters or less in length between devices.
- The total length of all cables used should not exceed twenty meters.
- When communicating, have at least two-thirds of the devices turned ON.
- When connecting multiple devices, use a star or linear configuration as shown in the figure below. Do not wire them in a loop or parallel configuration.



8.4 Selecting GP-IB Communications and Setting the GP-IB Address

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

1. Press **SHIFT+ENTER (UTILITY)**. The Utility menu is shown on Display 2.
2. Turn the **rotary knob** to display Netwrk in Display 2.
3. Press **>**. Device, GPIBadd, DHCP, IP add1, IP add2, IP add3, IP add4, NetMsk1, NetMsk2, NetMsk3, NetMsk4, Gatewy1, Gatewy2, Gatewy3, Gatewy4, MACadd1, MACadd2, MACadd3, or Timeout is displayed.

Selecting GP-IB Communications

4. Turn the **rotary knob** to select Device.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Turn the **rotary knob** to select GPib.
7. Press **ENTER**.

Setting the GP-IB Address

4. Turn the **rotary knob** to select GPIBadd.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Use **rotary knob & < >** to set the GP-IB address.
7. Press **ENTER**.

Explanation

GP-IB Communication

The instrument can be controlled using communication commands sent from a PC or other controller device via the GP-IB interface.

GP-IB Address

When connecting via GP-IB, each device has its own unique system-internal GP-IB address. This address is used to differentiate the devices. When connecting the TA220 to a PC or other device, you must specify a GP-IB address for the TA220. The available setting range is 0 to 30.

8.5 Responses to Interface Messages

Interface Messages

Interface messages are also called interface commands or bus commands, and are commands which are output from the controller. The following categories of messages exist.

Uniline Messages

A message is sent using a single command line. The following three types are available.
IFC (Interface Clear), REN (Remote Enable), and IDY (Identify)

Multiline Messages

A message is sent using eight data lines. The following categories exist.

- **Address Commands**
  These commands are valid for the instruments set to listener or talker. The following five types are available.
  - Commands available to instruments set to listener
    GTL (Go To Local), SDC (Selected Device Clear), PPC (Parallel Poll Configure), and GET (Group Execute Trigger)
  - Commands available to instruments set to talker
    TCT (Take Control)
- **Universal Commands**
  These commands are valid on all instruments regardless of the listener/talker designations. The following five types are available.
  LLO (Local Lockout), DCL (Device Clear), PPU (Parallel Poll Unconfigure), SPE (Serial Poll Enable), and SPD (Serial Poll Disable)

Other Interface Messages

Two commands are available, Listener and Talker.

Differences between SDC and DCL

Of the multi-line messages, SDC requires talker or listener designation and DCL requires no such designation. Therefore, SDC works only with specific devices, but DCL works with all devices on the bus.

Responses to Interface Messages

Response to Uniline Messages

- **IFC**
  Clears talker and listener. Stops any data that may be being output.
- **REN**
  Switches between remote and local status.
- **IDY**
  Not supported.

Responses to Multiline Messages (Address Commands)

- **GTL**
  Switches to local status.
- **SDC**
  - Clears the program message (command) being received and the output queue (see section 10.3.5).
  - The COMMunicate:WAIT command is immediately terminated.
- **GET**
  Same operation as the “*TRG” command.
- **PPC, TCT**
  Not supported.

Responses to Multiline Messages (Universal Commands)

- **LLO**
  Disables LOCAL on the front panel to prohibit switching to local mode.
- **DCL**
  Performs the same action as SDC.
- **SPE**
  Sets the talker function of all devices on the bus to serial poll mode. The controller polls each instrument in order.
- **SPD**
  Clears serial poll mode for the talker function of all devices on the bus.
- **PPU**
  Not supported.

9.1 Ethernet Interface Functions and Specifications

Ethernet Interface Functions

Receive Function

- You can enter the same settings that are available using the front panel keys.
- You can receive measured or computed data, panel setup information, and error code output requests.

Transmission Function

- You can output measured or computed data.
- You can output panel setup information and status bytes.
- You can output any error codes that are generated.

Switching between Remote and Local

When Switching from Local to Remote Mode

When in local mode, if the :COMMunicate:REMote ON command is received from the PC, the instrument enters remote mode.

- The REMOTE indicator (see section 1.2) illuminates.
- When not in LOCAL mode, keys are disabled.
- The settings that existed in local mode are maintained even when the instrument switches to remote mode.

When Switching from Remote to Local Mode

Pressing LOCAL when the instrument is in remote mode causes the instrument to switch to local mode. However, this is disabled if the :COMMunicate:LOCKout ON command is received from the PC (local lockout mode is ON). If the :COMMunicate:REMote OFF command is received from the PC, the instrument enters local mode regardless of the lockout mode.

- REMOTE indicator goes out.
- Key operations are enabled.
- The settings that existed in remote mode are maintained even when the instrument switches to local mode.

Note

Ethernet communications cannot be carried out simultaneously with other modes of communication (such as GP-IB).

Ethernet Interface Specifications

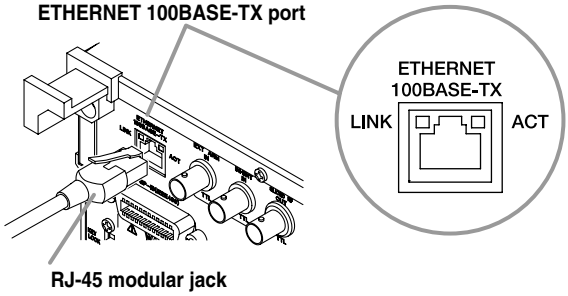
Connector type:	RJ-45
No. of ports	1
Electrical and mechanical:	Conforms to IEEE 802.3
Transmission system:	100BASE-TX/10BASE-T
Max. transmission rate:	100 Mbps
Protocol	TCP/IP
Port no.:	10001/tcp
Supported services:	DHCP

User Authentication

When using Ethernet communications, entry of user name and password is required when connecting to the network. When accessing the instrument, enter a user name of anonymous and no password.

9.2 Connecting to the Network

Connect a UTP (unshielded twisted-pair) cable or STP (shielded twisted-pair) cable from a hub or other adapter to the 100BASE-TX port on the rear panel of the instrument.



LINK Indicator
Illuminates when the link between the port on the TA220 and the connected device is established and communication is mutually possible.

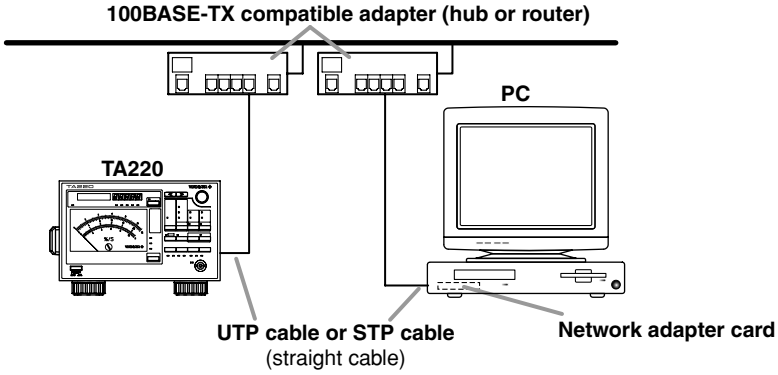
ACT Indicator
Illuminates when packet transmission is normal.

Cable

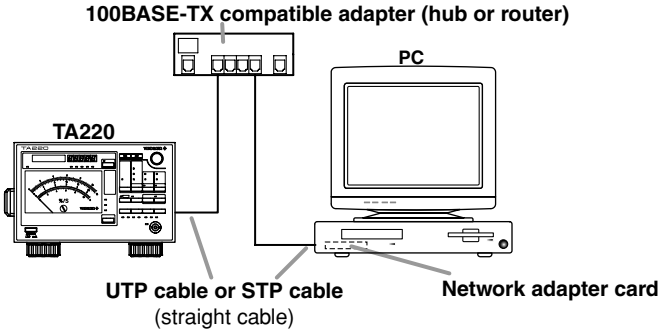
Be sure to use one the following cables for connection.

- UTP (Unshielded Twisted-Pair) cable (category 5 or better)
- STP (Shielded Twisted-Pair) cable (category 5 or better)

When Connecting to a PC on the Network



When Making a 1-to-1 Connection with a PC

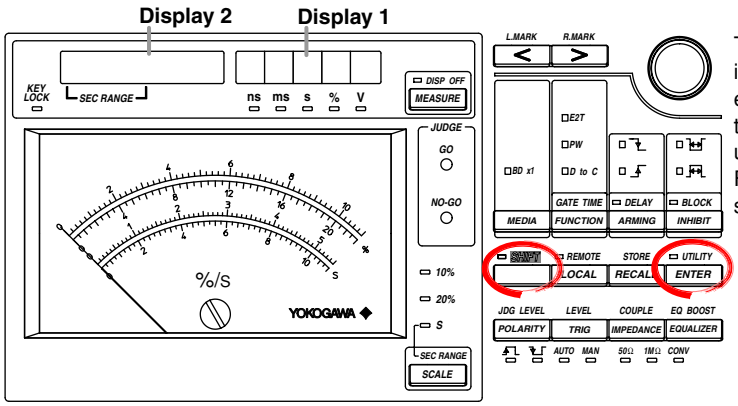


Note

- When using a UTP cable or STP cable (straight cable), be sure to use a category 5 or better cable.
- Avoid connecting the PC directly to the TA220 without going through the hub or router. Operations are not guaranteed for communications using a direct connection.

9.3 Entering the TCP/IP and Timeout Settings, and Confirming the MAC Address

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

1. Press **SHIFT+ENTER (UTILITY)**. The Utility menu is shown on Display 2.
2. Turn the **rotary knob** to display Netwrk in Display 2.
3. Press **>**. Device, GPIBadd, DHCP, IP add1, IP add2, IP add3, IP add4, NetMsk1, NetMsk2, NetMsk3, NetMsk4, Gatewy1, Gatewy2, Gatewy3, Gatewy4, MACadd1, MACadd2, MACadd3, or Timeout is displayed.

Selecting Ethernet Communications

4. Turn the **rotary knob** to select Device.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Turn the **rotary knob** to select EtHEr.
7. Press **ENTER**.

Turning DHCP ON and OFF

4. Turn the **rotary knob** to select DCHP.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Turn the **rotary knob** to select on or oFF.
7. Press **ENTER**.

Setting the IP Address

Turn DHCP OFF according to the procedure above before setting the IP address.

4. Turn the **rotary knob** to select IP add1, IP add2, IP add3, or IP add4.
   The address is expressed using four octets (each from 0 to 255), separated by a period as in 192.168.111.24. Of these four octets, set the left-most to IP add1, the second one from the left to IP add2, the third one from the left to IP add3, and the last one on the right to IP add4.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Use **rotary knob & < >** to set the address.
7. Press **ENTER**.
8. Repeat steps 4 through 7 to enter all the addresses from IP add1 to IP add4.

Setting the Subnet Mask

Turn DHCP OFF according to the procedure above before setting the IP address.

4. Turn the **rotary knob** to select NetMsk1, NetMsk2, NetMsk3, or NetMsk4.
   The subnet mask is expressed in the same manner as the IP address, using four octets (each from 0 to 255), separated by a period as in 255.255.254.0. Of these four octets, set the left-most to NetMsk1, the second one from the left to NetMsk2, the third one from the left to NetMsk3, and the last one on the right to NetMsk4.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Use **rotary knob & < >** to set the mask value.
7. Press **ENTER**.
8. Repeat steps 4 through 7 to enter all the mask values from NetMsk1 to NetMsk4.

Setting the Default Gateway

Turn DHCP OFF according to the procedure above before setting the IP address.

4. Turn the **rotary knob** to select Gatewy1, Gatewy2, Gatewy3, or Gatewy4.
   The default is expressed in the same manner as the IP address, using four octets (each from 0 to 255), separated by a period as in 0.0.0.0. Of these four octets, set the left-most to Gatewy1, the second one from the left to Gatewy2, the third one from the left to Gatewy3, and the last one on the right to Gatewy4.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Use **rotary knob & < >** to set the gateway.
7. Press **ENTER**.
8. Repeat steps 4 through 7 to enter all the gateway addresses from Gatewy1 to Gatewy4.

Confirming the MAC Address

4. Turn the **rotary knob** to select MACadd1, MACadd2, MACadd3, or MACadd4.
   The MAC address is an instrument-specific address. In accordance with the number of display digits on Display 1, the MAC address is displayed in four-digit sections starting from the top four digits. MACadd1 is the first four digits, MACadd2 is the second four digits displayed, and MACadd3 is the last four digits displayed.
5. You can confirm the MAC address by repeating step 4 to view the digits corresponding to MACadd1 through MACadd3.

Setting the Timeout Time

4. Turn the **rotary knob** to select Timeout.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Use **rotary knob & < >** to set the timeout time.
7. Press **ENTER**.

Explanation

Each TCP/IP setting must be entered to use the network functions on the instrument.

Ethernet Communications

The instrument can be controlled using communication commands sent from a PC via the Ethernet interface.

DHCP (Dynamic Host Configuration Protocol)

DCHP is a protocol that allocates setup information that is needed temporarily to PCs connecting to the network. When DHCP is turned ON, the following settings are automatically assigned.

IP address
Subnet mask
Default gateway

- To use DHCP, the network must have a DHCP server. Consult your network administrator to see if DHCP can be used.
- When turning DHCP from OFF to ON, up to ten seconds may be required to obtain the IP address.
- When DHCP is turned ON, different settings may be assigned each time the power is turned ON. When accessing the instrument from a PC, be sure to check the IP address and other settings of the instrument each time you turn it ON.

IP Address (Internet Protocol Address)

You can assign an IP address to the TA220. The setting cannot be assigned unless DHCP is turned OFF.

- The IP address is an ID that is assigned to each device on an IP network such as the internet or an intranet.
- The address is a 32-bit value expressed using four octets (each 0 to 255), each separated by a period as in 192.168.111.24.
- Obtain an IP address from your network administrator.
- The setting is automatically configured in environments using DHCP.

Subnet Mask

You can set the mask value used when determining the subnet network address from the IP address. The setting cannot be assigned unless DHCP is turned OFF.

- Huge TCP/IP networks such as the Internet are often divided up into smaller networks called sub networks. The subnet mask is a 32 bit value that specifies the number of bits of the IP address used to identify the network address. The portion other than the network address is the host address that identifies individual computers on the network.
- Consult your network administrator for the subnet mask value. You may not need to set the value.
- The setting is automatically configured in environments using DHCP.

Default Gateway

You can set the IP address of the gateway (default gateway) used to communicate with other networks. The setting cannot be assigned unless DHCP is turned OFF.

- The default gateway has control functions that handle protocol exchanges when communicating with multiple networks, so that data transmission is carried out smoothly.
- Consult your network administrator for the default gateway value. You may not need to set the value.
- The setting is automatically configured in environments using DHCP.

MAC Address

A MAC address is a unique address that is pre-assigned to the TA220. You can check this MAC address.

Setting the Timeout Time

If access to the instrument is unavailable for the time specified here, the network connection to the instrument is automatically closed. The default setting of 0 means that no timeout time is specified.
Setting range: 1 to 60 s (in steps of 1 s)

Note

- If you changed settings related to the network, the instrument must be power cycled.
- If the instrument is turned ON with the DHCP function enabled without an Ethernet cable connected, communications functions may not operate properly. In this case, turn DHCP OFF and power cycle the TA220.
- Network parameters such as the IP address must be specified also on the PC side. For details on these parameters, consult your PC's user's manual (or help file) or with your network administrator.
- If - - - - - is displayed for the MAC address in Display 1, contact the dealer from which you purchased the instrument.

10.1 Program Format

10.1.1 Syntactic Symbols

The following table contains symbols that are used for syntax, mainly in section 10.2. These symbols are called BNF (Backus-Naur Form) symbols. For details on the data, see pages 10-5 to 10-7.

Symbol	Meaning	Example
< >	Defined value	`STATus:FILTer<x> <x>=1 to 16` Input example `STATUS:FILTER2`

{ }	One element within the braces is selected	`MEASure:FUNCtion {DTOC|PWIDth}`
		Input example
		`MEASURE:FUNCTION DTOC`

|	Exclusive OR	`MEASure:FUNCtion {DTOC|PWIDth}`
		Input example
		`MEASURE:FUNCTION DTOC`

[ ]	Can be omitted	`INPut:PLL[:MODE]`
...	Can be repeated	

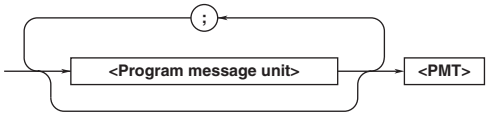
10.1.2 Messages

Messages

Transmission and reception between controller and this instrument is carried out using messages. A message sent from the controller to the instrument is called a program message, and a message received by the controller from the instrument is called a response message. If a program message contains a message unit that requests a response (a query), the instrument returns a response message upon receiving the program message. Only one response message can be sent per program message.

Program Messages

Data that are sent from the controller to the instrument are called program messages. The following is the format for program messages.

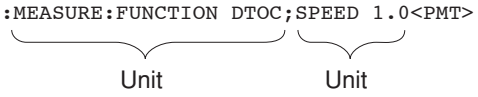


<Program Message Unit>

A program message consists of one or more program message units; each unit corresponds to one command. A program message unit corresponds to a single command. The instrument carries out the commands in the order in which they are received. Program message units are delimited by a semicolon (`;`).

For details regarding the format of the program message, see the next section.

Example:



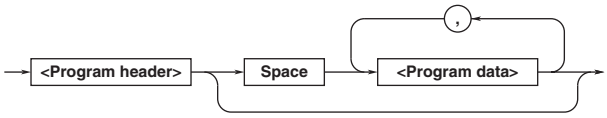
<PMT>

PMT stands for program message terminator. The following three types are available.

- **NL (newline)**
  Same as LF (Line Feed). ASCII code “0 AH”
- **^END**
  The END message (EOI signal) as defined in IEEE488.1. (The data byte that is sent with the END message will be the last data of the program message.)
- **NL^END**
  END message added to NL (NL is not included in the program message)

Program Message Unit Format

The following is the format for program message units.



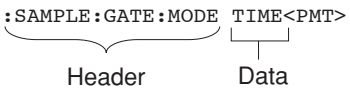
<Program Header>

The program header expresses the type of command. For details, see page 10-3.

<Program Data>

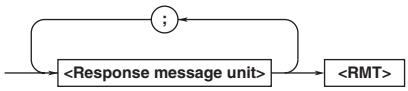
Program data contains any conditions or other information that may be required to execute a command. A space (ASCII code “20H”) separates the program data from the header. If multiple data are used, each data is separated by a comma (`,`).
For details, see page 10-5.

Example:



Response Messages

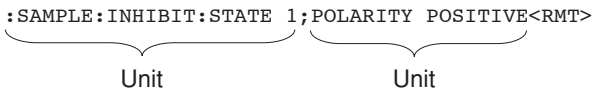
Data that are sent from the instrument to the controller are called response messages. The following is the format for response messages.



<Response Message Units>

A response message consists of a chain of one or more response message units. A response message unit corresponds to a single response. Response message units are delimited by a semicolon (`;`). For details regarding the format of the response message unit, see the next section.

Example:

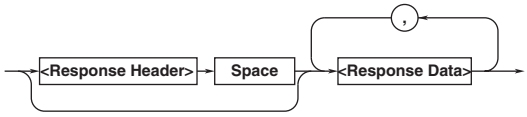


<RMT>

RMT stands for the response message terminator, which is NL^END.

Response Message Unit Format

The response message unit format is shown below.



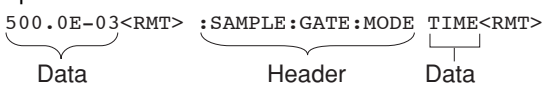
<Response Header>

Response headers can be added to the front of response data. Header and data are separated by a single space. For details, see page 10-5.

<Response Data>

The response data consists of the contents of the response. If multiple data are used, each data is separated by a comma (`,`).

Example:



If multiple queries are present within a program message, the order of responses follows the order of the queries. Most queries are answered with a single response message unit, but sometimes multiple units are returned. The first query is answered by the first response unit, but the nth response does not necessarily correspond to the nth unit. When you want to necessarily generate a response, separate the program messages.

Notes Regarding Sending and Receiving Messages

- When a program message is sent that does not contain a query, the next program message can be sent any time.
- When a program message is sent that contains a query, a response message must be received before the next program message can be sent. If a response message is not received, or only received in part, an error occurs when the next program message is sent. Unreceived response messages are thrown out.
- If the controller attempts to receive a response message that does not exist, an error occurs. If the controller tries to receive a response message before completing the sending of a program message, an error occurs.
- When sending a program message with multiple units in the message, if any of the units are incomplete, the instrument attempts to execute the program message units it thinks are complete, but will not necessarily do so successfully. Also, if a query is included in the units, a response will not necessarily be returned.

Deadlock Status

This instrument can store messages of at least 1024 bytes (received or sent) in a buffer (the number of bytes increases or decreases depending on the operational status). When both the transmit and receive buffers become full at the same time, the instrument can no longer continue to operate. This is called deadlock status. In this situation, operation can be restored by discarding the response message. If you keep program messages including to 1024 bytes or less, deadlock should not occur. Also, deadlock will not occur if queries are not included in the program message.

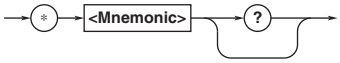
10.1.3 Commands

Commands

There are three types of commands (program headers) that can be sent from the controller to the instrument. The format of each kind of header is different.

Common Command Headers

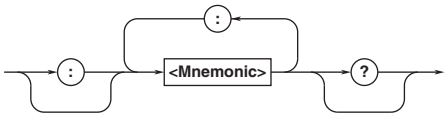
Commands defined in the IEEE 488.2-1987 standard are called common commands. The following is the format of common commands. Headers must begin with an asterisk (*).



An example of a common command: `*CLS`

Compound Header

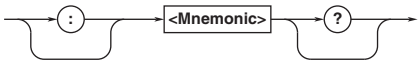
Instrument-specific commands which are not common commands are classified by function, and are layered hierarchically. The following is the format for compound headers. Sub layers must begin with a colon (:).



An example of a compound header:
`MEASURE:FUNCTION`

Simple Header

These are functionally independent commands without sub layers. The following is the format for the simple header.



An example of a simple header: `START`

Note

The mnemonic is an alphanumeric string.

Writing Consecutive Commands

Groups

A group of commands having common compound headers with hierarchically layered structure is called a group. Smaller groups can be nested inside of larger ones.

Example: Example Group of commands related to sampling

```
SAMPLE?
SAMPLE:ARMING
SAMPLE:ARMING:DELAY:TIME
SAMPLE:ARMING:SLOPE
SAMPLE:ARMING:SOURCE
SAMPLE:GATE?
SAMPLE:GATE:TIME
SAMPLE:INHIBIT?
SAMPLE:INHIBIT:POLARITY
SAMPLE:INHIBIT:STATE
```

Writing Consecutive Commands of the Same Group

The instrument remembers which layer the command being executed is on, and performs analysis based on the assumption that the next command sent belongs to the same layer. Therefore the common headers for commands of the same group can be omitted.

Example:
```
INPUT:DATA:TRIG:MODE MAN;
LEVEL 1.000V<PMT>
```

Writing Consecutive Commands from Different Groups

To write commands from different groups, add a colon (`:`) to the front of the new group header.

Example:
```
MEASURE:FUNCTION DTOC;:
DISPLAY:SCALE R10<PMT>
```

When Concatenating Simple Headers

If a simple header follows another command, a colon (`:`) is placed in front of the simple header.

Example:
```
MEASURE:FUNCTION DTOC;:
START<PMT>
```

Writing Consecutive Common Commands

Layers do not apply to commands defined as common by IEEE 488.2-1992. Colons (`:`) are not needed before a common command.

Example:
```
MEASURE:FUNCTION DTOC;*CLS<PMT>
```

Separating Commands with

When commands are separated with a terminator, it means two program messages are sent. Therefore even with consecutive commands of the same group, the common header cannot be omitted.

Example:
```
MEASURE:FUNCTION DTOC<PMT>
MEASURE:SPEED 1.0<PMT>
```

Top Level Query

A query with a question mark (`?`) added to the top level command of a group appearing for the first time is called a top level query. When executing a top level query, all settings that can be set in that group can be received all at once. With groups with three layers or more, there are ones in which all lower layers are output.

Example:
```
SAMPLE?<PMT> -> :SAMPLE:ARMING:
SOURCE AUTO;:TIME 100.0E-03;:
SAMPLE:INHIBIT:STATE 0
```

The response to a top level query can be sent as-is as a program message to the instrument. When sending, the settings returned by the top level query can be edited if necessary and reused in the new program message. However, top level queries do not receive currently unused settings in the response. Please note that all information for that group will not necessarily be output as a response.

Rules for Interpreting Headers

The instrument interprets received headers according to the following rules.

- Mnemonics are case insensitive.
  Example "`MEASure`" can also be written as "`measure`" or "`Measure`."
- Lowercase letters can be omitted.
  Example "`MEASure`" can also be written as "`MEASU`" or "`MEAS`."
- The question mark (`?`) at the end of a header identifies it as a query. The question mark cannot be omitted.
  Example "`MEASure?`" -> Abbreviated format: [`MEAS?`]
- If the x (number) on the end of the mnemonic is omitted, it is interpreted as x=1.
  Example If "`FILTer`" is written as "`FILT`," it means "`FILTer1`."
- The section enclosed by braces ([ ]) can be omitted.
  Example `INPut:PLL[:MODE] 1`
  `INPut:PLL 1` also allowed

However, for a top level query, the final part cannot be omitted.

10.1.4 Response

When the controller sends a message unit that has a question mark (?) in its program header (query), the instrument returns a response message to the query. There are two possible formats for the response.

- **Header + Data Response**
  For responses that can be used as-is as a program message, the command header is added and the response is returned.
  Example: `SAMPLE:GATE:TIME?<PMT> ->`
  `:SAMPLE:GATE:MODE TIME<RMT>`

- **Data Only Response**
  For those that cannot be used as-is as a program message (query only commands), a header is not added, and only data is returned. However, there are query only commands for which headers are added to the responses.
  Example: `STATUS:ERROR?<PMT> ->`
  `0,"NO ERROR"<RMT>`

Returning a Response without a Header

You can force a response not to include a header, even if it is the Header + Data type of response. To do so, use the "`COMMunicate:HEADer`" command.

About Abbreviated Formats

Normally, the lowercase portions of response headers are omitted. However, you can specify that commands not be abbreviated. Use the "`COMMunicate:VERBose`" command for this task. The sections enclosed by braces ([ ]) are also omitted in the abbreviated form.

10.1.5 Data

Data

Data refers to the conditions and numbers that are preceded by a space, and before that, the header. The following categories of data exist.

Data	Meaning
<Decimal>	A numerical value expressed as a decimal. (Example: recalling setup information `-> RECALL 2`)
<Voltage><Time> <Phase> <Percent>	Numbers with physical dimensions. (Example: Gate Time `-> SAMPle:GATE:TIME 1MS`)
<Register>	Register value expressed in base 2, 8, 10, or 16 (Ex.: extended event register value `-> :STATUS:EESE #HFE`)
<Character Data>	Defined character string (mnemonic) Select options in braces ({ }). (Example: selecting the Gate mode `:SAMPle:GATE:MODE {EVENt|TIME}`)
<Boolean>	Shows ON or OFF. Set to ON, OFF, or a numerical value. (Ex.: turning the equalizer display ON `-> :INPUT:EQ:MODE ON`)

<Decimal>

<Decimal> is a number expressed in base 10 as shown below. This is also the NR format defined by ANSI X3.42-1975.

Symbol	Meaning	Example		
<NR1>	Integer	`125`	`-1`	`+1000`
<N2>	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.			

- When the instrument receives a decimal from the controller, it receives it regardless of which format between <NR1> and <NR3> it is in. This is notated as <NRf>.
- The determination as to which format (<NR1> through <NR3>) is used for response messages returned to the controller from the instrument is made based on the query. The format varies depending on the size of the values used.
- With <NR3> format, the "+" after the "E" is omitted. The "–" cannot be omitted.
- To describe values outside of the setting range, the nearest value that can be set is used.
- If a value has more significant digits than the available resolution, the value is rounded.

<Voltage>, <Ti me>, <Phase>, <Percent>

<Voltage>, <Ti me>, <Phase>, and <Percent> indicate decimal values that have physical dimensions. You can add <Multiplier> and <Unit> to the above <NRf>. One of the following formats can be used.

Format	Example
<NRf><Multiplier><Unit>	5MV
<NRf><Unit>	5E-3V
<NRf><Multiplier>	5M
<NRf>	5E-3

<Multiplier>

The following are the multipliers that can be used.

Symbol	Reading	Multiplier
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}
A	Ato	10^{-18}

<Unit>

The following are the units that can be used.

Symbol	Reading	Meaning
V	Volt	Voltage
S	Second	Time
PCT	Percent	Percentage

- The <Multiplier> and <Unit> are case insensitive.
- The symbol for micro (μ) is written as “U.”
- To distinguish “mega” from “mili,” MA is used.
- If both <Multiplier> and <Unit> are omitted, the default unit is used.
- Response messages are always in the <NR3> form. Response messages are returned using the default unit without the <Multiplier> or <Unit>.

<Register>

<Register> is an integer, but can be expressed as a <Decimal>, or in <Hexadecimal>, <Octal>, or <Binary> form. <Register> is used when each bit of a numerical value has meaning. One of the following formats can be used.

Format	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

- The <Register> is case insensitive.
- The response message returned is always in <NR1> format.

<Character Data>

<Character data> is data with specified characters (mnemonic). It is mainly used to express alternatives, and indicates that one item within the braces ({ }) can be selected. The way that the data is interpreted is the same as the description on page 10-4, “Rules for Interpreting Headers.”

Format	Example
{POSitive|NEGative|BOTH}	POSitive

- In the same manner as with headers, you can use COMMunicate:VERBose with response messages for full spelling, or choose the abbreviated format.
- The COMMunicate:HEADer setting does not affect <Character data>.

<Boolean>

<Boolean> is for data that indicates an ON or OFF state. One of the following formats can be used.

Format	Example
{ON|OFF|<NRf>}	ON OFF 1 0

- When expressing it in <NRf> format, it is OFF if the rounded integer is 0, and ON if the integer is non-zero.
- A response message is always returned with a “1” if the value is ON and “0” if the value is OFF.

<Character String Data>

Unlike the predefined character strings of <Character data>, <Character string data> is an arbitrary character string. The character string is enclosed in single quotation marks (') or double quotation marks (").

Format	Example
<Character string data>	'ABC' "IEEE488.2-1987"

- If a character string containing a quotation mark (") is included within two other quotation marks, it is represented by (""). This rule also applies to a single quotation mark (').
- A response message is always enclosed in double quotation marks (").
- Because <Character string data> is an arbitrary character string, if the last single quotation mark (') or double quotation mark (") is missing, the instrument may assume that the remaining program message units are part of the <Character string data> and may not detect the error.

10.1.6 Synchronization with the Controller

This instrument does not support overlap commands, which allows the execution of the next command to start before the execution of the previous command is completed. If multiple sequential commands of the type of commands supported by this instrument are sent consecutively, the execution of the next command is delayed until the execution of the previous command is completed.

Synchronization Using Sequential Commands

Even for sequential commands, synchronization is sometimes required for non communication-related reasons such as a trigger occurrence. For example, if the next program message is sent when querying the measured data of a single measurement, "CALCulation:JITTer?" is executed regardless of whether the data acquisition has finished and may result in a command execution error.

```
:SSTart;:CALCulation:JITTer?<PMT>
```

In this case, the following method must be used to synchronize with the end of the acquisition:

Using the STATus:CONDition? query

The "STATus:CONDition?" command queries the status register (page 10-37). Bit 0 of the status register is read to determine whether or not the measured data is valid. If bit 0 of the condition register is "1," the measured data are valid. If it is "0," measurement or computation is in progress and the measured data are invalid.

Example:
```
:SSTart
STATus:CONDition?<PMT>
```
If bit 0 is 0, repeat this command until it becomes 1.)
```
CALCulation:JITTer?<PMT>
```

Using the Extended Event Register

The changes in the condition register can be reflected in the extended event register (page 10-37).

Example:
```
STATus:FILTer1 RISE;:STATus:
EESE 1;EESR?;*SRE 8;SSTart<PMT>
(Wait for a service request)
CALCulation:JITTer?<PMT>
```

The "STATus:FILTer1 RISE" command sets the transition filter so that bit 0 (FILTer1) of the extended event register is set to "1" when bit 0 of the condition register changes from "0" to "1."
The "STATus:EESE 1" command is used to reflect only bit 0 of the extended event register to the status byte.
The "STATus:ESSR?" command clears the extended event register after querying its contents.
The "*SRE" command is used to generate a service request solely on the cause of the extended event register.
The "CALCulation:JITTer?" command will not be executed until a service request is generated.

Using the COMMunicate:WAIT command

The "COMMunicate:WAIT" command is used to wait for a specific event to occur.

Example:
```
STATus:FILTer1 RISE;:STATus:
EESR?;SSTart<PMT>
(reads the response to STATus:ESSR?)
COMMunicate:WAIT 1;:
CALCulation:JITTer?<PMT>
```

The descriptions of "STATus:FILTer1 RISE" and "STATus:EESR?" are the same as those given in the previous section regarding the extended event register.
The "COMMunicate:WAIT 1" command indicates that the program will wait for bit 0 of the extended event register to be set to "1."
The "CALCulation:JITTer?" command will not be executed until bit 0 of the extended event register is set to "1."

Note

On the TA220, the statistical data can be read during measurement without having to synchronize with the controller. The value queried in this case is the previous statistical value.
Example: `CALCulation:JITTer?`

10.2 Commands

10.2.1 Command List

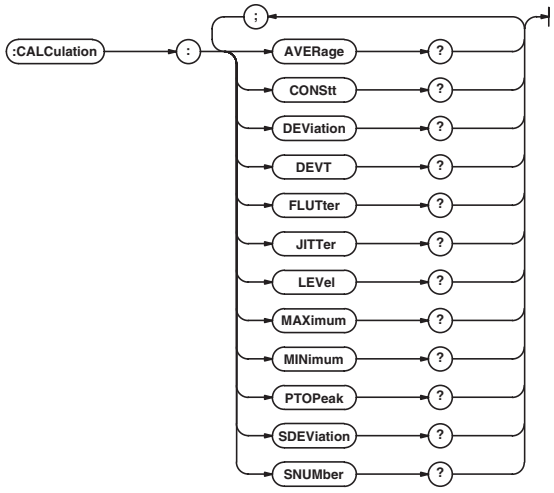
Command	Function	Page
CALCulation Group		
:CALCulation:AVERage?	Queries the average value.	10-12
:CALCulation:CONStt?	Queries time width T.	10-12
:CALCulation:DEViation?	Queries the deviation.	10-12
:CALCulation:DEVT?	Queries the deviation/T value.	10-12
:CALCulation:FLUTter?	Queries the σ/AVE (flutter) value.	10-12
:CALCulation:JITTer?	Queries the σ/T (jitter ratio).	10-12
:CALCulation:LEVel?	Queries the level.	10-12
:CALCulation:MAXimum?	Queries the maximum value.	10-13
:CALCulation:MINimum?	Queries the minimum value.	10-13
:CALCulation:PTOPeak?	Queries the P-P value.	10-13
:CALCulation:SDEViation?	Queries the jitter (σ).	10-13
:CALCulation:SNUMber?	Queries the number of samples of the statistical calculation.	10-13
COMMunicate Group		
:COMMunicate?	Queries all settings related to communication.	10-14
:COMMunicate:HEADer	Sets whether or not to add a header to the response data, or queries the setting.	10-14
:COMMUNICATE:LOCKout	Sets/queries the local lockout setting.	10-14
:COMMunicate:REMote	Switches between remote and local mode.	10-14
:COMMunicate:VERBose	Sets abbreviated or verbose format for response data, or queries the setting.	10-14
:COMMUNICATE:WAIT	Wait for specified extended event to occur.	10-14
:COMMunicate:WAIT?	Creates response data upon occurrence of the specified extended event.	10-14
DCOut Group		
:DCOut?	Queries all settings related to DC output.	10-15
:DCOut:CYCLe	Sets the DC output average coefficient or queries the current setting.	10-15
:DCOut:COEFficient	Sets the DC output correction coefficient or queries the current setting.	10-15
:DCOut:JITTer:PERCent	Sets the upper and lower limits of the DC output of the jitter ratio or queries the current setting.	10-15
:DCOut:JUDGe:PERCent	Sets the jitter ratio determination level or queries the current setting.	10-15
:DCOut:JUDGe:RESult?	Queries the determination result.	10-16
:DCOut:MODE	Sets the DC output mode or queries the current setting.	10-16
DISPlay Group		
:DISPlay?	Queries all settings related to display.	10-18
:DISPlay:MEASure	Sets the statistical value display parameters or queries the current setting.	10-18
:DISPlay:PARameter:AVERage	Sets AVE display or queries the current setting.	10-18
:DISPlay:PARameter:CONStt	Sets T display or queries the current setting.	10-18
:DISPlay:PARameter:DELay	Sets Dly display or queries the current setting.	10-18
:DISPlay:PARameter:EQ	Sets EQ display or queries the current setting.	10-18
:DISPlay:PARameter:JITTer	Sets σ/T display or queries the current setting.	10-18
:DISPlay:PARameter:LSNum	Sets the SnL display or queries the current setting.	10-18
:DISPlay:PARameter:SDEViation	Sets the σ display or queries the current setting.	10-18
:DISPlay:PARameter:USNum	Sets the SnU display or queries the current setting.	10-18
:DISPlay:SCALe	Sets the scale of the analog meter or queries the current setting.	10-18
:DISPlat:SECond	Sets the time scale of the analog meter or queries the current setting.	10-19
:DISPlay:STATe	Turns ON/OFF the numerical display or queries the current setting.	10-19
HHIStogram Group		
:HHIStogram?	Queries all settings related to marker.	10-19
:HHIStogram:MARKer?	Queries all settings related to marker.	10-19
:HHIStogram:MARKer:LEFT	Sets the left marker or queries the current setting.	10-19
:HHIStogram:MARKer:RIGHt	Sets the right marker or queries the current setting.	10-19

Command	Function	Page
INPut Group		
:INPut?	Queries all settings related to signal input.	10-21
:INPut:DATA?	Queries all settings related to signal input (excluding the equalizer).	10-21
:INPut:DATA:COUPling	Sets the input coupling or queries the current setting.	10-21
:INPut:DATA:IMPedance	Sets the input impedance or queries the current setting.	10-21
:INPut:DATA:POLarity	Sets the polarity of the data signal or queries the current setting.	10-21
:INPut:DATA:TRIGger?	Queries all settings related to the trigger.	10-21
:INPut:DATA:TRIGger:LEVel	Sets the trigger level (slice level) or queries the current setting.	10-21
:INPut:DATA:TRIGger:MODE	Sets the trigger mode or queries the current setting.	10-21
:INPut:EQ?	Queries all settings related to the equalizer.	10-21
:INPut:EQ:STATus	Sets the equalizer status or queries the current setting.	10-21
:INPut:EQ:BOOSt	Sets the boost amount of the equalizer or queries the current setting.	10-22
:INPut:EQ:AGC	Turns the equalizer's AGC function ON and OFF or queries the current setting.	10-22
:INPut:EQ:DCCLamp	Turns the equalizer's DC clamp function ON and OFF or queries the current setting.	10-22
:INPut:EQ:PLLHold	Turns the equalizer's PLL hold function ON and OFF or queries the current setting.	10-22
:INPut:HISPeed:STATe	Sets the D-to-C high speed calculation function or queries the current setting.	10-22
:INPut:PLL:STATus?	Queries PLL lock status.	10-22
LVOut Group		
:LVOut?	Queries all settings related to level measurement.	10-23
:LVOut:STATe	Turns level measurement ON or OFF or queries the current setting.	10-23
:LVOut:MODE	Sets the level measurement output mode or queries the current setting.	10-23
:LVOut:CYCLe	Sets the level measurement output filter average coefficient or queries the current setting.	10-23
:LVOut:LEVel:RANGe	Sets the upper and lower limit of the level measurement output range or queries the current setting.	10-23
:LVOut:JUDGe:LEVel	Sets the upper and lower limit of the level measurement output determination level or queries the current setting.	10-24
:LVOut:JUDGe:RESult?	Queries the level measurement output determination results.	10-24
MEASure Group		
:MEASure?	Queries all settings related to measurement conditions.	10-24
:MEASure:FUNCtion	Sets the measurement function or queries the current setting.	10-24
:MEASure:SPEed?	Queries the measurement speed.	10-24
MEMory Group		
:MEMory?	Queries all settings related the external transmission of the measured data.	10-25
:MEMory:BYTeorder	Sets the transmission order of binary data or queries the current setting.	10-25
:MEMory:CLEar	Clears measured data.	10-25
:MEMory:DATaselect	Sets the data to be transmitted or queries the current setting.	10-25
:MEMory:END	Sets the position of the data to be transmitted or queries the current setting.	10-25
:MEMory:FORMat	Sets format of the data to send or queries the current setting.	10-25
:MEMory:SEND?	Executes the transmission of the measured data specified by MEMory:DATaselect.	10-26
:MEMory:STARt	Sets the transmission start position of the data to be transmitted or queries the current setting.	10-26
RECall Group		
:RECall	Recalling setting information	10-26
SAMPle Group		
:SAMPle?	Queries all settings related to sampling.	10-27
:SAMPle:ARMing?	Queries all settings related to arming.	10-27
:SAMPle:ARMing:DELay?	Queries all settings related to the arming delay.	10-28
:SAMPle:ARMing:DELay:TIME	Sets the arming delay time or queries the current setting.	10-28
:SAMPle:ARMing:SLOPe	Sets the arming slope or queries the current setting.	10-28

Command	Function	Page
:SAMPle:ARMing:SOURce	Sets the arming source or queries the current setting.	10-28
:SAMPle:BLOCk?	Queries all settings related to block sampling.	10-28
:SAMPle:BLOCk:SIZE	Sets the number of blocks for block sampling or queries the current setting.	10-28
:SAMPle:BLOCk:STATe	Turns block sampling ON and OFF or queries the current setting.	10-28
:SAMPle:GATE?	Queries all settings related to the gate.	10-28
:SAMPle:GATE:TIME	Sets the gate time or queries the current setting.	10-28
:SAMPle:INHibit?	Queries all settings related to inhibit.	10-28
:SAMPle:INHibit:POLarity	Sets the polarity of inhibit or queries the current setting.	10-29
:SAMPle:INHibit:STATe	Turns ON/OFF inhibit or queries the current setting.	10-29
SSTart Group		
SSTart	Executes single measurement.	10-29
STARt Group		
STARt	Starts the measurement.	10-29
STATus Group		
:STATus?	Queries all settings related to the communication status.	10-30
:STATus:CONDition?	Queries contents of the status register.	10-30
:STATus:EESE	Sets the extended event enable register value or queries the current setting.	10-30
:STATus:EESR?	Queries contents of the extended event register, and clears the register.	10-30
:STATus:ERRor?	Queries any error codes that occur and message information.	10-30
:STATus:FILTer	Sets the transition filter or queries the current setting.	10-30
:STATus:QMESsage	Sets whether or not to attach message information to the response to the “:STATus:ERRor?” query or queries the current setting.	10-30
STOP Group		
:STOP	Stops the measurement.	10-30
STORe Group		
:STORe	Stores setup information.	10-30
SYSTem Group		
:SYSTem?	Queries all settings related to system.	10-31
:SYSTem:BRIGhtness:DOTMatrix	Sets the brightness of the dot matrix LED display or queries the current setting.	10-31
UNIT Group		
:UNIT?	Queries default units of voltage, time, and frequency.	10-31
:UNIT:TIME	Sets the default unit of time or queries the current setting.	10-31
:UNIT:VOLTage	Sets the default unit of voltage or queries the current setting.	10-31
Common Command Group		
*CAL?	Performs calibration and queries the result.	10-32
*CLS	Clears the standard event register, extended event register, and the error queue.	10-32
*ESE	Enters/queries the standard event enable register value.	10-32
*ESR?	Queries the standard event register, and clears the register.	10-32
*IDN?	Queries the instrument type.	10-32
*OPC	Sets whether or not to clear the OPC event upon the completion of the specified overlap command.	10-32
*OPC?	Creates a response upon the completion of the specified overlap command.	10-33
*OPT?	Queries the installed options.	10-33
*RST	Initializes settings.	10-33
*SRE	Enters/queries the service request enable register value.	10-33
*STB?	Queries the status byte register.	10-33
*TRG	Executes single measurement.	10-33
*TST?	Executes the self test and queries the result.	10-33
*WAI	Holds the subsequent command until the completion of the specified overlap operation.	10-33

10.2.2 CALCulation Group

This group consists of statistical computation related commands.



:CALCulation:AVERage?

Function Queries the average value.
Syntax `:CALCulation:AVERage?`
Example `:CALCULATION:AVERAGE?`
`-> :CALCULATION:AVERAGE 1.00035E-7`
Description If the statistical value is not valid, “NAN” is returned in response to a query.

:CALCulation:CONStt?

Function Queries the time width T.
Syntax `:CALCulation:CONStt?`
Example `:CALCULATION:CONSTT?`
`-> 100.000E-9`
Description For the D-to-C function, returns the value of the measured clock. For the PulseWidth function, returns the difference between right and left markers.

:CALCulation:DEViation?

Function Queries the deviation.
Syntax `:CALCulation:DEViation?`
Example `:CALCULATION:DEVIATION?`
`-> 1.4425E+1`
Description
- If the statistical value is not valid, or if INPut:HISPeed:STATe (D-to-C high speed calculation) is ON, “NAN” is returned in response to a query.
- DEVIATION = AVERAGE - X_{CENTER}
- X_{CENTER} is determined as follows:
  For D-to-C jitter measurement,
  X_{CENTER} = T / 2
  For pulse width jitter measurement,
  X_{CENTER} = (RightMarker + LeftMarker) / 2

:CALCulation:DEVT?

Function Queries the deviation/T value.
Syntax `:CALCulation:DEVT?`
Example `:CALCULATION:DEVT?`
`-> 9.99437E-8`
Description
- If the statistical value is not valid, or if INPut:HISPeed:STATe (D-to-C high speed calculation) is ON, “NAN” is returned in response to a query.
- DEVT = DEVIATION / CONSTT × 100 %

:CALCulation:FLUTter?

Function Queries the σ/AVE value (flutter).
Syntax `:CALCulation:FLUTter?`
Example `:CALCULATION:FLUTTER?`
`-> 1.2887E+1`
Description
- If the statistical value is not valid, or if INPut:HISPeed:STATe (D-to-C high speed calculation) is ON, “NAN” is returned in response to a query.
- FLUTTER = SDEVIATION / AVERAGE × 100 %

:CALCulation:JITTer?

Function Queries the σ/T (jitter ratio) value.
Syntax `:CALCulation:JITTer?`
Example `:CALCULATION:JITTER?`
`-> 1.2366E+1`
Description If the statistical value is not valid, “NAN” is returned in response to a query.

:CALCulation:LEVel?

Function Queries the level value.
Syntax `:CALCULATION:LEVel?`
Example `:CALCULATION:LEVEL?`
`-> 1.236+0`
Description If the statistical value is not valid, “NAN” is returned in response to a query.

:CALCulation:MAXimum?

Function Queries the maximum value.
Syntax `:CALCulation:MAXimum?`
Example `:CALCULATION:MAXIMUM?`
`-> 1.1287E-7`
Description If the statistical value is not valid, or if INPut:HISPeed:STATe (D-to-C high speed calculation) is ON, “NAN” is returned in response to a query.

:CALCulation:MINimum?

Function Queries the minimum value.
Syntax `:CALCulation:MINimum?`
Example `:CALCULATION:MINIMUM?`
`-> 9.99437E-8`
Description If the statistical value is not valid, or if INPut:HISPeed:STATe (D-to-C high speed calculation) is ON, “NAN” is returned in response to a query.

:CALCulation:PTOPeak?

Function Queries the P-P value.
Syntax `:CALCulation:PTOPeak?`
Example `:CALCULATION:PTOPEAK?`
`-> 3.0245E-9`
Description If the statistical value is not valid, or if INPut:HISPeed:STATe (D-to-C high speed calculation) is ON, “NAN” is returned in response to a query.

:CALCulation:SDEViation?

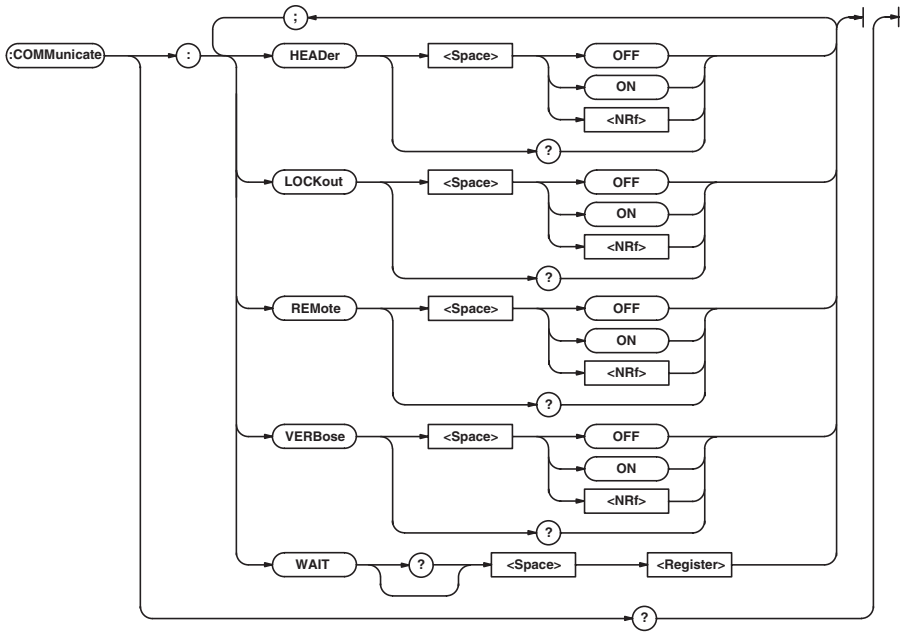
Function Queries the jitter (σ).
Syntax `:CALCulation:SDEViation?`
Example `:CALCULATION:SDEVIATION?`
`-> 2.4035E-9`
Description If the statistical value is not valid, “NAN” is returned in response to a query.

:CALCulation:SNUMber?

Function Queries number of samples for statistical calculation.
Syntax `:CALCulation:SNUMber?`
Example `:CALCULATION:SNUMBER?`
`-> 1000`
Description If the statistical value is not valid, “NAN” is returned in response to a query.

10.2.3 COMMunicate Group

This group consists of communication related commands. There are no front panel keys that correspond to this group.



:COMMunicate?

Function Queries all settings related to communications.
Syntax `:COMMunicate?`
Example `:COMMUNICATE?`
`-> :COMMUNICATE:HEADER 1;VERBOSE 1`

:COMMunicate:HEADer

Function Sets whether or not to attach a header to response data for queries, or queries the current setting (ON/OFF).
Syntax `:COMMunicate:HEADer {<Boolean>}`
`:COMMunicate:HEADer?`
Example `:COMMUNICATE:HEADER ON`
`:COMMUNICATE:HEADER?`
`-> :COMMUNICATE:HEADER 1`

:COMMunicate:LOCKout

Function Sets or clears local lockout.
Syntax `:COMMunicate:LOCKout {<Boolean>}`
`:COMMunicate:LOCKout?`
Example `:COMMUNICATE:LOCKOUT ON`
`:COMMUNICATE:LOCKOUT?`
`-> :COMMUNICATE:LOCKOUT 1`
Description This is a dedicated Ethernet command.

:COMMunicate:REMote

Function Sets remote or local mode. The instrument enters Remote mode when set to ON.
Syntax `:COMMunicate:REMote {<Boolean>}`
`:COMMunicate:REMote?`
Example `:COMMUNICATE:REMOTE ON`
`:COMMUNICATE:REMOTE?`
`-> :COMMUNICATE:REMOTE 1`
Description This is a dedicated Ethernet command.

:COMMunicate:VERBose

Function Sets whether to use verbose or abbreviated form in response data for queries, or queries the current setting (ON/OFF).
Syntax `:COMMunicate:VERBose {<Boolean>}`
`:COMMunicate:VERBose?`
Example `:COMMUNICATE:VERBOSE ON`
`:COMMUNICATE:VERBOSE?`
`-> :COMMUNICATE:HEADER ON`

:COMMunicate:WAIT

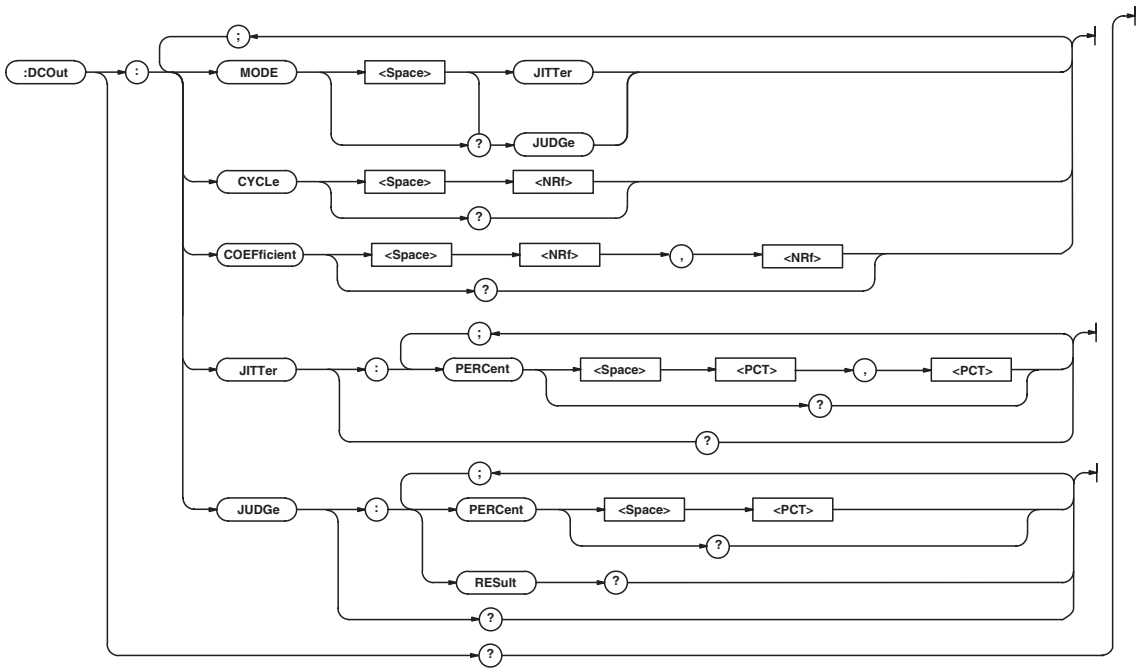
Function Waits for one of the specified extended events to occur.
Syntax `:COMMunicate:WAIT {<Register>}`
<Register> = 0–65535 (see page 10-37 for information on the extended event register)
Example `:COMMUNICATE:WAIT 65535`
Description See page 10-7 for information on synchronization using the `:COMMunication:WAIT` command.

:COMMunicate:WAIT?

Function Creates response data when one of the specified extended events occurs.
Syntax `:COMMunicate:WAIT? {<Register>}`
<Register> = 0 to 65535 (see page 10-37 for information on the extended event register)
Example `:COMMUNICATE:WAIT? 65535 -> 1`

10.2.4 DCOut Group

This group consists of DC output related commands.



:DCOut?

Function Queries all DC output related settings.

Syntax `:DCOut?`

Example `:DCOut?`
`->:DCOUT:MODE JITTER;CYCLE 1`

:DCOut:CYCLe

Function Sets the DC output average coefficient or queries the current setting.

Syntax `:DCOut:CYCLe <NRf>`
`:DCOut:CYCLe?`
<NRf>=1 to 10 (in steps of 1)

Example `:DCOUT:JITTER:CYCLE 1`
`:DCOUT:JITTER:CYCLE? -> 1`

:DCOut:COEFficient

Function Sets the DC output correction coefficient or queries the current setting.

Syntax `:DCOut:COEFficient {NRf>},{NRf>}`
`:DCOut:COEFficient?`
First parameter <NRf>= 0.0001 to 9.9999 (in 0.0001 steps)
Second parameter <NRf>= –9.999 to 9.999 (in 0.001 steps)

Example `:DCOUT:COEFFICIENT 1.0000E+00,0.0000E+00`

Description The first argument is the α in $y = \alpha x + \beta$
The second argument is the β in $y = \alpha x + \beta$

:DCOut:JITTer:PERCent

Function Sets the upper and lower limits for DC output of the jitter ratio or queries the current setting.

Syntax `:DCOut:JITTer:PERCent {PCT>},{PCT>}`
`:DCOut:JITTer:PERCent?`
First parameter <PCT>= 0.01 to 100.00 (in 0.01 steps)
Second parameter <PCT>= 0.00 to 99.99 (in 0.01 steps)
The first and second parameters are maximum value and minimum value, respectively. If the maximum value is less than or equal to the minimum value, an error occurs.

Example `:DCOUT:JITTER:PERCENT 25.000PCT,0.000PCT`
`:DCOUT:JITTER:PERCENT?`
`->25.000E+00,0.000E+00`

Description
- PCT used in the example can be omitted.
- Can only be set or queried when the DCOUT mode is JITTER.

:DCOut:JUDGe:PERCent

Function Sets the jitter ratio determination level or queries the current setting.

Syntax `:DCOut:JUDGe:PERCent {<PCT>}`
`:DCOut:JUDGe:PERCent?`
<PCT>= 0.00 to 25.00 (in 0.01 steps)

Example `:DCOUT:JUDGE:PERCENT 10.00PCT`
`:DCOUT:JUDGE:PERCENT?`
`-> :DCOUT:JUDGE:PERCENT 10.00E+00`

Description
- PCT used in the example can be omitted.
- Can only be set or queried when the DCOUT mode is JITTER.

:DCOut:JUDGe:RESult?

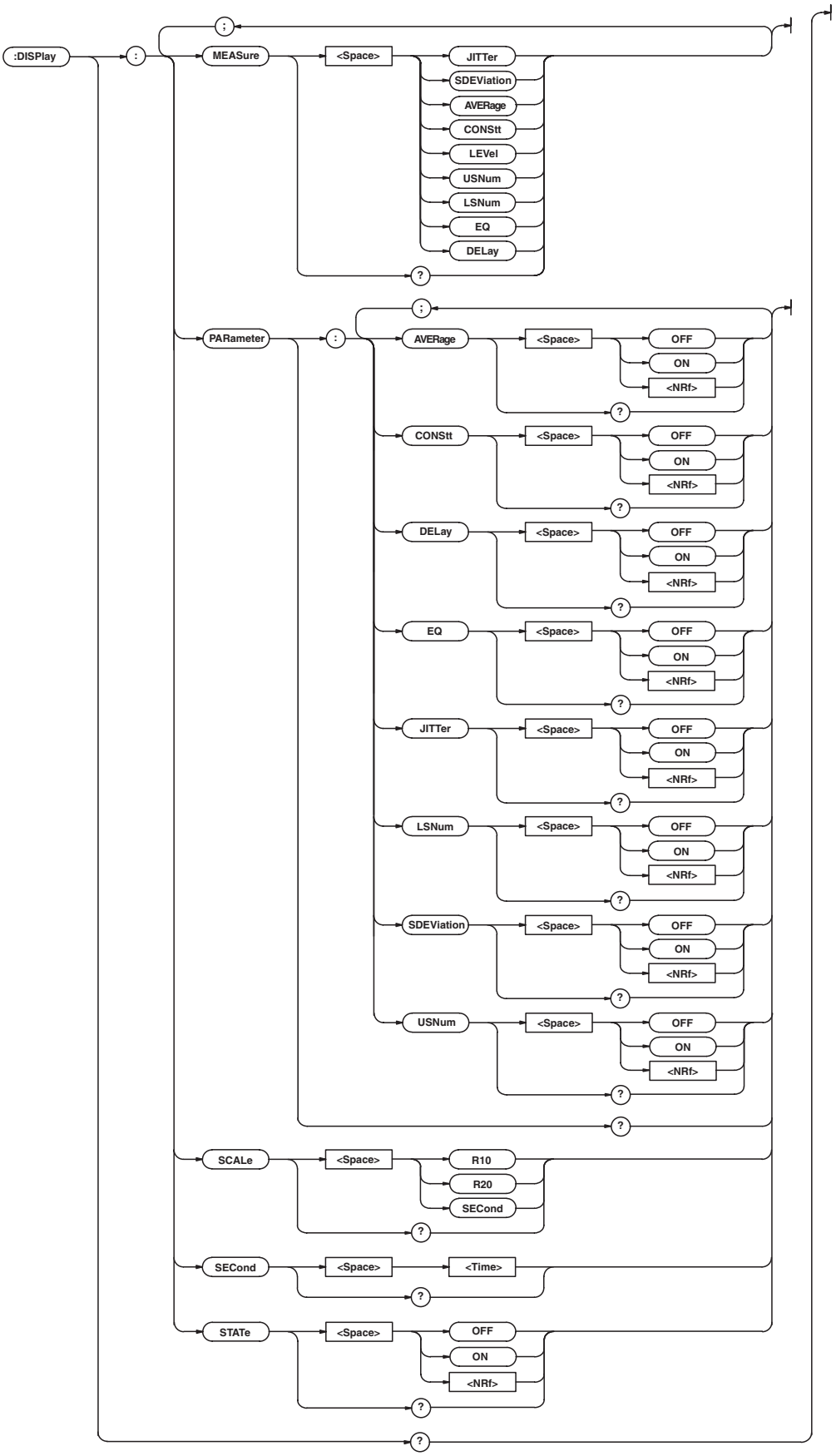
Function	Queries the determination result.
Syntax	:DCOut:JUDGe:RESult?
Example	:DCOut:JUDGE:RESULT? -> GO
Description	1. Returns GO if the measured jitter ratio is valid and equal to or lower than the determination level. 2. Returns NOGO if the measured jitter ratio is invalid or in excess of the determination level. 3. For D-to-C jitter measurement, returns NOJUD if the clock signal was not regenerated by the PLL circuit (unlock status).

:DCOut:MODE

Function	Switches the DC output mode or queries the current setting.
Syntax	:DCOut:MODE {JITTer|JUDGe} :DCOut:MODE?
Example	:DCOUT:MODE JITTER :DCOUT:MODE? -> :DCOUT:MODE JITTER

10.2.5 DISPlay Group

This group consists of display-related commands.



:DISPlay?

Function Queries all settings related to the display.

Syntax
```
:DISPlay?
```

Example
```
:DISPLAY?
-> :DISPLAY:MEASURE JITTER
;PARAMETER:JITTER 1;SDEVIATION 1
;AVERAGE 1;CONSTT 1;USNUM 1;LSNUM 1
;EQ 1;DELAY 1;:DISPLAY:SCALE R10
;STAT 1
```

:DISPlay:MEASure

Function Switches the statistical value display items or queries the current setting.

Syntax
```
:DISPlay:MEASure {JITTer|
SDEViation|AVERage|CONStt|LEVel|
USNum|LSNum|EQ|DELay}
:DISPlay:MEASure?
```

Example
```
:DISPLAY:MEASURE JITTER
:DISPLAY:MEASURE?
-> :DISPLAY:MEASURE JITTER
```

Description
- When LVOut:STATe (level measurement) is OFF, LEVEL cannot be measured.
- Parameters turned OFF using the DISPlay:PARameter:*** command cannot be selected.

:DISPlay:PARameter:AVERage

Function Sets the AVE displayed or queries the current setting.

Syntax
```
:DISPlay:PARameter
:AVERage {<Boolean>}
```

Example
```
:DISPLAY:PARAMETER:AVERAGE ON
:DISPLAY:PARAMETER:AVERAGE?
-> :DISPLAY:PARAMETER:AVERAGE 1
```

:DISPlay:PARameter:CONStt

Function Sets the T display or queries the current setting.

Syntax
```
:DISPlay:PARameter
:CONStt {<Boolean>}
```

Example
```
:DISPLAY:PARAMETER:CONStt ON
:DISPLAY:PARAMETER:CONStt?
-> :DISPLAY:PARAMETER:CONStt 1
```

:DISPlay:PARameter:DELay

Function Sets the Dly display or queries the current setting.

Syntax
```
:DISPlay:PARameter
:DELay {<Boolean>}
```

Example
```
:DISPLAY:PARAMETER:DELAY ON
:DISPLAY:PARAMETER:DELAY?
-> :DISPLAY:PARAMETER:DELAY 1
```

:DISPlay:PARameter:EQ

Function Sets the EQ display or queries the current setting.

Syntax
```
:DISPlay:PARameter:EQ {<Boolean>}
```

Example
```
:DISPLAY:PARAMETER:EQ ON
:DISPLAY:PARAMETER:EQ?
-> :DISPLAY:PARAMETER:EQ 1
```

:DISPlay:PARameter:JITTer

Function Sets the σ/T display or queries the current setting.

Syntax
```
:DISPlay:PARameter
:JITTer {<Boolean>}
```

Example
```
:DISPLAY:PARAMETER:JITTER ON
:DISPLAY:PARAMETER:JITTER?
-> :DISPLAY:PARAMETER:JITTER 1
```

:DISPlay:PARameter:LSNum

Function Sets the SnL display or queries the current setting.

Syntax
```
:DISPlay:PARameter
:LSNum {<Boolean>}
```

Example
```
:DISPLAY:PARAMETER:LSNUM ON
:DISPLAY:PARAMETER:LSNUM?
-> :DISPLAY:PARAMETER:LSNUM 1
```

:DISPlay:PARameter:SDEViation

Function Sets the σ display or queries the current setting.

Syntax
```
:DISPlay:PARameter
:SDEViation {<Boolean>}
```

Example
```
:DISPLAY:PARAMETER:SDEVIAION ON
:DISPLAY:PARAMETER:SDEVIAION?
-> :DISPLAY:PARAMETER:SDEVIAION 1
```

:DISPlay:PARameter:USNum

Function Sets the SnU display or queries the current setting.

Syntax
```
:DISPlay:PARameter
:USNum {<Boolean>}
```

Example
```
:DISPLAY:PARAMETER:USNUM ON
:DISPLAY:PARAMETER:USNUM?
-> :DISPLAY:PARAMETER:USNUM 1
```

:DISPlay:SCALe

Function Sets the meter scale or queries the current setting.

Syntax
```
:DISPlay:SCALe {R10|R20|SECond}
:DISPlay:SCALe?
```

Example
```
:DISPLAY:SCALE R10
:DISPLAY:SCALE?
-> :DISPLAY:SCALE R10
```

:DISPlay:SECond

Function Sets the meter time scale or queries the current setting.

Syntax
```
:DISPlay:SECond {<time>}
:DISPlay:SECond?
```
<time> = 0.5E-9, 1E-9, 5E-9, 10E-9, 50E-9, 100E-9, 500E-9, 1E-6, 5E-6

Example
```
:DISPLAY:SECOND 5.0E-9
:DISPLAY:SECOND?
-> :DISPLAY:SECOND 5.0E-9
```

Description You can perform this setting or query only when DISPlay:SCALe (meter scale) is set to SECond.

:DISPlay:STATe

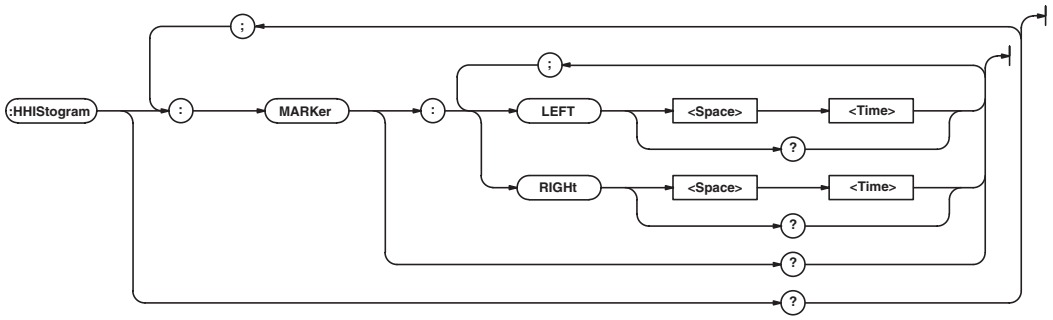
Function Turns the numerical display ON or OFF or queries the current setting.

Syntax
```
:DISPlay:STATe {<Boolean>}
:DISPlay:STATe?
```

Example
```
:DISPLAY:STATE ON
:DISPLAY:STATE?
-> :DISPLAY:STATE 1
```

10.2.6 HHIStogram Group

This group consists of marker setting related commands.



:HHIStogram?

Function Queries all settings related to markers.

Syntax
```
:HHIStogram?
```

Example
```
:HHISTOGRAM?
-> :HHISTOGRAM:MARKER:LEFT 0.00E-9
;RIGHT 37.00E-9
```

Description Cannot be set or queried when the function is D-to-C or E2T.

:HHIStogram:MARKer?

Function Queries all settings related to markers.

Syntax
```
:HHIStogram:MARKer?
```

Example
```
:HHISTOGRAM:MARKER?
-> :HHISTOGRAM:MARKER
:LEFT 100.000E-09;RIGHT 200.000E-09
```

Description Cannot be set or queried when the function is D-to-C or E2T.

:HHIStogram:MARKer:LEFT

Function Sets the position of the left marker or queries the current setting.

Syntax
```
:HHIStogram:MARKer:LEFT {<time>}
:HHIStogram:MARKer:LEFT?
```
<time> = 0.00 ns to 998.99 ns
However, it must be at least 1 ns smaller than the right marker (in steps of 10 ps).

Example
```
:HHISTOGRAM:MARKER:LEFT 100 ns
:HHISTOGRAM:MARKER:LEFT?
-> :HHISTOGRAM:MARKER:
LEFT 100.000E-09
```

Description Cannot be set or queried when the function is D-to-C or E2T.

:HHIStogram:MARKer:RIGHt

Function Sets the position of the right marker or queries the current setting.

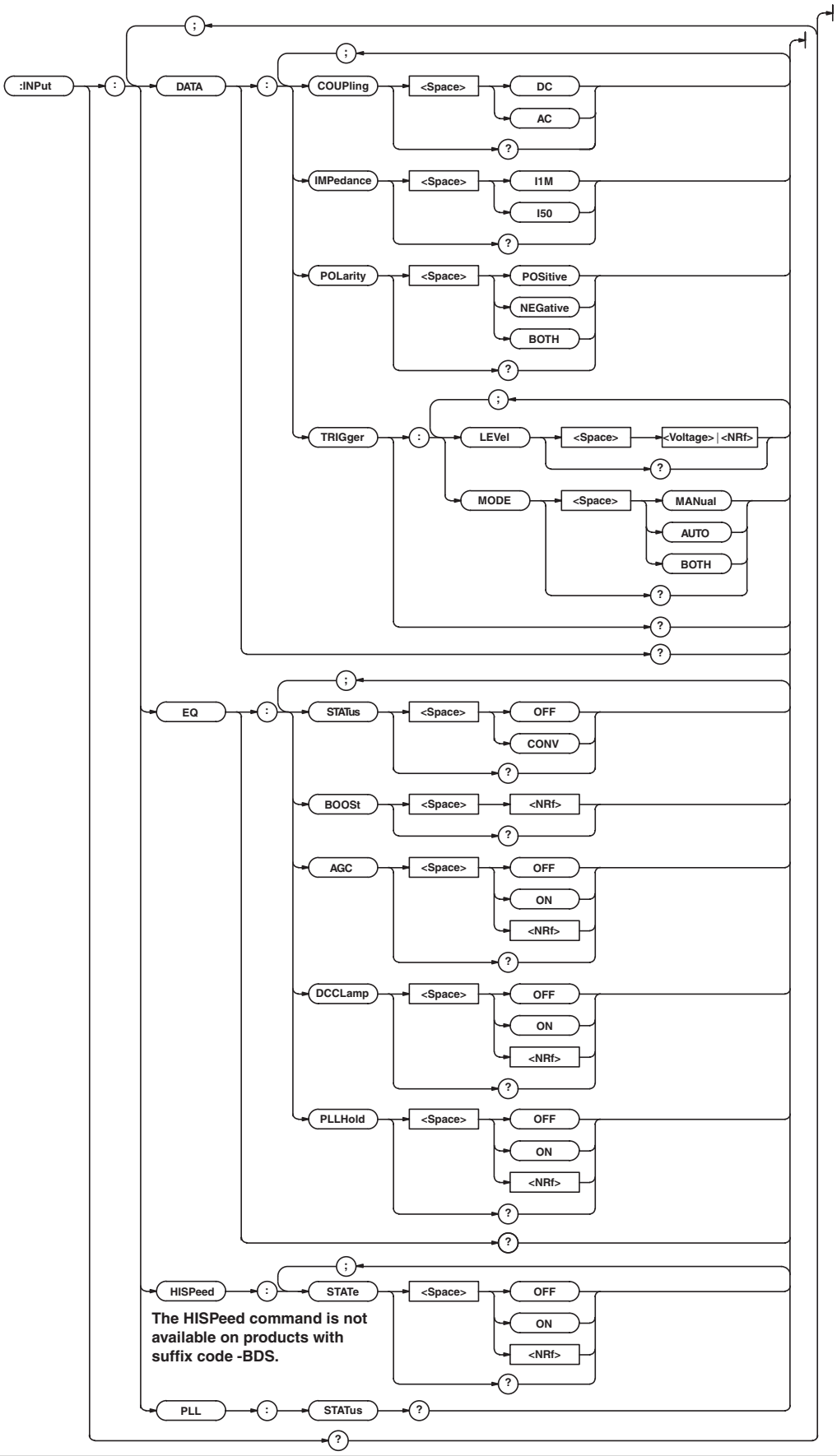
Syntax
```
:HHIStogram:MARKer:RIGHt {<time>}
:HHIStogram:MARKer:RIGHt?
```
<time> = 1.00 ns to 999.99 ns
However, it must be at least 1 ns or greater than the left marker (in steps of 10 ps).

Example
```
:HHISTOGRAM:MARKER:LEFT 100 ns
:HHISTOGRAM:MARKER:LEFT?
-> :HHISTOGRAM:MARKER:
LEFT 100.000E-09
```

Description Cannot be set or queried when the function is D-to-C or E2T.

10.2.7 INPut Group

This group consists of commands related to the input section.



:INPut?

Function Queries all settings related to the signal input section.

Syntax `:INPut?`

Example
```
:INPUT?
-> :INPUT:DATA:COUPLING DC
;IMPEDANCE I1M;TRIGGER
:LEVEL 100E+00;TRIGGER:MODE MANUAL
```

:INPut:DATA?

Function Queries all settings related to the signal input section (excluding the equalizer).

Syntax `:INPut:DATA?`

Example
```
:INPUT:DATA?
-> :INPUT:DATA:COUPLING DC
;IMPEDANCE I1M;TRIGGER
:LEVEL 100E+00;TRIGGER:MODE MANUAL
```

:INPut:DATA:COUPling

Function Sets the input coupling or queries the current setting.

Syntax
```
:INPut:DATA:COUPling {AC|DC}
:INPut:DATA:COUPling?
```

Example
```
:INPUT:DATAL:COUPLING DC
:INPUT:DATA:COUPLING?
-> :INPUT:DATA:COUPLING DC
```

:INPut:DATA:IMPedance

Function Sets the input impedance or queries the current setting.

Syntax
```
:INPut:DATA:IMPedance {I50|I1M}
:INPut:DATA:IMPedance?
```

Example
```
:INPUT:DATA:IMPEDANCE I1M
:INPUT:DATA:IMPEDANCE?
-> :INPUT:DATA:IMPEDANCE I1M
```

:INPut:DATA:POLarity

Function Sets the polarity of the data signal or queries the current setting.

Syntax
```
:INPut:DATA:POLarity {POSitive|
NEGative|BOTH}
:INPut:DATA:POLarity?
```

Example
```
:INPUT:DATA:POLARITY POSITIVE
:INPUT:DATA:POLARITY?
-> :INPUT:DATA:POLARITY POSITIVE
```

Description BOTH cannot be set when the function is PulseWidth.

:INPut:DATA:TRIGger?

Function Queries all settings related to the trigger.

Syntax `:INPut:DATA:TRIGger?`

Example
```
:INPUT:DATA:TRIGGER?
-> :INPUT:DATA:TRIGGER
:LEVEL 100E+00;MODE MANUAL
```

:INPut:DATA:TRIGger:LEVel

Function Sets the trigger level (slice level) or queries the current setting.

Syntax
```
:INPut:DATA:TRIGger
:LEVel {<voltage>|<NRf>}
:INPut:DATA:TRIGger:LEVel?
```

When the function is DTOC
- <NRf>= –1000 to 1000 (in steps of 1)

When the function is PulseWidth and the equalizer and AGC are OFF
- <Voltage> = –2.000 V to 2.000 V (in steps of 1 mV)

When the function is PulseWidth and the equalizer is OFF or AGC is ON
- <NRf>= –1000 to 1000 (in steps of 1)

Example
```
:INPUT:DATA:TRIGGER:LEVEL 100
:INPUT:DATA:TRIGGER:LEVEL?
-> :INPUT:DATA:TRIGGER
:LEVEL 100E+00
```

Description Cannot be set or queried when the trigger mode is AUTO.

:INPut:DATA:TRIGger:MODE

Function Sets the trigger mode or queries the current setting.

Syntax
```
:INPut:DATA:TRIGger
:MODE {AUTO|MANual|BOTH}
:INPut:DATA:TRIGger:MODE?
```

Example
```
:INPUT:DATA:TRIGGER:MODE MANUAL
:INPUT:DATA:TRIGGER:MODE?
-> :INPUT:DATA:TRIGGER:MODE MANUAL
```

Description
- Only MANUAL can be set when the function is PulseWidth and EQ and AGC are OFF.
- The trigger mode is forcibly set to AUTO when the limit equalizer is selected (see the option function user's manual, IM704610-51E). The trigger mode remains the same even if the equalizer is returned to OFF or CONV.

:INPut:EQ?

Function Queries all settings related to the equalizer.

Syntax `:INPut:EQ?`

Example
```
:INPUT:EQ?
-> :INPUT:EQ:STATUS OFF;AGC OFF
;DCCLAMP OFF;PLLHOLD OFF
```

:INPut:EQ:STATus

Function Sets the equalizer status or queries the current setting.

Syntax
```
:INPut:EQ:STATus {OFF|CONV}
:INPut:EQ:STATus?
```

Example
```
:INPUT:EQ:STATUS OFF
:INPUT:EQ:STATUS?
-> :INPUT:EQ:STATUS OFF
```

Description When the function is PulseWidth, AGC is OFF, and EQ:STATus is turned OFF, the trigger mode switches to manual trigger.

:INPut:EQ:BOOSt

Function Sets the equalizer boost amount or queries the current setting.

Syntax
```
:INPut:EQ:BOOSt {<NRf>}
:INPut:EQ:BOOSt?
```
<NRf> = 3.0 to 9.0

Example
```
:INPUT:EQ:BOOST 3.0
:INPUT:EQ:BOOST?
-> :INPUT:EQ:BOOST 3.0
```

Description Cannot set or query when :INPut:EQ:STATus is OFF.

:INPut:EQ:AGC

Function Sets the AGC function of the equalizer or queries the current setting.

Syntax
```
:INPut:EQ:AGC {<Boolean>}
:INPut:EQ:AGC?
```

Example
```
:INPUT:EQ:AGC OFF
:INPUT:EQ:AGC?
-> :INPUT:EQ:AGC 0
```

Description When the function is PulseWidth and the equalizer and AGC are turned OFF, the trigger mode switches to manual trigger.

:INPut:EQ:DCCLamp

Function Sets the DC clamp function of the equalizer or queries the current setting.

Syntax
```
:INPut:EQ:DCCLamp {<Boolean>}
:INPut:EQ:DCCLAMP?
```

Example
```
:INPUT:EQ:DCCLAMP OFF
:INPUT:EQ:DCCLAMP?
-> :INPUT:EQ:DCCLAMP 0
```

Description Cannot be set for media or functions that are not equipped with an equalizer.

:INPut:EQ:PLLHold

Function Sets the PLL hold function of the equalizer or queries the current setting.

Syntax
```
:INPut:EQ:PLLHold {<Boolean>}
:INPut:EQ:PLLHOLD?
```

Example
```
:INPUT:EQ:PLLHOLD OFF
:INPUT:EQ:PLLHOLD?
-> :INPUT:EQ:PLLHOLD 0
```

Description Cannot be set for media or functions that are not equipped with an equalizer.

:INPut:HISPeed:STATe

Function Sets the D-to-C high speed calculation function or queries the current setting.

Syntax
```
:INPut:HISPeed:STATe {Boolean>}
:INPut:HISPeed:STATe?
```

Example
```
:INPUT:HISPeed:STATe OFF
:INPUT:HISPeed:STATe?
-> :INPUT:HISPeed:STATe 0
```

Explanation This command is not available on products with suffix code -BDS.

:INPut:PLL:STATus?

Function Queries the PLL lock status.

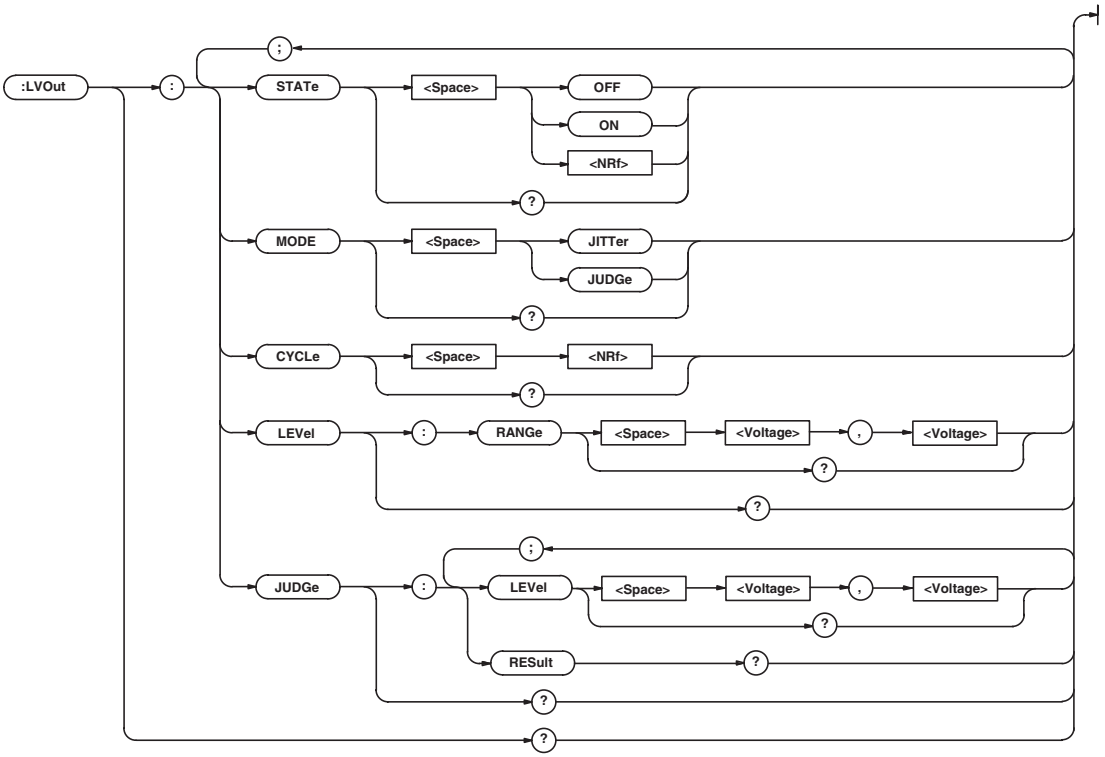
Syntax
```
:INPut:PLL:STATus?
```

Example
```
:INPUT:PLL:STATUS?
-> LOCK
```

Description 1. LOCK is returned if the result is lock.
2. UNLOCK is returned if the result is not lock.

10.2.8 LVOut Group

This group consists of level output related commands.



:LVOut?

Function Queries all settings related to level measurement.

Syntax `:LVOut?`

Example `:LVOUT?`
`-> LVOUT:STATE OFF`

:LVOut:STATe

Function Turns level measurement ON and OFF or queries the current setting.

Syntax `:LVOut:STATe {<Boolean>}`
`:LVOut:STATe?`

Example `:LVOUT:STATE ON`
`:LVOUT:STATE?`
`-> LVOUT:STATE 1`

:LVOut:MODE

Function Sets the level setting output mode or queries the current setting.

Syntax `:LVOut:MODE {JITTer|JUDGe}`
`:LVOut:MODE?`

Example `:LVOUT:MODE JITTER`
`:LVOUT:MODE?`
`-> LVOUT:MODE JITTER`

:LVOut:CYCLe

Function Sets the average coefficient for level measurement output or queries the current setting.

Syntax `:LVOut:CYCLe {<NRf>}`
`:LVOut:CYCLe?`
<NRf> = 1 to 10

Example `:LVOUT:CYCLE 1`
`:LVOUT:CYCLE?`
`-> LVOUT:CYCLE 1`

:LVOut:LEVel:RANGe

Function Sets the upper and lower limit of the level measurement output range or queries the current setting.

Syntax `:LVOut:LEVel:RANGe {<voltage>},`
`{<voltage>}`
`:LVOut:LEVel:RANGe?`
First argument <voltage> = 0.000 to 5.000 (in steps of 0.001)
Second argument <voltage> = 0.000 to 5.000 (in steps of 0.001)
The first and second parameters are maximum value and minimum value, respectively. If the maximum value is less than or equal to the minimum value, an error occurs.

Example `:LVOUT:LEVEL:RANGE 5,0`
`:LVOUT:LEVEL:RANGE?`
`-> LVOUT:LEVEL:RANGE 5,0`

:LVOut:JUDGe:LEVel

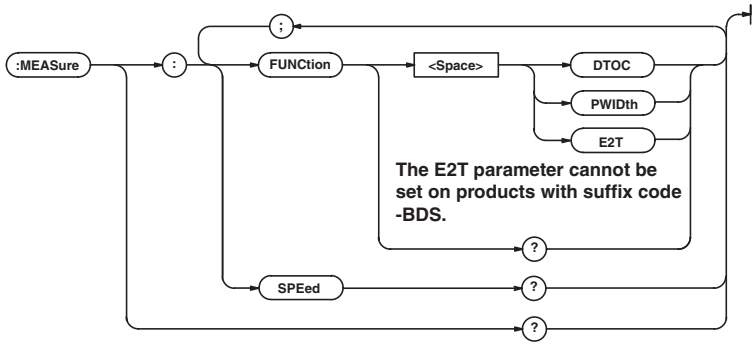
Function	Sets the upper and lower limit of the determination level of the level measurement output or queries the current setting.
Syntax	:LVOut:JUDGe:LEVel {<voltage>}, {<voltage>} :LVOut:JUDGe:LEVel?
	First argument <voltage> = 0.000 to 5.000 (in steps of 0.001) Second argument <voltage> = 0.000 to 5.000 (in steps of 0.001) The first and second parameters are maximum value and minimum value, respectively. If the maximum value is less than or equal to the minimum value, an error occurs.
Example	:LVOUT:JUDGE:LEVEL 3,2 :LVOUT:JUDGE:LEVEL? -> LVOUT:JUDGE:LEVEL 3,2

:LVOut:JUDGe:RESult?

Function	Queries the determination result for level measurement output.
Syntax	:LVOut:JUDGe:RESult?
Example	:LVOUT:JUDGE:RESULT? -> GO
Description	1. GO is returned if the result is GO. 2. NOGO is returned if the result is NOGO.

10.2.9 MEASure Group

This group consists of commands related to measurement conditions.



:MEASure?

Function	Queries all settings related to measurement conditions.
Syntax	:MEASure?
Example	:MEASURE? -> :MEASURE:FUNCTION DTOC ;SPEED 1.0E+00

:MEASure:FUNCtion

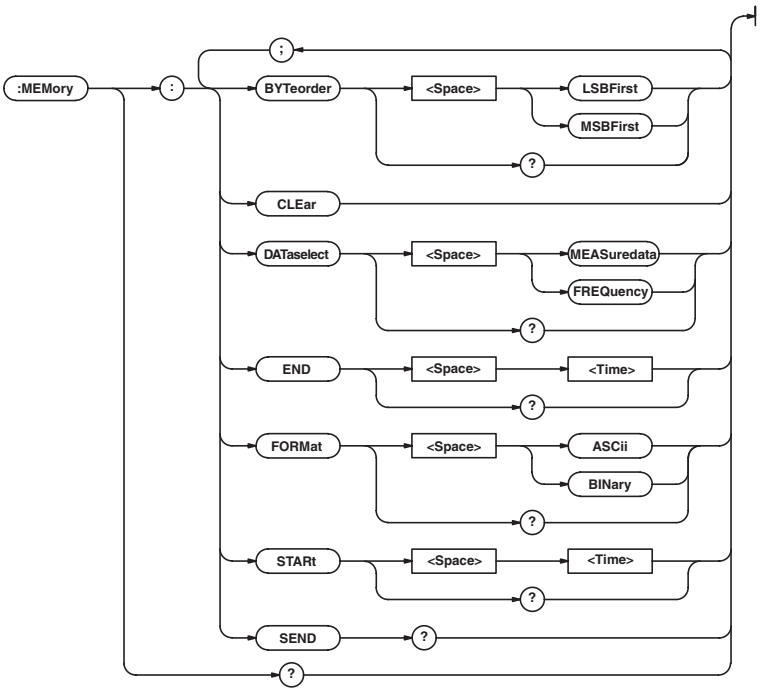
Function	Sets the measurement function or queries the current setting.
Syntax	:MEASure:FUNCtion {DTOC|PWIDTH|E2T} :MEASure:FUNCtion?
Example	:MEASURE:FUNCTION DTOC :MEASURE:FUNCTION? -> :MEASURE:FUNCTION DTOC
Explanation	The E2T parameter cannot be set on products with suffix code -BDS.

:MEASure:SPEed?

Function	Queries the measurement speed.
Syntax	:MEASure:SPEed?
Example	:MEASURE:SPEed? -> :MEASURE:SPEED 1.0

10.2.10 MEMory Group

The commands in this group deal with the external transmission of the measured data.
There are no front panel keys that correspond to this group.



:MEMory?

Function Queries all settings related the external transmission of the measured data.
Syntax `:MEMory?`
Example `:MEMORY?`
`-> :MEMORY:BYTEORDER LSBFIRST;DATASELECT FREQUENCY;END 15.1E-09;FORMAT ASCII;START 1.0E-09`

:MEMory:BYTeorder

Function Sets the transmission order of binary data or queries the current setting.
Syntax `:MEMory:BYTeorder {LSBFirst|MSBFirst}`
`:MEMory:BYTeorder?`
Example `:MEMORY:BYTEORDER LSBFIRST`
`:MEMORY:BYTEORDER?`
`-> :MEMORY:BYTEORDER LSBFIRST`

:MEMory:CLEar

Function Clears the measured data.
Syntax `:MEMory:CLEar`
Example `:MEMORY:CLEAR`

:MEMory:DATaselect

Function Sets the data to be transmitted or queries the current setting.
Syntax `:MEMory:DATaselect {MEASuredata|FREQuency}`
`:MEMory:DATaselect?`
Example `:MEMORY:DATASELECT FREQUENCY`
`:MEMORY:DATASELECT?`
`-> :MEMORY:DATASELECT FREQUENCY`

:MEMory:END

Function Sets the end position of transmitted data or queries the current setting.
Syntax `:MEMory:END {<time>}`
`:MEMory:END?`
<time> = 0 to 80 ns (when the measurement function is set to D-to-C)
<time> = 0 to 999.9 ns (when the measurement function is set to PulseWidth)
Example `:MEMORY:END 1 ns`
`:MEORY:END?`
`-> :MEMORY:END 1.0E-09`

:MEMory:FORMat

Function Sets the format of the data to be transmitted or queries the current setting.
Syntax `:MEMory:FORMat {ASCii|BINary}`
`:MEMory:FORMat?`
Example `:MEMORY:FORMAT ASCII`
`:MEMORY:FORMAT?`
`-> :MEMORY:FORMAT ASCII`

:MEMory:SEND?

Function Executes the transmission of the measured data specified by "MEMory:DATaselect."

Syntax `:MEMory:SEND?`

Example
```
:MEMORY:SEND?
-> #800000016abcdabceabcfabcg
```

Description
- When the transmission format is ASCII, response data of only the number of data points are output in <NR3> format delimited with commas. For BINARY, the output is simply block data.
- Conversion of binary data to real numbers is as follows.
  - Frequency (FREQuency): The frequency is stored using a 4-byte unsigned integer.
  - Measured values (MEASuredata): 4-byte signed integer. The measured value is derived by multiplying by 97.65625 s. The frequency outside of the HHISt:Marker:LEFT and HHISt:Marker:RIGHt range is 0. This command can only be used after the single measurement command (sstart). This command cannot be used after the start or stop command.

:MEMory:STARt

Function Sets the start position of transmitted data or queries the current setting.

Syntax
```
:MEMory:STARt {<time>}
:MEMory:STARt?
```
<time> = 0 to 80 ns (when the measurement function is set to D-to-C)
<time> = 0 to 999.9 ns (when the measurement function is set to PulseWidth)

Example
```
:MEMORY:START 1ns
:MEMORY:START?
-> :MEMORY:START 1.0E-9
```

10.2.11 RECall Group

:RECall

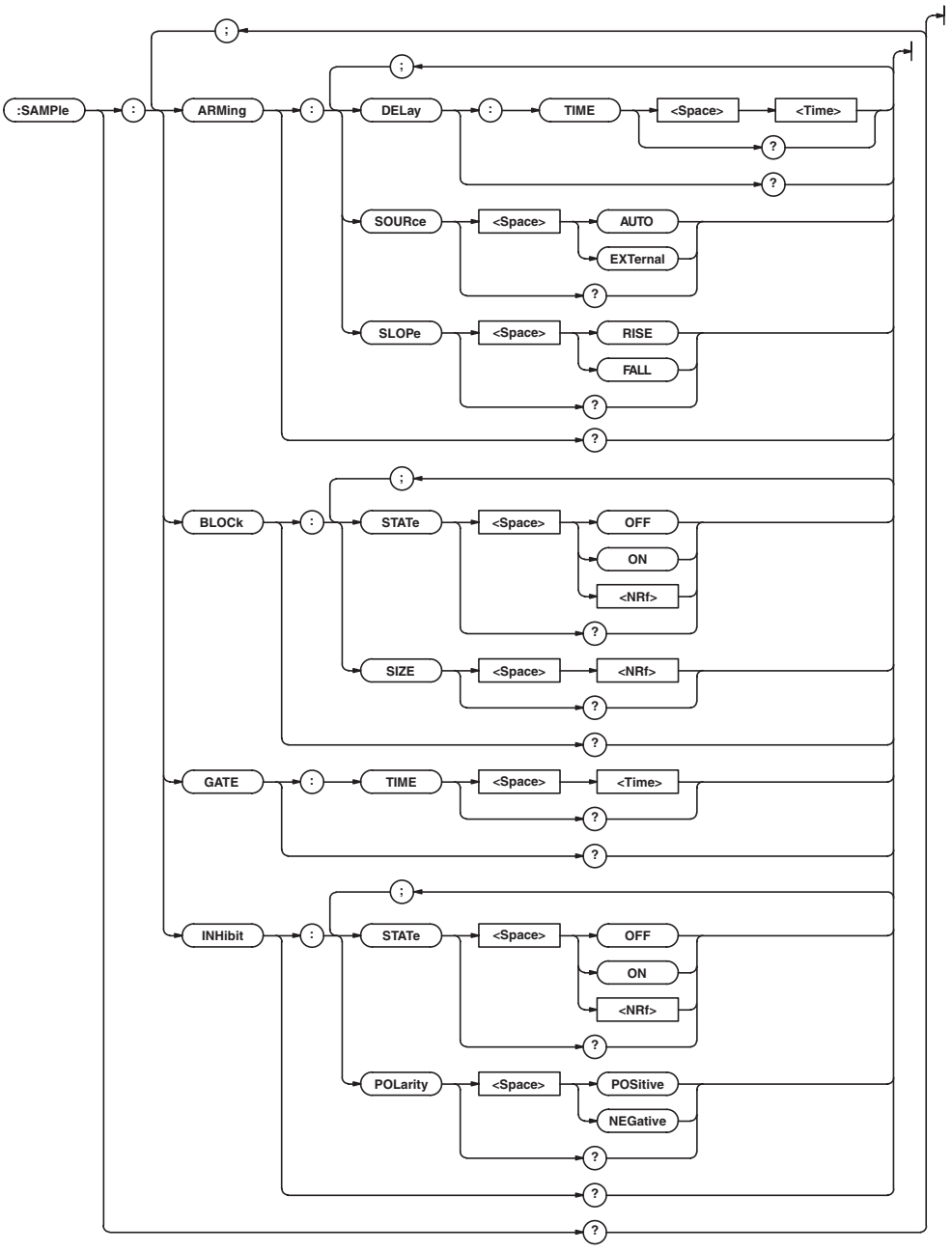
Function Recalls the setup information.

Syntax
```
:RECall {<NRf>}
```
<NRf> = 0 to 6

Example
```
:RECALL 0
```

10.2.12 SAMPle Group

This group consists of commands related to sampling conditions.



:SAMPle?

Function Queries all settings related to sampling.

Syntax :SAMPle?

Example :SAMPLE?

-> :SAMPLE:ARMING:DELAY

:TIME 0.0E-03;:SAMPLE:ARMING:

SOURCE EXTERNAL;SLOPE RISE

:SAMPle:ARMing?

Function Queries all settings related to arming.

Syntax :SAMPle:ARMing?

Example :SAMPLE:ARMING?

-> :SAMPLE:ARMING:DELAY

:TIME 0.0E-3;::SAMPLE:ARMING

:SOURCE EXTERNAL;SLOPE RISE

:SAMPLe:ARMing:DELay?

Function Queries all settings related to arming delay.
Syntax :SAMPle:ARMing:DElay?
Example :SAMPLE:ARMING:DELAY?
-> :SAMPLE:ARMING:DELAY:TIME 1.0E-03
Description Cannot be set or queried when SAMPle:ARMing:SOURce (arming source) is AUTO.

:SAMPle:ARMing:DELay:TIME

Function Sets the arming delay time or queries the current setting.
Syntax :SAMPle:ARMing:DELay:TIME {<time>}
:SAMPle:ARMing:DELay:TIME?
<time>=0.0 ms to 1.0000 s (in steps of 0.1 ms)
Example :SAMPLE:ARMING:DELAY:TIME 1ms
:SAMPLE:ARMING:DELAY:TIME?
-> :SAMPLE:ARMING:DELAY
:TIME 1.0E-03
Description Cannot be set or queried when SAMPle:ARMing:SOURce (arming source) is AUTO.

:SAMPle:ARMing:SLOPe

Function Sets the arming slope or queries the current setting.
Syntax :SAMPLe:ARMing:SLOPe {RISE|FALL}
:SAMPle:ARMing:SLOPe?
Example :SAMPLE:ARMING:SLOPE RISE
:SAMPLE:ARMING:SLOPE?
-> :SAMPLE:ARMING:SLOPE RISE
Description Cannot be set or queried when SAMPle:ARMing:SOURce (arming source) is AUTO.

:SAMPle:ARMing:SOURce

Function Sets the arming source or queries the current setting.
Syntax :SAMPLe:ARMing:SOURce {AUTO|EXTernal}
:SAMPle:ARMing:SOURce?
Example :SAMPLE:ARMING:SOURCE AUTO
:SAMPLE:ARMING:SOURCE?
-> :SAMPLE:ARMING:SOURCE AUTO
Description Cannot be set or queried when SAMPle:ARMing:SOURce (arming source) is AUTO.

:SAMPle:BLOCk?

Function Queries all settings related to block sampling.
Syntax :SAMPle:BLOCk?
Example :SAMPLE:BLOCK?
-> :SAMPLE:BLOCK:SIZE 10;STATE 1

:SAMPle:BLOCk:SIZE

Function Sets the number of blocks for block sampling or queries the current setting.
Syntax :SAMPLe:BLOCk:SIZE {<NRf>}
:SAMPle:BLOCk:SIZE?
<NRf> = no. of blocks (2 to 99)
Example :SAMPLE:BLOCK:SIZE 10
:SAMPLE:BLOCK:SIZE?
-> :SAMPLE:BLOCK:SIZE 10
Description
- Cannot be set or queried when SAMPle:ARMing:SOURce (arming source) is AUTO, or when the arming source is EXT and the block state is OFF.
- The maximum number of blocks that can be specified is 5 seconds ÷ gate time (digits after the decimal point are ignored), or 99, whichever is smaller.

:SAMPle:BLOCk:STATe

Function Turns block sampling ON and OFF or queries the current setting.
Syntax :SAMPLe:BLOCk:STATe {<Boolean>}
:SAMPle:BLOCk:STATe?
Example :SAMPLE:BLOCK:STATE ON
:SAMPLE:BLOCK:STATE?
-> :SAMPLE:BLOCK:STATE 1
Description Cannot be set or queried when the arming source is AUTO.

:SAMPle:GATE?

Function Queries all settings related to the gate.
Syntax :SAMPle:GATE?
Example :SAMPLE:GATE?
-> :SAMPLE:GATE:TIME 1.000E+00

:SAMPle:GATE:TIME

Function Sets the gate time or queries the current setting.
Syntax :SAMPLe:GATE:TIME {<time>}
:SAMPle:GATE:TIME?
<time> = 1 to 1000 ms (in steps of 1 ms)
Example :SAMPLE:GATE:TIME 1ms
:SAMPLE:GATE:TIME?
-> :SAMPLE:GATE:TIME 1E-03

:SAMPle:INHibit?

Function Queries all settings related to inhibit.
Syntax :SAMPLe:INHibit?
Example :SAMPLE:INHIBIT?
-> :SAMPLE:INHIBIT OFF

:SAMPle:INHibit:POLarity

Function Sets the polarity of inhibit or queries the current setting.

Syntax
```
:SAMPLe:INHibit:POLarity {POSitive|NEGative}
:SAMPle:INHibit:POLarity?
```

Example
```
:SAMPLE:INHIBIT:POLARITY OFF
:SAMPLE:INHIBIT:POLARITY?
-> :SAMPLE:INHIBIT:POLARITY OFF
```

Description Cannot be set or queried when SAMPle:INHibit:STATe (inhibit) is OFF.

:SAMPle:INHibit:STATe

Function Turns ON/OFF inhibit or queries the current setting.

Syntax
```
:SAMPLe:INHibit:STATe {<Boolean>}
:SAMPle:INHibit:STATe?
```

Example
```
:SAMPLE:INHIBIT:STATE OFF
:SAMPLE:INHIBIT:STATE?
-> :SAMPLE:INHIBIT:STATE OFF
```

10.2.13 SSTart Group

:SSTart

Function Executes single measurement.

Syntax
```
:SSTart
```

Example
```
:SSTART
```

Explanation Cannot be executed when INPut:HISPeed:STATe (D-to-C high speed calculation) is ON.

10.2.14 STARt Group

:STARt

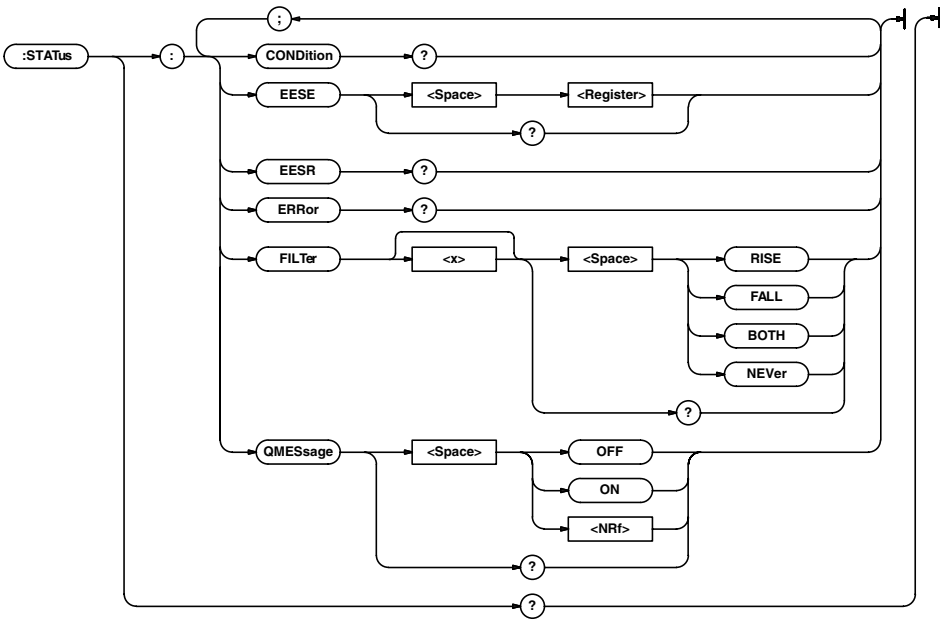
Function Starts measurement.

Syntax
```
:STARt
```

Example
```
:START
```

10.2.15 STATus Group

This group consists of statistical computation related commands. See section 10.3 for more information on the status report.



:STATus?

Function Queries all settings related to the communication status.

Syntax :STATus?

Example :STATUS?

```
-> :STATUS:EESE 0;FILTER1 RISE
;FILTER2 NEVER;FILTER3 NEVER
;FILTER4 NEVER;FILTER5 NEVER
;FILTER6 NEVER;FILTER7 NEVER
;FILTER8 NEVER;FILTER9 RISE
;FILTER10 RISE;FILTER11 RISE
;FILTER12 RISE;FILTER13 RISE
;FILTER14 NEVER;FILTER15 NEVER
;FILTER16 NEVER;QMESSAGE 1
```

:STATus:CONDition?

Function Queries the contents of the status register.

Syntax :STATus:CONDition?

Example :STATUS:CONDITON?

```
-> 1
```

:STATus:EESE

Function Sets the extended event enable register or queries the current setting.

Syntax :STATus:EESE {<Register>}

:STATus:EESE?

<Register> = 0 to 65535

Example :STATUS:EESE 257

:STATUS:EESE?

-> :STATUS:EESE 257

:STATus:EESR?

Function Queries the contents of the extended event register and clears the register.

Syntax :STATus:EESR?

Example :STATUS:EESR?

```
-> 1
```

:STATus:ERRor?

Function Queries any error codes that occurred and message information (top of the error queue).

Syntax :STATus:ERRor?

Example :STATUS:ERROR?

```
-> 113,"Undefine header"
```

:STATus:FILTer

Function Sets the transition filter or queries the current setting.

Syntax :STATus:FILTer<x> {RISE|FALL|BOTH|NEVer}

:STATus:FILTer

<x> = 1 to 16

Example :STATUS:FILTER1 RISE

:STATUS:FILTER1?

-> :STATUS:FILTER1 RISE

:STATus:QMESsage

Function Sets whether or not to attach message information to the response to the ":STATus:ERRor?" query or queries the current setting.

Syntax :STATus:QMESsage {<Boolean>}

:STATus:QMESsage?

Example :STATUS:QMESSAGE OFF

:STATUS:QMESSAGE?

-> :STATUS:QMESSAGE 0

10.2.16 STOP Group

:STOP

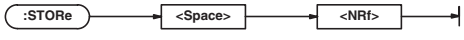
Function Stops measurement.

Syntax :STOP

Example :STOP

Explanation Cannot be executed when INPut:HISPeed:STATe (D-to-C high speed calculation) is ON.

10.2.17 STORe Group



:STORe

Function Stores the current settings

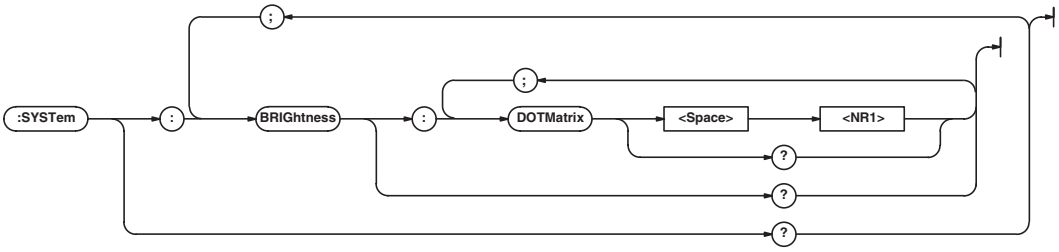
Syntax :STORe {<NRf>}

<NRf> = 0 to 6

Example :STORE 0

10.2.18 SYSTem Group

This group consists of commands related to system settings.



:SYSTem?

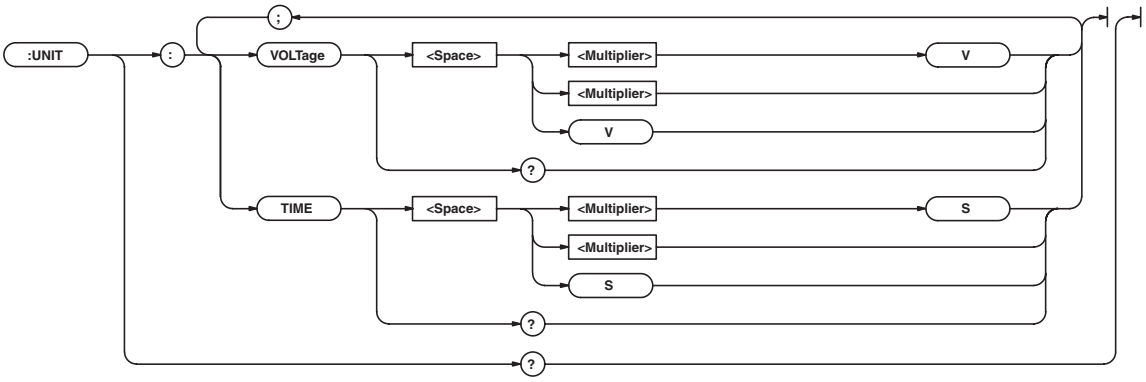
Function Queries all settings related to the system group.
Syntax :SYSTem?
Example :SYSTEM?
-> :SYSTEM:BRIGHTNESS:DOTMATRIX 3

:SYSTem:BRIGhtness:DOTMatrix

Function Sets the brightness of the dot matrix LED display or queries the current setting.
Syntax :SYSTem:BRIGhtness
:DOTMatrix {<NR1>}
:SYSTem:BRIGhtness:DOTMatrix?
<NR1> = 1 to 6
Example :SYSTEM:BRIGHTNESS:DOTMATRIX 1
:SYSTEM:BRIGHTNESS:DOTMATRIX?
-> :SYSTEM:BRIGHTNESS:DOTMATRIX 1

10.2.19 UNIT Group

This group consists of commands related to the default units for voltage, time, and frequency.



:UNIT?

Function Queries the default units of voltage, time, and frequency.
Syntax :UNIT?
Example :UNIT?
-> :UNIT:FREQUENCY HZ;VOLTAGE V
;TIME S

:UNIT:TIME

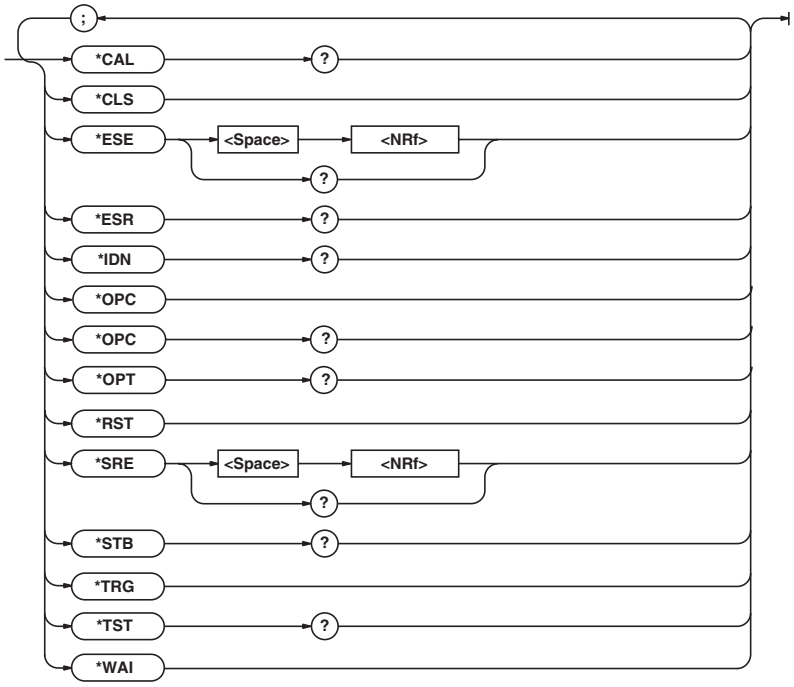
Function Sets the default unit of time or queries the current setting.
Syntax :UNIT:TIME [<multiplier>]S
:UNIT:TIME?
<multiplier> See section 10.1.
Example :UNIT:TIME S
:UNIT:TIME?
-> :UNIT:TIME S

:UNIT:VOLTage

Function Sets the default unit of voltage or queries the current setting.
Syntax :UNIT:VOLTage [<multiplier>]V
:UNIT:VOLTage?
<multiplier> See section 10.1.
Example :UNIT:VOLTAGE V
:UNIT:VOLTAGE?
-> :UNIT:VOLTAGE V

10.2.20 Common Command Group

The commands in the common group are defined in the IEEE 488.2-1992 and are independent of the instrument's functions.



***CAL?**

Function	Performs calibration and queries the result.
Syntax	`*CAL?`
Example	`*CAL?` `-> 0`
Description	If the calibration terminates normally, "0" is returned. If an abnormality is detected, a non-zero value is returned.

***CLS**

Function	Clears the standard event register, extended event register, and error queue.
Syntax	`*CLS`
Example	`*CLS`
Description	For details on the standard event register, extended event register, and error queue, see section 10.3, "Status Report."

***ESE**

Function	Sets the standard event enable register or queries the current setting.

Syntax	`*ESE {<NRf>}`
	`*ESE?`
	<NRf> = 0 to 255

Example	`*ESE 253`
	`*ESE?`
	`-> 253`

Description	For details on the standard event enable register, see section 10.3, "Status Report."

***ESR?**

Function	Queries the standard event register and clears the register.
Syntax	`*ESR?`
Example	`*ESR?` `-> 253`
Description	For details on the standard event register, see section 10.3, "Status Report."

***IDN?**

Function	Queries the instrument model.
Syntax	`*IDN?`
Example	`*IDN?` `-> YOKOGAWA,704610-BDS,0,F1.00`
Description	Returns the manufacturer name, model, serial number (unused, always 0), and firmware version.

***OPC**

Function	Sets a "1" to the standard event register bit upon the completion of the specified overlap command. Because the instrument does not support overlap commands, the command is discarded.
Syntax	`*OPC`

***OPC?**

Function Returns a "1" when the specified overlap command is finished. A "1" is always returned, because the instrument does not support overlap commands.
Syntax `*OPC?`

***OPT?**

Function Queries the options.
Syntax `*OPT?`
Example `*OPT?`
`-> 1`
Description Response varies depending on the installed options.

***RST**

Function Initializes the setup information.
Syntax `*RST`
Example `*RST`
Description Performs the same action as when the Execute soft key under the INIT (SHIFT+MARKER) key is pressed. For details on initialization, see the user's manual of the main unit.

***SRE**

Function Sets the service request enable register or queries the current setting.
Syntax `*SRE {<NRf>}`
`*SRE?`
<NRf> = 0 to 255
Example `*SRE 175`
`*SRE?`
`-> 175`
Description Bit 6 of the service request enable register is always 0. For details on the service request enable register, see section 10.3, "Status Report."

***STB?**

Function Queries the status byte register.
Syntax `*STB?`
Example `*STB?`
`-> 4`
Description For details on the status byte register, see section 10.3, "Status Report."

***TRG**

Function Same operation as when the SINGLE key is pressed.
Syntax `*TRG`
Description
- The multi-line message GET (Group Execute Trigger) also performs the same operation as this command.
- Cannot be executed when INPut:HISPeed:STATe (D-to-C high speed calculation) is ON.

***TST?**

Function Performs a self test and queries the result.
Syntax `*TST?`
Example `*TST?`
`-> 0`
Description
- Performs the same operation as the Board test under the Selftest soft key.
- If all tests are completed normally, "0" is returned. If an abnormality is detected, a non-zero value is returned.

***WAI**

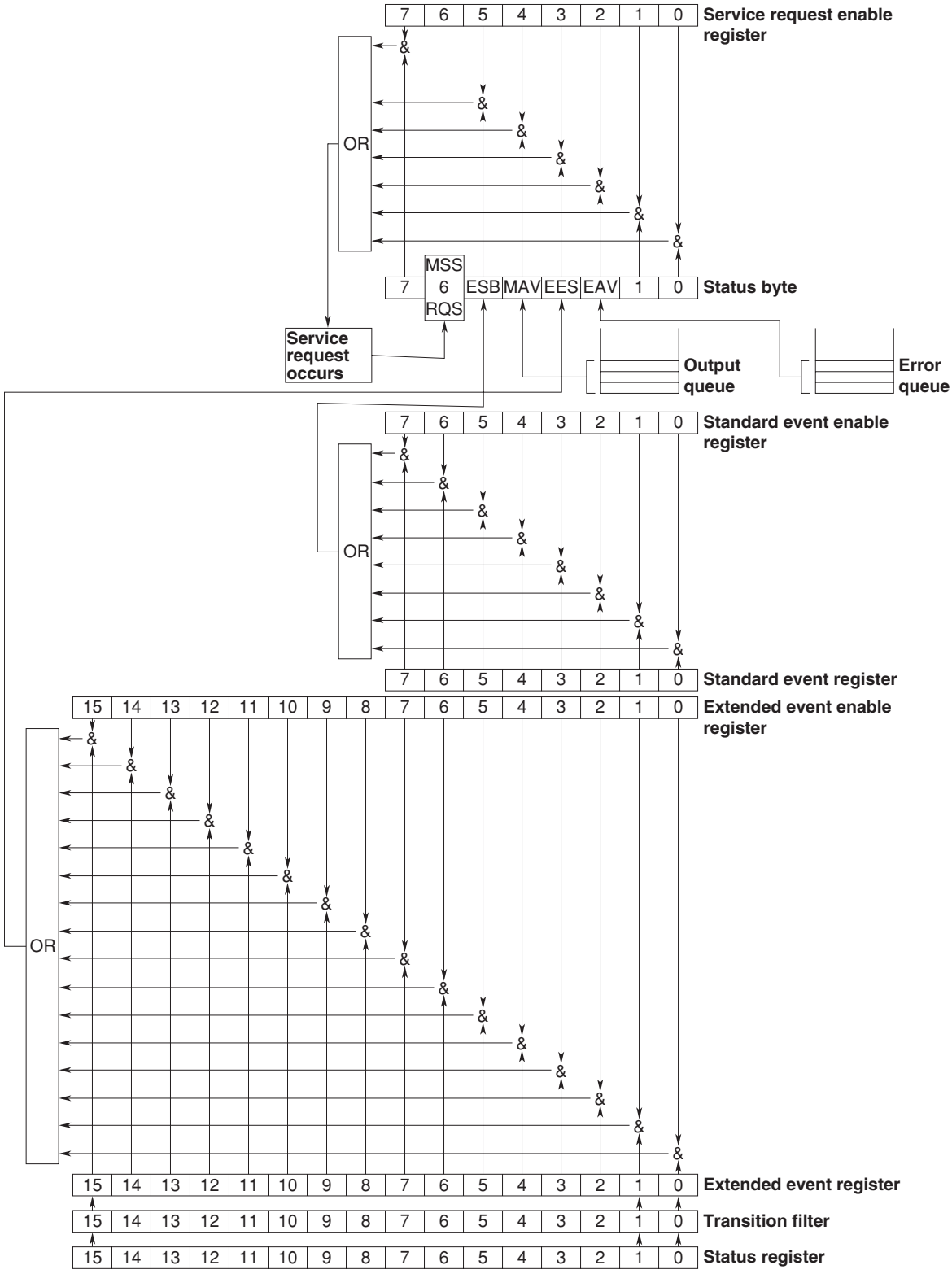
Function Holds the subsequent command until the completion of the specified overlap operation. Because the instrument does not support overlap commands, the command is discarded.
Syntax `*WAI`

10.3 Status Report

10.3.1 Regarding the Status Report

Status Report

The figure shows the status report that is read by serial polling. This status report is an extended version of the status report defined in IEEE 488.2-1992.



Overview of Registers and Queues

Name (Function)	Write	Read
Status Byte		Serial Poll (RQS), *STB?(MSS)
Service request enable register (status byte mask)	*SRE	*SRE?
Standard event register (changes in device status)	–	*ESR?
Standard event enable register (standard event register mask)	*ESE	*ESE?
Extended event register (changes in device status)	–	STATus:EESR?
Extended event enable register (extended event register mask)	STATus:EESE	STATus:EESE?
Condition register (current device status)	–	STATus:CONDition?
Transition filter (conditions that change the extended event register)	STATus:FILTer<x>?	STATus:FILTer<x>?
Output queue (stores a response message to a query)	All query commands	
Error queue (stores the error no. and message)	–	STATus:ERRor?

Registers and Queues Affecting the Status Byte

The following is a consolidation of registers affecting individual bits of the status byte.

- Status event register: sets bit 5 (ESB) of the status byte to 1/0.
- Output queue: sets bit 4 (MAV) of the status byte to 1/0.
- Extended event register: sets bit 3 (ESS) of the status byte to 1/0.
- Error queue: sets bit 2 (EAV) of the status byte to 1/0.

Enable Registers

The following is a consolidation of registers that can mask each bit and effectively disable them even if the bits are set to 1.

- Status byte: masks each bit per the service request enable register
- Standard event register: masks each bit per the standard event enable register
- Extended event register: masks each bit per the extended event enable register

Reading from and Writing to Registers

The *ESE command is used to set each bit of the standard event register to 1 or 0. The *ESE? command can be used to confirm whether each bit of the standard event register is set to 1 or 0. This is explained in detail for each command in section 10.2.

10.3.2 Status Byte

Status Byte

Bits 0, 1, and 7

Unused (always 0)

Bit 2 EAV (Error Available)

Set to 1 when the error queue is not empty. In other words, set to 1 when an error occurs. See page 10-38.

Bit 3 EES (Extend Event Summary Bit)

Set to “1” when the logical product of the extended event register and the corresponding event register is “1.” In other words, set to 1 when an instrument-internal event occurs. See page 10-37.

Bit 4 MAV (Message Available)

Set to 1 when the output queue is not empty. In other words, set to 1 when data exists that must be output in response to a query. See page 10-38.

Bit 5 ESB (Event Summary Bit)

Set to “1” when the logical product of the standard event register and the corresponding event register is “1.” In other words, set to 1 when an instrument-internal event occurs. See page 10-36.

Bit 6 RQS (Request Service)/MSS (Master Status Summary)

Set to 1 when the logical product of bits other than bit 6 of the status byte and the service request enable register is not 0. In other words, set to 1 when the instrument makes a service request to the controller. RQS is set to 1 when MSS changes from 0 to 1, and is cleared during a serial poll or when MSS changes to 0.

Bit Masking

To mask bits of the status register so that they are not a factor of SRQ, the corresponding bits of the service request enable register are set to 0. For example, to request a service even when bit 2 (EAV) is masked and an error occurs, set bit 2 of the service request enable register to 0. This is done using the *SRE command. Also, you can query whether each bit of the service request enable register is 1 or 0 using the *SRE? command. See section 10.2 for information on the *SRE command.

Status Byte Operation

When bit 6 of the status byte is 1, a service request occurs. When a bit other than 6 is set to 1, bit 6 also becomes 1 (if the corresponding service request enable register is set to 1).

For example, if an event occurs and the logical AND of the standard event register and the corresponding enable register becomes a "1", then bit 5 (ESB) is set to "1." In this case, if bit 5 of the service request enable register is 1, bit 6 (MSS) is set to 1, and a service is requested of the controller. Also, by reading the status byte, you can confirm what type of event occurred.

Reading the Status Byte

The following two methods can be used to read the contents of the status byte.

Query Using *STB?

If you send a query using *STB?, bit 6 becomes MSS. Therefore, MSS is read out. After it is read out, none of the bits of the status byte are cleared.

Serial Poll

When serial poll is performed, bit 6 becomes RQS. Therefore, RQS is read out. After it is read out, only RQS is cleared. MSS cannot be read out using serial poll.

Clearing the Status Byte

There is no way to forcibly clear all bits of the status byte. The following shows which actions clear which bits.

Query Using *STB?

No bits are cleared.

When 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 and other registers that have an effect on each bit are cleared. As a result, the corresponding status byte bits are cleared. However, the output queue cannot be cleared using the *CLS command, so bit 4 (MAV) of the status byte is not affected.

However, when sending the *CLS command directly after the program message terminator, the output queue is also cleared.

10.3.3 Standard Event Register

Standard Event Register

7	6	5	4	3	2	1	0
PON	URQ	CME	EXE	DDE	QYE	RQC	OPC

Bit 7 PON (Power ON) ON (power)

Set to 1 when the instrument's power is turned ON.

Bit 6 URQ (User Request)

Unused (always 0)

Bit 5 CME (Command Error)

Set to 1 when a syntax error is found in a command.

Example: Mistaken command name, or a 9 occurring within octal data.

Bit 4 EXE (Execution Error)

Set to 1 when the command syntax is correct but the command cannot be executed in the current condition.

Example: Parameters are out of range.

Bit 3 DDE (Device Dependent Error)

Set to 1 when a command could not be executed due to an instrument-internal problem other than a command syntax error or command execution error.

Bit 2 QYE (Query Error)

Set to 1 when a query command was sent but either the output queue is empty or data was lost.

Example: No response data, or data was lost due to an overflowing output queue.

Bit 1 RQC (Request Control)

Unused (always 0)

Bit 0 OPC (Operation Complete)

Set to "1" when the operation specified by the *OPC command (see section 10.2) has been completed.

Bit Masking

To mask bits of the standard event register so that they are not a factor of bit 5 (ESB) of the status byte, the corresponding bits of the standard event enable register are set to 0.

For example, to have ESB not be set to 1 even when bit 2 (QYE) is masked and a query error occurs, set bit 2 of the standard event enable register to 0. This is done using the *ESE command. Also, you can query whether each bit of the standard event enable register is 1 or 0 using the *ESE? command. See section 10.2 for information on the *ESE command.

Standard Event Register Operation

The standard event register is for the 8 types of events that can occur internally within the instrument. When any bit becomes 1, bit 5 (ESB) of the status byte is set to 1 (if the corresponding bits of the standard event enable register are also set to 1).

Example:

1. Query error occurs.
2. Bit 2 (QYE) is set to 1.
3. If bit 2 of the standard event enable register is 1, bit 5 (ESB) of the status byte is set to 1.

Also, by reading the standard event register, you can confirm what type of event occurred within the instrument.

Reading the Standard Event Register

The standard event register is read using the *ESR? command. The register is cleared after being read out.

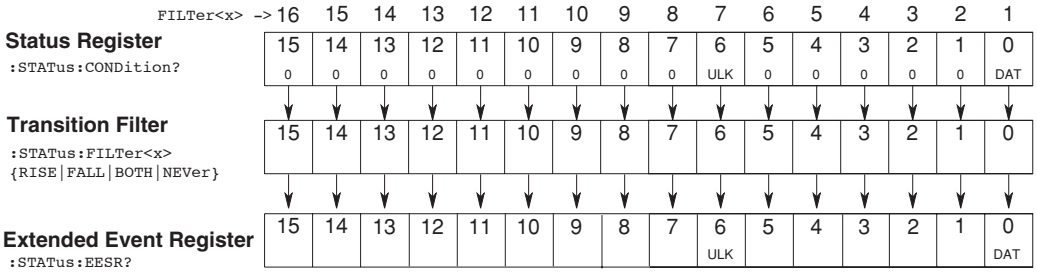
Clearing the Standard Event Register

The standard event register is cleared in the following three cases.

- When the contents of the standard event register are read out using the *ESR? command.
- When the *CLS command is received
- When restarting the instrument

10.3.4 Extended Event Register

The transition filter detects the changes in the condition register that indicate the internal condition of the instrument and writes the result to the extended event register.



The meaning of each bit of the condition register is as follows:

Bit 0	DAT (Data Available) Set to “1” when the measured data and the computed data are valid.
Bit 6	ULK (UnLock) Set to “1” when the PLL is unlocked.

The transition filter parameters detect changes in specified bits (numerical suffix 1 to 16) of the status register and rewrite the extended event register.

RISE	Sets the specified bit of the extended event register to 0 upon a change from 1 to 1.
FALL	Sets the specified bit of the extended event register to 1 upon a change from 1 to 0.
BOTH	Sets the specified bit of the extended event register to 1 upon a change from 1 to 0 or 0 to 1.
NEVer	Always 0.

10.3.5 Output Queue and Error Queue

Output Queue

The output queue stores the response message for a query.

As shown in the example below, data are stored in order and read from the oldest ones first. Other than when it is read out, the output queue becomes empty in the following cases.

- When a new message is received from the controller
- When a deadlock occurs (see page 10-3)
- When a device clear (DCL or SDC) is received
- When the instrument is restarted

Also, the *CLS command cannot be used to empty the output queue. You can check bit 4 (MAV) of the status byte to determine whether the output queue is empty.

Error Que

eThe error queue stores the number and message of n error when it occurs. For example, if the controll r sends an incorrect program message, the err r number “113” and the message “Undefined heade ” are stored in the error queue when the error s displaye .The error queue can be read using t e STATus:ERRor? query. Like the output queue, t e oldest data in the error queue is read out firs When the error queue overflows, the last message s replaced by the message “350, Queue overflow ”Other than when it is read out, the error que e becomes empty in the following case • When the *CLS command is receiv d • When the instrument is restart dYou can check bit 2 (EAV) of the status byte o determine whether the error queue is empt

10.4 Sample Program

Precautions Regarding Use of Sample Programs

Yokogawa will accept no responsibility for any problems occurring as a result of using a sample program.

10.4.1 Before Programming

Environment

Model: MS-DOS/V machine
Language: Visual Basic Version 6.0 Professional Edition or later
GPIB card: AT-GPIB/TNT IEEE-488.2 by National Instruments

Visual Basic Modules

Standard modules used: Niglobal.bas
Vbib-32.bas
tmctl.bas
tmval.bas

Note

The tmctl.bas and tmval.bas modules, and the sample program itself can be downloaded from our Web site under “GPIB/RS-232 Sample Programs” in the free software area.

Settings on the TA220

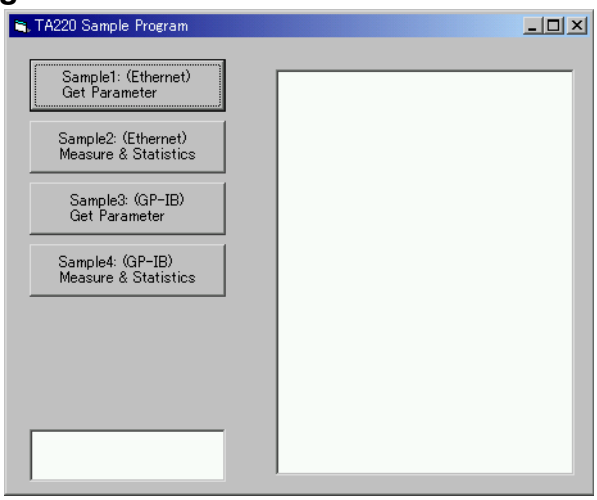
GP-IB

All sample programs given in this chapter use a GP-IB address of 1 for the TA220. The GP-IB address can be set to 1 according to the procedure in section 8.4.

Ethernet

All sample programs given in this chapter use an IP address of 11.22.33.44 for the TA220, a user name of anonymous, and a nothing for the password. Enter the TCP/IP and timeout settings according to the procedure in section 9.3.

10.4.2 Sample Program Interface



10.4.3 Initialization/Error/Execution Function

```
Private Declare Sub Sleep Lib "kernel32" (ByVal dwMillseconds As Long)
Option Explicit
Dim StartFlag As Integer                            'Start Flag
Dim Timeout As Integer                              'Timeout
Dim Dev As Long                                     'Device ID
Dim CtsFlag As Integer                              'CTS Flag
Dim term As String                                  'Terminator
Dim Query(100) As String                            'Query String
Dim Dummy As Integer

Private Function InitEthernet() As Integer
    Dim ret As Long                                 'EOI

    ret = TmInitialize(4, "10.0.229.37,anonymous,", Dev)   'Ethernet
    If (ret <> 0) Then
        Call DisplayError(Dev, "TmInitialize")
        InitEthernet = 1
        Exit Function
    End If

    ret = TmSetTerm(Dev, 2, 1)
    If (ret <> 0) Then
        Call DisplayError(Dev, "TmSetTerm")
        InitEthernet = 1
        Exit Function
    End If

    ret = TmSetTimeout(Dev, 100)
    If (ret <> 0) Then
        Call DisplayError(Dev, "TmSetTimeout")
        InitEthernet = 1
        Exit Function
    End If
    InitEthernet = 0
End Function
'-----------------------------------------------------------------------
Private Function InitGpib() As Integer
    Dim ret As Long                                 'EOI

    ret = TmInitialize(1, "1", Dev)                  'Address = 1
    If (ret <> 0) Then
        Call DisplayError(Dev, "TmInitialize")
        InitGpib = 1
        Exit Function
    End If

    ret = TmSetTerm(Dev, 2, 1)
    If (ret <> 0) Then
        Call DisplayError(Dev, "TmSetTerm")
        InitGpib = 1
        Exit Function
    End If

    ret = TmSetTimeout(Dev, 100)
    If (ret <> 0) Then
        Call DisplayError(Dev, "TmSetTimeout")
        InitGpib = 1
        Exit Function
    End If
    InitGpib = 0
End Function
'-----------------------------------------------------------------------
Private Sub DisplayError(ByVal sts As Integer, ByVal msg As String)
    Dim wrn As String
    Dim ers As String
    Dim ern As Integer
```

```
    ern = TmGetLastError(Dev)

    If (ern = 2) Then
        ers = "Device not found"
    ElseIf (ern = 4) Then
        ers = "Connection to device failed"
    ElseIf (ern = 8) Then
        ers = "Device not connected"
    ElseIf (ern = 16) Then
        ers = "Device already connected"
    ElseIf (ern = 32) Then
        ers = "Incompatible PC"
    ElseIf (ern = 64) Then
        ers = "Illegal parameter"
    ElseIf (ern = 256) Then
        ers = "Send error"
    ElseIf (ern = 512) Then
        ers = "Receive error"
    ElseIf (ern = 1024) Then
        ers = "Received data not block data"
    ElseIf (ern = 4096) Then
        ers = "System error"
    ElseIf (ern = 8192) Then
        ers = "Illegal device ID"
    End If

    MsgBox ("Status No. " + Str(sts) + Chr(13) + wrn + "Error No. " + Str(ern) +
Chr(13) + ers + Chr(13) + msg), vbExclamation, "Error!"
    'Call TmFinish(Dev)
    ern = TmFinish(Dev)
    Dev = -1
End Sub
'-----------------------------------------------------------------------
Private Sub Command1_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    Dummy = DoEvents()
    sts = InitEthernet                          'Initialize Ethernet
    If (sts <> 0) Then
        Exit Sub
    End If
    sts = SetParameter                          'Run Sample1 Set/Get Measure
Parameter

    If (sts = 0) Then
        List1.AddItem Query(0)
        List1.AddItem Query(1)
    End If
    Text1.Text = "END"
    StartFlag = 0
End Sub
'-----------------------------------------------------------------------
Private Sub Command2_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    Dummy = DoEvents()
```

```
    sts = InitEthernet                              'Initialize Ethernet
    If (sts <> 0) Then
        Exit Sub
    End If
    sts = GetStatistics                             'Run Sample2 GetStatistics
    If (sts = 0) Then
        List1.AddItem Query(0)
        List1.AddItem Query(1)
        List1.AddItem Query(2)
        List1.AddItem Query(3)
        List1.AddItem Query(4)
        List1.AddItem Query(5)
        List1.AddItem Query(6)
        List1.AddItem Query(7)
        List1.AddItem Query(8)
        List1.AddItem Query(9)
        List1.AddItem Query(10)
    End If
    Text1.Text = "END"
    StartFlag = 0

End Sub
'-----------------------------------------------------------------------
Private Sub Command3_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    Dummy = DoEvents()
    sts = InitGpib                                   'Initialize Gpib
    If (sts <> 0) Then
        Exit Sub
    End If
    sts = SetParameter                              'Run Sample3 Set/Get Measure
Parameter
    If (sts = 0) Then
        List1.AddItem Query(0)
        List1.AddItem Query(1)
    End If
    Text1.Text = "END"
    StartFlag = 0

End Sub
'-----------------------------------------------------------------------
Private Sub Command4_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    Dummy = DoEvents()
    sts = InitGpib                                    'Initialize Gpib
    If (sts <> 0) Then
        Exit Sub
    End If
    sts = GetStatistics                               'Run Sample4 GetStatistics
    If (sts = 0) Then
        List1.AddItem Query(0)
        List1.AddItem Query(1)
        List1.AddItem Query(2)
        List1.AddItem Query(3)
```

```
        List1.AddItem Query(4)
        List1.AddItem Query(5)
        List1.AddItem Query(6)
        List1.AddItem Query(7)
        List1.AddItem Query(8)
        List1.AddItem Query(9)
        List1.AddItem Query(10)
    End If
    Text1.Text = "END"
    StartFlag = 0

End Sub
'--------------------------------------------------------------------
Private Sub Form_Load()

    StartFlag = 0                                   'Clear Start Flag
    Dev = -1                                        'Clear device id
    Command1.Caption = "Sample1: (Ethernet)" + Chr(13) + "Get Parameter"
    Command2.Caption = "Sample2: (Ethernet)" + Chr(13) + "Measure && Statistics"
    Command3.Caption = "Sample3: (GP-IB)" + Chr(13) + "Get Parameter"
    Command4.Caption = "Sample4: (GP-IB)" + Chr(13) + "Measure && Statistics"
    Text1.Text = ""

End Sub
'--------------------------------------------------------------------
```

10.4.4 Setting Measurement Parameters and Querying the Current Setting

```
Private Function SetParameter() As Integer
    Dim msg As String                               'Command buffer
    Dim qry As String                               'Query buffer
    Dim sts As Integer
    Dim length As Long                              'Receive query length

    msg = Space$(100)
    qry = Space$(100)

    msg = "*RST" + term                             'Initialize Setting Parameter
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts <> 0) Then
        Call DisplayError(sts, msg)
        SetParameter = 1
        Exit Function
    End If

    msg = ":COMMUNICATE:HEADER ON" + term           'Header = ON
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts <> 0) Then
        Call DisplayError(sts, msg)
        SetParameter = 1
        Exit Function
    End If
    msg = ":COMMUNICATE:VERBOSE ON" + term          'Verbose = ON
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts <> 0) Then
        Call DisplayError(sts, msg)
        SetParameter = 1
        Exit Function
    End If

    msg = ":MEASURE:FUNCTION DTOC" + term           'Mode = DTOC
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts <> 0) Then
        Call DisplayError(sts, msg)
        SetParameter = 1
        Exit Function
    End If

    msg = ":MEASURE:FUNCTION?" + term               'Get Function
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts <> 0) Then
        Call DisplayError(sts, msg)
        SetParameter = 1
        Exit Function
    End If
    sts = TmReceive(Dev, qry, 100, length)         'Receive Query
    If (sts <> 0) Then
        Call DisplayError(sts, msg)
        SetParameter = 1
        Exit Function
    End If
    Query(0) = Left$(qry, length - 1)
    Query(1) = ""
    Call TmFinish(Dev)
    Dev = -1
    SetParameter = 0
End Function
'------------------------------------------------------------------------
```

10.4.5 Querying the Measurement and Measured Result

```
Private Function GetStatistics() As Integer
    Dim msg As String                               'Command buffer
    Dim qry As String                               'Query buffer
    Dim sts As Integer
    Dim length As Long                              'Receive query length
    Dim i As Integer
    Dim temp As String
    Dim count As Integer

    msg = Space$(100)
    qry = Space$(100)

    msg = "*RST" + term                             'Initialize Setting Parameter
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    msg = ":COMM:HEAD OFF" + term                   'Header = OFF
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    msg = ":MEAS:FUNC DTOC" + term                  'Function = DtoC
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    msg = ":STAT:FILT1 RISE" + term                  'Filter1 Rise(Data Available)
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    msg = ":STAT:EESR?" + term                      'Clear Extended Event Register
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    sts = TmReceive(Dev, qry, 100, length)          'Receive Query
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    msg = ":SST" + term                             'Single Measure Start
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If

    count = 0
    Do
        msg = ":STAT:COND?" + term                  'Status condition
        sts = TmSend(Dev, msg)                      'Send Command
```

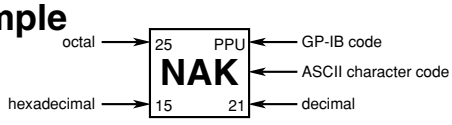
```
        If (sts < 0) Then
            Call DisplayError(sts, msg)
            GetStatistics = 1
            Exit Function
        End If
        sts = TmReceive(Dev, qry, 100, length)     'Receive Query
        If (sts < 0) Then
            Call DisplayError(sts, msg)
            GetStatistics = 1
            Exit Function
        End If
        temp = Left$(qry, length - 1)
        sts = val(temp) And 1
        If sts = 1 Then
            Exit Do
        End If
        If count > 100 Then
            msg = ":STOP" + term                    'Stop
            sts = TmSend(Dev, msg)                  'Send Command
            If (sts < 0) Then
                Call DisplayError(sts, msg)
                GetStatistics = 1
                Exit Function
            End If
            Exit Do
        End If
        count = count + 1
        Sleep 100
    Loop
    msg = ":CALC:AVER?" + term                      'Get Average value
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    sts = TmReceive(Dev, qry, 100, length)          'Receive Query
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    temp = Left$(qry, length - 1)
    i = 0
    Query(i) = msg + Space$(13 - Len(temp)) + temp
                                                    'Get Standard Deviation value
    msg = ":CALC:SDEV?" + term
    sts = TmSend(Dev, msg)                          'Send Command
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    sts = TmReceive(Dev, qry, 100, length)          'Receive Query
    If (sts < 0) Then
        Call DisplayError(sts, msg)
        GetStatistics = 1
        Exit Function
    End If
    temp = Left$(qry, length - 1)
    i = i + 1
    Query(i) = msg + Space$(13 - Len(temp)) + temp

    Call TmFinish(Dev)
    Dev = -1
    GetStatistics = 0
End Function
```

10.5 ASCII Character Codes

The following is a chart of ASCII character codes.

	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**		**Secondary Command**	

Example



11.1 Backed Up Setup Information

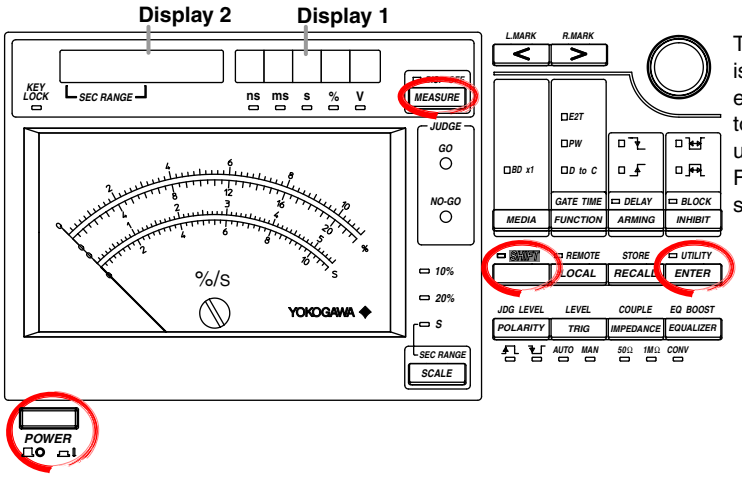
The setup information listed below is stored using the lithium battery. When the power switch is turned ON, the TA220 starts the measurement using the settings that existed immediately before the power switch was turned OFF. If the setup information can no longer be stored due to a dead lithium battery, the TA220 is reset to the factory default settings. For factory default settings, see section 11.2.

Item	
Measurement conditions*	Measurement media (fixed to BD) Measurement function Upper and lower limit of the pulse width measurement (L.MARK/ R.MARK) Polarity of the data signal Gate time Arming type (internal, external ⌐↑, external ↓¬) Arming delay setting Block sampling setting values Inhibit ON (⌐↔¬ or ↔) or OFF Turning the Equalizer ON (CONV) or OFF Boost amount of the equalizer Trigger mode type Slice level Input Impedance Input coupling
Display	Meter scale type Time range of meter scale Numerical value display parameters Numerical/alphabetical character display ON or OFF Determination level (GO/NO-GO indicator, jitter ratio determination output)
UTILITY-Netwrk	Network device type GPIB address DHCP ON or OFF IP address Subnet mask Default gateway Timeout time setting
UTILITY-DC out*	DC output mode Upper limit of the jitter ratio output range Lower limit of the jitter ratio output range Average coefficient of the DC output filter Jitter ratio correction coefficient α. Jitter ratio correction coefficient β.
UTILITY-Level*	Voltage level measurement ON or OFF Voltage level DC output mode Upper limit of the voltage level DC output range Lower limit of the voltage level DC output range Upper limit of the voltage level determination range Lower limit of the voltage level determination range Average coefficient for DC output of the voltage level
UTILITY-System	Digital display (green) brightness setting
UTILITY-Meas	PLLhold ON or OFF Turning D-Ccalc H-ON or H-OFF (there are no D-Ccalc settings on products with suffix code -BDS.) AGC ON or OFF DCclamp ON or OFF
UTILITY-Display	Selection of numerical value display parameters Items initially displayed on each level of the Utility menu The items last displayed in the Utility menu are changed to those initially displayed on each level.

* The number of setup information backed up is [types of measurement media] × [types of measurement functions].

11.2 Initializing Settings

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

Note

- Check that it is okay to initialize the settings before actually doing so. You cannot undo the changes after initialization. We recommend that you transmit the setup information to a PC using a communication command and save the information beforehand.
- If the instrument is initialized to its factory default settings, communication related settings (Netwrk menu contents, chapters 8 and 9), the brightness setting (section 11.3), and stored setup information (section 6.1) are also initialized.

The following two methods are available to perform the initialization.

Initialization to Factory Default Settings

1. Check that the power switch is turned OFF.
2. Hold down **MEASURE** and turn ON the power switch (press **POWER**). Hold MEASURE down for approximately three seconds. The settings are initialized.

Initializing Settings Other than the Stored Setup Information, Communication Related Settings, and Brightness Setting

1. Press **SHIFT+ENTER (UTILITY)**. The Utility menu is shown on Display 2.
2. Turn the **rotary knob** to display System in Display 2.
3. Press **>**. init, ROMver, or LEDbrit is displayed.
4. Turn the **rotary knob** to display init in Display 2.
5. Press **>** (or **ENTER**). The settings are initialized. The word, donE appears in Display 1 for approximately one second, then measurement restarts.

Explanation

The following setup information can be initialized to the factory default settings.

Item	Factory Default Settings
Measurement Conditions	
Measured media	BD (fixed)
Measurement function	D to C
Lower limit of the pulse width measurement (L.MARK)	22.72 ns
Upper limit of the pulse width measurement (R.MARK)	37.88 ns
Polarity of the data signal	⌐¬
Gate time	10 ms
Arming type	Auto arming (internal arming)
Slope of the external arming signal	Unselected
Arming delay setting	0.0 ms
Block sampling setting values	1
ON or OFF condition of inhibit	OFF
Polarity of the inhibit signal	Unselected
ON or OFF condition of the equalizer	OFF
Boost amount of the equalizer	CONV: 5.8 dB
Trigger mode type	AUTO (auto mode)
Slice level	0
Offset level	0
Input Impedance	1 MΩ
Input coupling	DC
Display	
Meter scale type	10%
Time range of meter scale	0.5 ns
Numerical value display parameters	σ/T (jitter ratio)
Numerical/alphabetical character display ON or OFF	ON
Jitter ratio determination level (GO/NO-GO indicator)	10.00%
Store/Recall memory number 0	
UTILITY-DC out	
DC output mode	DC output of jitter ratio
Upper limit of the jitter ratio output range	25.00%
Lower limit of the jitter ratio output range	0.00%
Average coefficient of the DC output filter	1
Jitter ratio correction coefficient α	1.0000
Jitter ratio correction coefficient β	0.000%
UTILITY-Level	
Voltage level measurement ON or OFF	OFF
Voltage level DC output mode	Voltage level DC output
Upper limit of the voltage level DC output range	5.000 V
Lower limit of the voltage level DC output range	0.000 V
Upper limit of the voltage level determination range	1.000 V
Lower limit of the voltage level determination range	0.000 V
Average coefficient for DC output of the voltage level	1
UTILITY-Meas	
PLL hold ON/OFF	OFF
Turning D-Ccalc H-ON or H-OFF (there are no D-Ccalc settings on products with suffix code -BDS.)	H-OFF
AGC ON or OFF	ON
ON or OFF condition of the numerical display	OFF
UTILITY-Display	
Turning display of σ/T ON or OFF	ON
Turning display of σ ON or OFF	ON
Turning display of AVE ON or OFF	ON
Turning display of T ON or OFF	ON
Turning display of SnU ON or OFF	OFF
Turning display of SnL ON or OFF	OFF
Turning display of EQ ON or OFF	ON
Turning display of Dly ON or OFF	ON

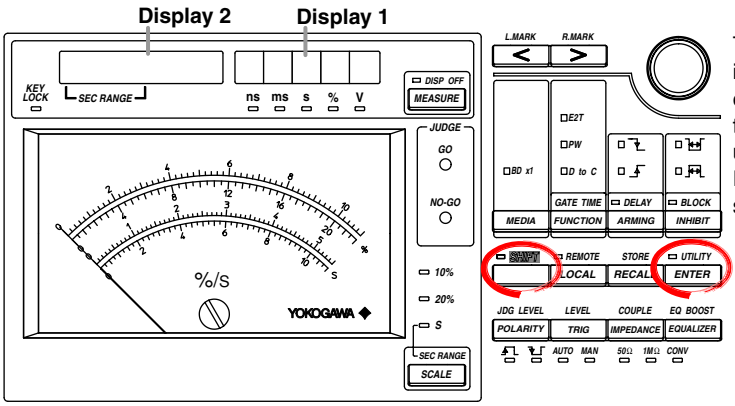
Item	Factory Default Settings
UTILITY-Netwrk	
Not initialized by the (Utility menu (UTILITY > System > init) procedure.)	
Network device type	GP-IB
GPIB address	1
DHCP ON or OFF	OFF
IP Address	0.0.0.0
Subnet mask	255.255.255.0
Default gateway	0.0.0.0
Timeout time setting	0
UTILITY-System	
Not initialized by the (Utility menu (UTILITY > System > init) procedure.)	
Digital display (green) brightness setting	3
Setup information from all internal memories, number 0 through 6.	
Not initialized by the (Utility menu (UTILITY > System > init) procedure.)	
	Factory Default Settings

Note

The communication command “*RST” initializes all settings other than the stored setup information, communication settings, and the brightness setting.

11.3 Brightness Setting of the Numerical Value Display (Display 2-Green)

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

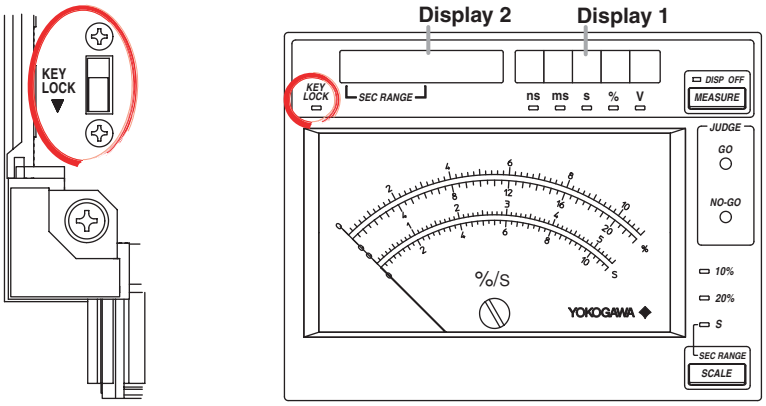
1. Press **SHIFT+ENTER (UTILITY)**. The Utility menu is shown on Display 2.
2. Turn the **rotary knob** to display System in Display 2.
3. Press **>**. init, ROMver, or LEDbrit is displayed.
4. Turn the **rotary knob** to display LEDbrit in Display 2.
5. Press **>** (or **ENTER**). Display 1 blinks.
6. Use **rotary knob & < >** to set the brightness.
7. Press **ENTER**.

Explanation

You can set the brightness of the numerical display on Display 2 (green) according to the surrounding lighting conditions.
Setting range: 1 to 6 (in steps of 1)

11.4 Turning the Key Lock ON and OFF

Procedure



Key Lock ON

Slide the **KEY LOCK** switch on the rear panel downward (in the direction of the arrow). The key lock turns ON and the KEY LOCK indicator on the front panel illuminates. From this point, all key operations except the power switch and the KEY LOCK switch are disabled.

Key Lock OFF

Slide the **KEY LOCK** switch on the rear panel upward (in the opposite direction of the arrow). The key lock turns OFF and the KEY LOCK indicator on the front panel turns OFF. All key operations are enabled.

Explanation

You can disable (key lock) the front panel key operation. However, the following switch and key operations are enabled even when key lock is ON:

- Turning ON/OFF the Power Switch
- Turning ON/OFF the KEY LOCK switch

Note

- Key lock can be enabled even when the TA220 is in remote mode through the communication function.
- Operations in the maintenance mode (see sections 12.4 to 12.6) are available even when key lock is ON.
- When the key lock is ON and you move the rotary knob, KeyLock appears in Display 2.

12.1 Malfunction? First, Investigate.

- For the appropriate corrective actions when an error code is shown on the display, see section 12.2.
- If servicing is necessary, or if the instrument is not operating correctly after performing the following corrective actions, contact your nearest YOKOGAWA dealer for repairs.

Description	Possible Problem	Corrective Action	Ref. section
The power does not turn ON.	Using a power supply outside the ratings.	Use a correct power supply.	3.3
	Fuse blown	Replace the fuse	12.8
Nothing is displayed.	Display of numerical values/alphabetical characters is turned OFF.	Turn display of numerical values/ alphabetical characters ON.	5.2
Display 2 (green) is dim.	The brightness is set low.	Adjust the brightness.	11.3
The display is not correct.	The system has malfunctioned.	Reboot the system.	3.4
	Noise appears on the display.	Install the TA220 where there is no noise. Remove the noise.	3.2 —
	The ambient temperature or humidity is outside the specifications.	Install the TA220 in a place that meets the specifications.	3.2
Keys do not work.	Key lock is ON.	Turn OFF the key lock.	11.4
	The TA220 is in remote mode.	Set the TA220 in local mode.	8.2, 9.1
Cannot make measurements.	The trigger mode/slice level is not correct.	Set them correctly.	4.4
	RF signal is not being input correctly.	Input the RF signal correctly.	3.5, 3.6, 4.2, 4.3
	The measurement range is exceeded.	Check the measurement range.	4.1, 13.2
	Arming is not appropriate.	Check arming.	4.6
	Inhibit is not appropriate.	Check inhibit.	4.8
Cannot take measurements.	Can only set the trigger mode to MAN.	Turn ON AGC.	4.4, 4.9
	Can not set the number of block samples as desired.	Increase the gate time.	4.5, 4.7
The DC output is not correct.	The average coefficient setting for the DC output filter is not reflected in the output values.	Turn OFF D-to-C high speed calculation.	4.9, 7.1
	The RF signal voltage level is not DC-output.	Turn OFF D-to-C high speed calculation.	4.9, 7.2

12.2 Error Code Description and Corrective Actions

There are cases in which error messages appear on the display during operation or error codes and error messages appear on the PC (controller) when using the communication function. This section describes the meanings of the messages and their corrective actions. Contact the dealer from which you purchased the instrument if servicing is required.

Error Codes and Error Messages

Error codes are shown on the display. If you query the error using the "`STATus:ERRor?`" command from the PC through the communication function, the error code and error message are displayed on the monitor of your PC.

Error in communication command

Code	Message	Description and Corrective Action	Ref. Section
102	Syntax error	A syntax error other than the ones listed below was found.	10.1, 10.2
103	Invalid separator	<DATA SEPARATOR> is missing. Separate each data by a comma (,).	10.1
104	Data type error	The <DATA> type is not correct. Use the correct data format.	10.1
108	Parameter not allowed	There are too many <DATA>. Check the number of data.	10.1, 10.2
109	Missing parameter	Required <DATA> is missing. Include the required data.	10.1, 10.2
111	Header separator error	<HEADER SEPARATOR> is missing. Separate headers and data with a space.	10.1
112	Program mnemonic too long	<mnemonic> is too long. Check the mnemonic (a string consisting of numbers and alphabetical characters).	10.2
113	Undefined header	No such command. Check whether the header is correct.	10.2
114	Header suffix out of range	The value of <HEADER> is not correct. Check whether the header is correct.	10.2
120	Numeric data error	The mantissa of the value is missing. A mantissa is required before the exponent in the <NRf> form.	10.1
123	Exponent too large	The exponent used is too large. Make the exponent after "E" smaller when using the <NR3> format.	10.1, 10.2
124	Too many digits	There are too many significant digits. The value must contain 255 or fewer digits.	10.1, 10.2
128	Numeric data not allowed	Numerical data cannot be used. Use a data format other than <NRf>.	10.1, 10.2
131	Invalid suffix	The units are incorrect. Check the unit of the <Voltage> and <Time>.	10.1
134	Suffix too long	Spelling of units is too long. Check the unit of the <Voltage> and <Time>.	10.1
138	Suffix not allowed	The units cannot be used. Units other than those for <Voltage> and <Time> cannot be used.	10.1
141	Invalid character data	No such selection available. Select character data from the selections available in {...|...|...}	10.2
144	Character data too long	Spelling of <CHARACTER DATA> is too long. Check the length of the string in {...|...|...}	10.2

Code	Message	Description and Corrective Action	Ref. section
148	Character data not allowed	<CHARACTER DATA> cannot be used. Write in a data form other than {...|...|...}.	10.2
150	String data error	There is no delimiter to the right of <STRING DATA>. Enclose <String data> in double quotation or single quotation marks.	10.1
151	Invalid string data	The contents of <STRING DATA> are inappropriate. <String data> is too long or invalid character is present.	10.2
158	String data not allowed	<STRING DATA> cannot be used. Write in a data form other than <String data> form.	10.2
161	Invalid block data	The data length of <BLOCK DATA> does not match. <Block data> cannot be used.	10.1, 10.2
168	Block data not allowed	<BLOCK DATA> cannot be used.	10.1, 10.2
171	Invalid expression	There is an invalid character in the <EXPRESSION DATA>. Equation cannot be used.	10.2
178	Expression data not allowed	<EXPRESSION DATA> cannot be used. Equations cannot be used.	10.2
181	Invalid outside macro definition	The placeholder is outside the macro. IEEE488.2 macro function is not supported.	—

Error in communication execution

Code	Message	Description and Corrective Action	Ref. section
221	Setting conflict	Contradictory settings are in affect. Check the relevant communication settings.	10,2
222	Data out of range	The value of <DATA> is outside the range. Check the range.	10,2
223	Too much data	The byte length of <DATA> is too long. Check the length of data bytes.	10,2
224	Illegal parameter value	The value of <DATA> is inappropriate. Check the range.	10,2
241	Hardware missing	Hardware not installed. Check for the presence or absence of options.	—
260	Expression error	<EXPRESSION DATA> is not correct. Equation cannot be used.	—
270	Macro error	Macro nesting is too deep. IEEE488.2 macro function is not supported.	—
272	Macro execution error	Macros cannot be used. IEEE488.2 macro function is not supported.	—
273	Illegal macro label	The macro label is inappropriate. IEEE488.2 macro function is not supported.	—
275	Macro definition too long	Macro is too long. IEEE488.2 macro function is not supported.	—
276	Macro recursion error	Macro was recursively called. IEEE488.2 macro function is not supported.	—
277	Macro redefinition not allowed	Macros cannot be redefined. IEEE488.2 macro function is not supported.	—
278	Macro header not found	The macro is not defined. IEEE488.2 macro function is not supported.	—
708	Cannot output data while measuring	Cannot transmit data while measurement in progress. Stop the measurement using the STOP or SSTART command.	10.2.13, 10.2.6

Error in communication query

Code	Message	Description and Corrective Action	Ref. section
410	Query INTERRUPTED	Sending of the response was interrupted. Check the sequence of transmissions and receptions.	10.1
420	Query UNTERMINATED	No sendable response exists. Check the sequence of transmissions and receptions.	10.1
430	Query DEADLOCKED	Transmission or reception was deadlocked. Transmission stopped. Set the length of a program message including the <PMT> to less than or equal to 1024 bytes.	10.1
440	Query UNTERMINATED after indefinite response	The order of requests for responses is incorrect. Do not add a query after *IDN? or *OPT?.	—

Error in system operation

Code	Message	Description and Corrective Action	Ref. section
906	Fan stopped. Turn OFF the power immediately.	The cooling fan has stopped. In this case, immediately turn OFF the power.	3.4
909	No Battery.	The backup battery is dead. Servicing is required for battery replacement.	3.4
910	Calibration data lost	The calibration value is abnormal. Servicing is required for calibration.	—
912	Fatal error in Communication-driver	Communication driver error. Service required.	—
914	Time out occurs in Communication	Communication timeout error during GP-IB communications. Make sure to receive the data within the timeout time. There may a problem in the communication line.	—
930	- - - - - (bar display)	An abnormality may have occurred in the internal memory (ROM). Service required.	—
931	- - - - - (bar display)	An abnormality may have occurred in the internal memory (DRAM). Service required.	—

Miscellaneous

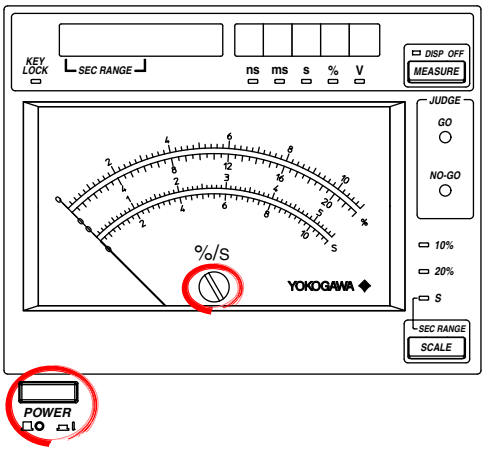
Code	Message	Description and Corrective Action	Ref. section
350	Queue overflow	Read the error queue. Occurs when there are 16 or more messages in the error buffer.	10.3.5

Note

Code “350” occurs when the error queue overflows. This error is output only during a STATus:ERRor? query and does not appear on the screen.

12.3 Adjusting the Zero Position of the Needle

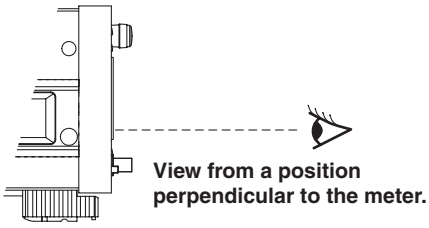
Procedure



1. Check that the **power switch** is turned OFF.
2. Adjust the needle by turning the **adjustment trimmer** ⊘ with a flat-head screwdriver so that the needle is vertical.

Explanation

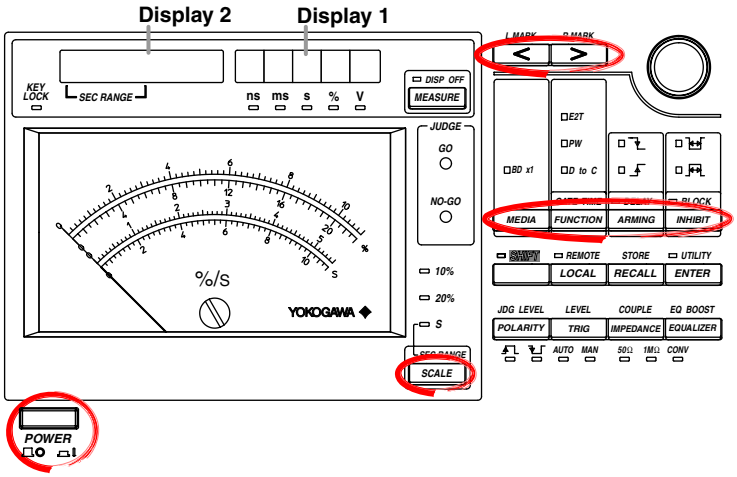
When the zero position of the needle goes off alignment, you can adjust the needle position using the adjustment trimmer located at the center of the meter. View the analog meter straight on (eye level perpendicular to the zero line), and adjust so that the needle is exactly over the zero line.



View from a position perpendicular to the meter.

12.4 Self Diagnostics (Self Test)

Procedure



Before starting the self test, remove all cables connected to the instrument (both input and output) other than the power cable and communication cable. When doing so, make sure that the TA220 is not in remote mode.

For the procedure in switching from remote mode to local mode, see section 8.2 or section 9.1.

Starting in Maintenance Mode

1. Check that the **power switch** is turned OFF.
2. Hold down **SCALE** and turn ON the power switch (press **POWER**). Hold SCALE down for approximately three seconds. When the power switch is turned ON, the model name and results of each test are displayed on Display 2 (model name -> EQ board -> MEMORY -> ETHER, and so on). At this point the instrument enters maintenance mode, and TESTMODE is displayed on Display 2.

Display and Indicator Test

3. Press **MEDIA**. LED is displayed in Display 2.
4. Turn the **rotary knob** to the right. Confirm that the lit indicator position moves in order from the upper left to the lower right, starting with the two types of dot patterns on Display 2. The 7-segment LED and decimal point on Display 1 are also lit one segment at a time.
   Turn the **rotary knob** to the left and confirm that the lit position of the indicator moves from the lower right to the upper left in order.
5. Press **<**. TESTMODE is once again displayed in Display 2.

Key and Rotary Knob Test

3. Press **FUNCTION**. KEYBOARD is displayed in Display 2.
4. Press a **key** and confirm that the corresponding character(s) is displayed in Display 2.
   Turn the **rotary knob** and confirm that the word indicating the correct direction (JogRight or JogLeft) is displayed in Display 2.
   Press **<** or **>** and confirm that Left or Right is displayed in Display 2.
5. Press **<** twice. TESTMODE is once again displayed in Display 2.

Meter Test

3. Press **ARMING**. METER is displayed in Display 2. Confirm that the needle points almost to the center of the scale.
4. Turn the **rotary knob** to the left and right. Confirm that the values displayed in Display 1 increase or decrease, and that the needle moves to the left or right accordingly.
5. Press **<**. TESTMODE is once again displayed in Display 2.

Board Test

3. Press **INHIBIT**. BOARD is displayed in Display 2, the sequence of tests is displayed in Display 1 as they are carried out (Cpu -> MEAS -> inPut -> EqLZ -> EtHEr), and then PASS or FAIL is indicated.
   If PASS is displayed, the board is operating normally. Go to step 5.
   If FAIL is displayed, this indicates a problem with the instrument's port. Go to step 4.

Confirming the Test Results of Each Board

4. Turn the **rotary knob** to display CPU b., MEAS b., INPUT b., EQLZ b., or ETHER b. in Display 2. PASS or a hexadecimal value is displayed in Display 1.
   If PASS is displayed, the board is operating normally.
   If a hexadecimal value is displayed, a problem has occurred. Please note the hexadecimal value that is displayed.
   The characters displayed in Display 2 correspond to the following boards.

CPU b.: CPU board	MEAS b.: Measure board
INPUT b.: Input board	EQLZ b.: Equalizer board
ETHER b.: Ethernet board	

   To perform all board tests again, press **INHIBIT**.
5. Press **<**. TESTMODE is once again displayed in Display 2.

Note

When you wish to perform measurement again after the self test, reboot the TA220.

Explanation

If a problem is discovered during the diagnostic test (self test), contact the dealer from which you purchased the instrument for repairs.

Signal Cables

When performing the self test, remove all cables connected to the instrument (both input and output) other than the power cable and communication cable. Also, the self test cannot be performed if the TA220 is in remote mode. Switch from remote mode to local mode.

Display and Indicator Test

You can test all indicators on the instrument including the 7-segment LED and decimal point of Display 1, and the dot pattern of Display 2. However, the indicators for the measurement input terminal (RF input) cannot be tested. Turn the rotary knob and confirm that the lit position of the indicator moves accordingly. If all displays and indicators (excluding the measurement input terminal indicator) illuminate in order, they are functioning normally.

Key and Rotary Knob Test

When you press a key or turn the rotary knob, the corresponding characters are displayed in Display 2. If the words/characters indicated in the table below are displayed, the key or rotary knob is operating normally.

Key/Rotary Knob	Words/Characters Displayed in Display 2
MEDIA	Media
FUNCTION	Function
ARMING	Arming
INHIBIT	Inhibit
SHIFT	Shift
LOCAL	Local
RECALL	Recall
ENTER	Enter
POLARITY	Polarity
TRIG	Trig
IMPEDANCE	Impedanc
EQUALIZER	Equalize
<	Left
>	Right
MEASURE	Measure
SCALE	Scale
Rotary knob turned right	JogRight
Rotary knob turned left	JogLeft

Meter Test

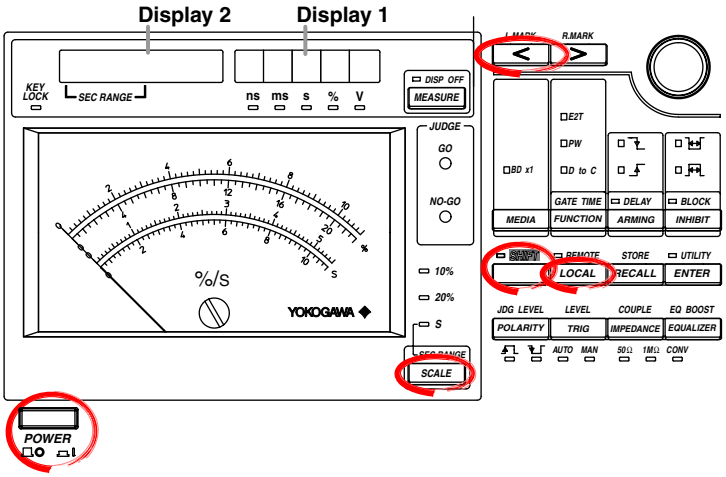
If the values displayed in Display 1 increase or decrease, and the needle moves to the left or right as you turn the rotary knob to the left or right, the meters are functioning normally.

Board Test

You can test the CPU board, measure board, input board, equalizer board, and Ethernet board. If PASS is displayed, the board is operating normally. If a problem is detected, a hexadecimal value indicating the problem can be displayed separately for each board. When contacting your nearest YOKOGAWA dealer for repairs, please give them that hexadecimal number.

12.5 Calibration (Changing the Factory Default Calibration Values)

Procedure



Note

When calibration completes normally, new calibration values are obtained. To apply the calibration values obtained through this operation, you must change the factory default calibration values. If you change the factory default calibration values, you cannot undo the changes. Please confirm that it is okay to change the factory default calibration values beforehand. Note that initialization (see section 11.2) will not set the calibration value back to factory default.

The operations mentioned below should be carried out in the following cases:

- **When the allowable range is exceeded in the performance test described in section 12.6.**
- **When parts of the TA220 have been replaced.**

Before starting calibration, remove all cables connected to the instrument (both input and output) other than the power cable and communication cable. Make sure that the TA220 is not in remote mode at this point.

For the procedure in switching from remote mode to local mode, see section 8.2 or section 9.1.

Starting in Maintenance Mode

1. Check that the **power switch** is turned OFF.
2. Hold down **SCALE** and turn ON the power switch (press **POWER**). Hold SCALE down for approximately three seconds. When the power switch is turned ON, the model name and results of each test are displayed on Display 2 (model name -> EQ board -> MEMORY -> ETHER, and so on). At this point the instrument enters maintenance mode, and TESTMODE is displayed on Display 2.

   Let the TA220 warm up for at least thirty minutes in this condition.

Executing Calibration

3. Press **LOCAL**. CALIB is displayed in Display 2, the sequence of tests is displayed in Display 1 as they are carried out (dC -> tV -> FunC), and then PASS or FAIL is indicated.
   If PASS is displayed, the board is operating normally. Go to step 4.
   If FAIL is displayed, a problem has occurred. Proceed to step 5.

Changing the Factory Default Calibration Values

4. Press **SHIFT**. CAL COPY appears in Display 2, and after the factory default calibration value is changed, PASS appears in Display 1. The new calibration value will take effect the next time the power is turned ON. Go to step 6.
   If calibration is not completed successfully, FAIL is displayed in Display 1 after CAL COPY. In this case, servicing is required. Contact your nearest YOKOGAWA dealer for repairs.

Checking the Calibration Results

5. Turn the **rotary knob** to display DC CAL, TV CAL, or FUNC CAL in Display 2. PASS or a hexadecimal value is displayed in Display 1.
   If PASS is displayed, the calibration results are normal.
   If a hexadecimal value is displayed, a problem has occurred. Please note the hexadecimal value that is displayed.
   The calibration items corresponding to the words displayed in Display 2 are as follows:
   DC CAL: AC voltage level
   TV CAL: Time–voltage conversion
   FUNC CAL: Measurement/computation
   To perform all calibrations again, press **LOCAL**.
6. Press **<**. TESTMODE is once again displayed in Display 2.

Restarting the Instrument

7. Turn OFF the **power switch**.
8. After approximately three seconds, turn the **power switch** ON again. The model name and results of each test are displayed on Display 2 (model name -> EQ board -> MEMORY -> ETHER, and so on). If the test program finishes successfully, the instrument enters measurement mode.

Explanation

The calibration function can be used to change the factory default calibration values of the TA220. However, once you make the changes, you cannot restore the calibration values back to their factory defaults. Perform calibration when the allowable range is exceeded in the performance test described in section 12.6 or when parts of the TA220 are replaced. If a problem is discovered during calibration, contact the dealer from which you purchased the instrument for repairs.

Removing Signal Cables

When performing the self test, remove all cables connected to the instrument (both input and output) other than the power cable and communication cable.
If the TA220 is in remote mode at this point, calibration cannot be performed. Switch from remote mode to local mode.

Warm Up

Warm up the TA220 for at least thirty minutes with the power turned ON before performing calibration. During warm-up or calibration, make sure not to block the inlet and exhaust holes on the top, bottom, and rear panel of the instrument.

Calibrated Items

The following items can be calibrated:

- DC voltage level.
- Time-voltage conversion
- Measurement/computation

Changing the Factory Default Calibration Values

- When calibration completes normally, new calibration values are obtained. To apply the new calibration values, you must change the factory default calibration values. If you change the factory default calibration values, you cannot undo the changes. Please confirm that it is okay to change the factory default calibration values beforehand. However, once you make the changes, you cannot restore the default calibration values even if you initialize them (see section 11.2).
- If the factory default calibration values are not changed, the new calibration values are not applied.
- The factory default calibration values can be changed only when all calibrations are completed normally.
- If you do not change the factory default calibration values, return the instrument to the condition in which TESTMODE is displayed in Display 2, or turn OFF the power switch.

Checking the Calibration Result

If PASS is displayed after calibration, the result is normal. If a problem is detected, a hexadecimal value indicating the problem can be displayed separately for each calibration item. When contacting your nearest YOKOGAWA dealer for repairs, please give them that hexadecimal number.

Restarting the Instrument

After calibration, check that the TA220 starts up normally and that it is ready to make measurements.

Performing Calibration with Communication Commands

You can perform calibration using a communication command. To do this, first connect a communication cable. When the instrument is in maintenance mode, it can be controlled using communication commands. Restart the instrument in normal mode following the procedure on page 12-10.

- **When Restoring the Factory Default Calibration Values after Rebooting**
  - Perform calibration using the *CAL? command (see page 10-32). You can make measurements using the calibration values obtained through the execution of the *CAL? command until the system is rebooted. Once you turn OFF the TA220 and turn it back ON, the calibration values return to their factory defaults.
  - You cannot perform the calibration corresponding to the *CAL? command from the front panel of the TA220.
- **When Changing the Factory Default Calibration Values**
  - Perform the calibration using the XCAL command. After calibration, the factory default calibration values are changed. Care should be taken because once the factory default calibration values are overwritten, you cannot undo the changes even if you execute the *CAL? command.
  - Calibration using the XCAL command is the same function as the calibration performed from the front panel.

Command	Description
*CAL?	Execute calibration. The factory default calibration values are not changed.
DUMPENABLE	Enable the calibration values to be changed.
XCAL	Execute calibration and then change the factory default calibration values.
DUMPDISABLE	Prohibits the calibration values from being changed.

Note

After you enable the calibration values to be changed using the DUMPENABLE command, execute calibration and change the factory default calibration values using the XCAL command, then prevent the calibration values from being changed again inadvertently using the DUMPDISABLE command.

12.6 Performance Test

CAUTION

- Do not apply a voltage exceeding the maximum input voltage to the input terminal of each instrument. This may cause damage to the input section.
- Do not short the output terminals of instruments or apply external voltage to it. This may cause damage to the internal circuitry.

Trigger Voltage (Slice Level) Accuracy Test

Items Required

The following items are required.

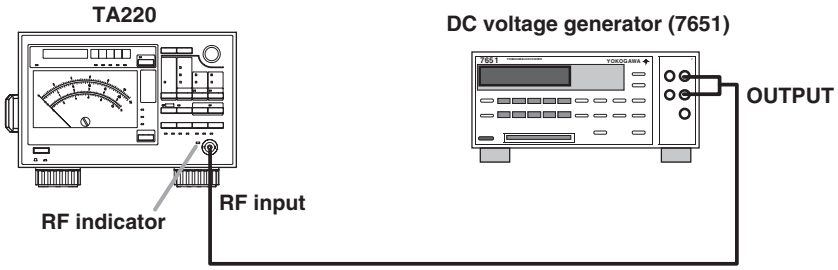
DC voltage generator

- Voltage accuracy: 1 mV or less
- Recommended instrument: Programmable DC voltage/current source 7651 (YOKOGAWA)

The procedure for testing the trigger voltage accuracy using the recommended instruments is described below.

Device Connections

- Ensure that all instruments are turned OFF before making any connections.
- Connect the output terminal (OUTPUT) of the DC voltage generator to the measurement input terminal (RF input) on the TA220.



Instrument Settings

- TA220
  - Media: BD
  - Measurement function: PW
  - Input impedance: 1 MΩ
  - Input coupling: DC
  - Equalizer: OFF
  - Trigger mode: MAN
  - Slice level: 0.000 V
  - AGC: OFF
- 7651

  Output level: 1.000 V, 0 V, and –1.000 V

Note

If noise is present due to the influence from the outside environment, connect a 1-mF capacitor between the signal line and ground.

Test Procedure

- Test the TA220 after thirty minutes of warm-up.
- This test compares the applied DC voltage to the trigger level (slice level) set by the TA220 and checks the error in the trigger level.
- Actual trigger detection is monitored by the TA220's RF indicator.

Test Procedure

1. Set the output level of the 7651 to 1.000 V.
2. Set the trigger level of the TA220 to 1.060 V.
3. Decrease the trigger level of the TA220 in 1-mV steps. Gradually decrease the trigger level and record the voltage level at which the RF signal input indicator blinks as VL.
4. Set the trigger level of the TA220 to 0.940 V.
5. Increase the trigger level of the TA220 in 1-mV steps. Gradually increase the trigger level and record the voltage at which the RF signal input indicator blinks as VH.
6. The trigger voltage is derived by taking the average of VL and VH. Confirm that this voltage is within the allowable range.
   VTRIG = (VL + VH)/2
7. Perform similar tests by setting the output of the DC voltage generator to 0 V and –1.000 V.

Test Results

Voltage of the 7651	VL	VH	VTRIG	Judgment Criteria
1.000 V				0.95 V to 1.05 V
0.000 V				–0.01 V to 0.01 V
–1.000 V				–1.05 V to –0.95 V

Pulse Width Jitter Measurement Test

Items Required

The following items are required.

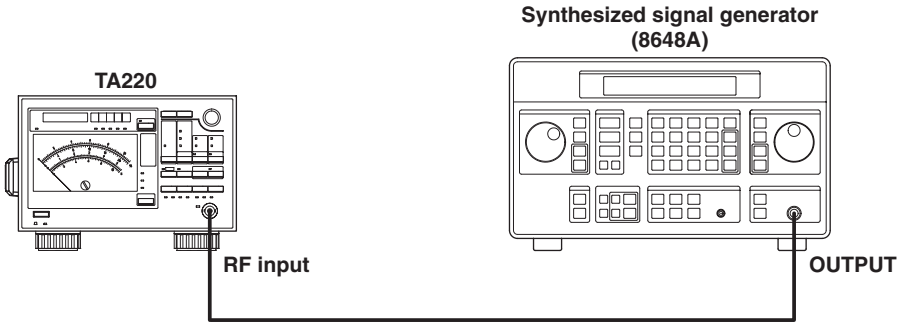
Synthesized signal generator

- Frequency range: 1 MHz to 20 MHz
- Output level: 720 mVrms or more
- Recommended instrument: Synthesized signal generator 8648A (Agilent Technologies)

The procedure for testing the pulse width jitter measurement using the recommended instruments is described below.

Device Connections

- Ensure that all instruments are turned OFF before making any connections.
- Connect the output terminal (OUTPUT) of the synthesized signal generator to the measurement input terminal (RF input) on the TA220.



Instrument Settings

- TA220
  - Media: BD
  - Measurement function: PW
  - Polarity: ⎍, ⎎
  - Pulse width lower limit: 0.00 ns
  - Pulse width upper limit: 999.90 ns
  - Input impedance: 50 Ω
  - Input coupling: DC
  - Equalizer: OFF
  - Trigger mode: MAN
  - Slice level: 0.000 V
  - Gate Time: 1000 ms
  - AGC: OFF
- 8648A
  - Output level: 360 mV_{rms}
  - Output frequency: 1.0 MHz, 4.0 MHz, 8.0 MHz, 16.5 MHz

Test Procedure

- Test the TA220 after a thirty-minute warm-up.
- Set the frequency of the 8648A to the values indicated in the table below and confirm that the standard deviation σ (jitter) of the pulse width jitter measurement on the TA220 are within the ranges given in the table. The average value is reference value.

Test Procedure

1. Set the output level of the 8648A to 360 mVrms and the frequency to 1.0 MHz.
2. Read the standard deviation σ (jitter) on the TA220 and confirm it is within the determination reference range. The average value is reference value.
3. Set the output level and frequency of the 8648A and the polarity of the data signal of the TA220 according to the table below, then perform the test in a similar fashion.

Test Results

- **Polarity of the data signal:** 

Frequency of the 8648A	Standard Deviation σ (jitter)		Average	
	Measured value	Judgment Criteria	Measured value	Reference Value
1.0 MHz		1.40 ns or less		500±10 ns
4.0 MHz		0.40 ns or less		125±2.5 ns
8.0 MHz		0.25 ns or less		62.5±1.5 ns
16.5 MHz		0.15 ns or less		30.3±1 ns

- **Polarity of the data signal:** 

Frequency of the 8648A	Standard Deviation σ (jitter)		Average	
	Measured value	Judgment Criteria	Measured value	Reference Value
1.0 MHz		1.40 ns or less		500±10 ns
4.0 MHz		0.40 ns or less		125±2.5 ns
8.0 MHz		0.25 ns or less		62.5±1.5 ns
16.5 MHz		0.15 ns or less		30.3±1 ns

Equalizer Boost Amount Test

Items Required

The following items are required.

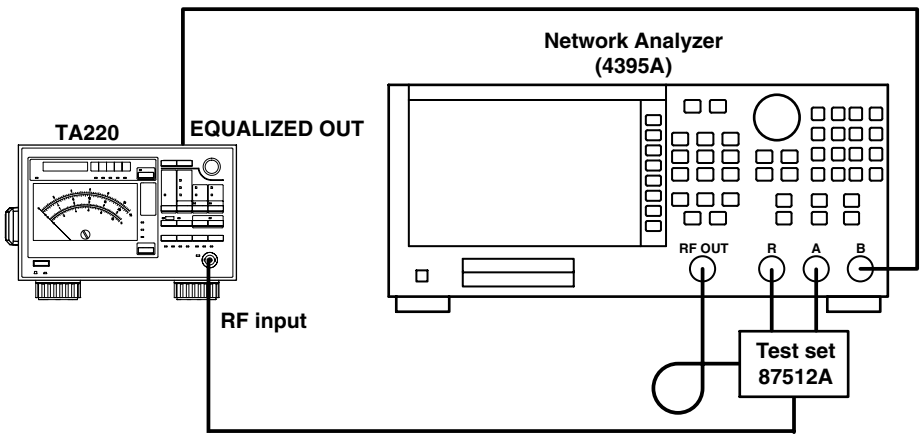
Network Analyzer

- Frequency range: 10 Hz to 10 MHz
- Recommended device
  - Network Analyzer 4395 A (Agilent Technologies, Corp.)
  - Test Set 87512 A (Agilent Technologies, Corp.)

The procedure for testing the equalizer boost amount using the recommended instrument is described below.

Device Connections

- Ensure that all instruments are turned OFF before making any connections.
- After calibrating the network analyzer, connect the TA220 measurement input terminal (RF input) to the output terminal of the test set connected to the output terminal (TEST PORT) of the network analyzer.
- After calibrating the network analyzer, connect the TA220 equalized RF signal monitor output terminal (EQUALIZED OUT) to channel B of the network analyzer.



Instrument Settings

- TA220
  - Media: BD
  - Measurement function: D to C
  - Input impedance: 50 Ω
  - Input coupling: DC
  - Equalizer: CONV
  - AGC: OFF
- 4395A

  Set the measurement mode of the frequency gain characteristics.

Test Procedure

- Test the TA220 after a thirty-minute warm-up.
- While changing the TA220 equalizer boost amount, use the 4395A to measure the frequency gain from the TA220's measurement input terminal (RF input) to the equalized RF signal monitor output terminal (EQUALIZED OUT), and confirm that the gain is within the allowed range.

Test Procedure

1. Connect the output terminals (TEST PORT) of the 87512A and 4395A, and connect the output terminal of the 87512A to channel B of the 4395A. Place the 4395A in frequency gain characteristics measurement mode, then calibrate the 4395A in the 10 kHz to 50 MHz range.
2. With the 87512A connected to the output terminal (TEST PORT) of the 4395A, connect the TA220 measurement input terminal (RF input) to the output terminal of the 87512A, and the TA220 equalized RF signal monitor output terminal (EQUALIZED OUT) to channel B of the 4395A.
3. Set the boost amount on the TA220 to 5.8 dB, then check that the difference in gain between 100 kHz and 16.5 MHz is within the allowable range.

Test Results

Frequency of the 4395	Gain (Measured value)	Difference in Gain (Criterion value)	Judgment Criteria
100 kHz	(A)	-	-
16.5 MHz	(B)	(B–A)	5.8±0.3 dB

Auto Slice Test

Items Required

The following items are required.

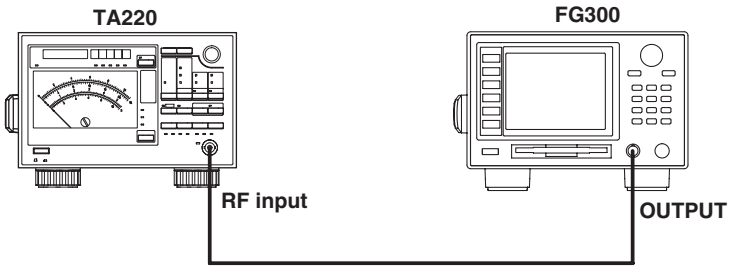
Function generator

- Output amplitude resolution: 12 bits or more
- Memory length: 8192 points or more
- With arbitrary waveform generation function
- Recommended instrument: Synthesized function generator FG300 (YOKOGAWA)

The procedure for testing the auto slice using the recommended instrument is described below.

Device Connections

- Ensure that all instruments are turned OFF before making any connections.
- Connect the output terminal (OUTPUT) of the function generator to the measurement input terminal (RF input) on the TA220.



Instrument Settings

- TA220
  - Media: BD
  - Measurement function: PW
  - Polarity: ⎍
  - Pulse width lower limit: 0.00 ns
  - Pulse width upper limit: 999.90 ns
  - Input impedance: 50 Ω
  - Input coupling: DC
  - Equalizer: CONV (boost amount 5.8 dB)
  - Trigger mode: AUTO
  - Gate Time: 1000 ms
  - AGC: OFF
- FG300
  - Output frequency: 8 MHz
  - Output voltage amplitude: 1 V_{P-P}
  - Output waveform: Sine wave
  - Modulation type: Offset
  - Modulated waveform: Sine wave
  - Peak offset voltage shift: 1 V

Test Procedure

- Test the TA220/FG300 after a thirty-minute warm-up.
- Input the offset modulated FG signal to the TA220, and confirm that the standard deviation σ (jitter) of the pulse width jitter measurement is within the allowable range. The average value is the reference value.

Test procedure

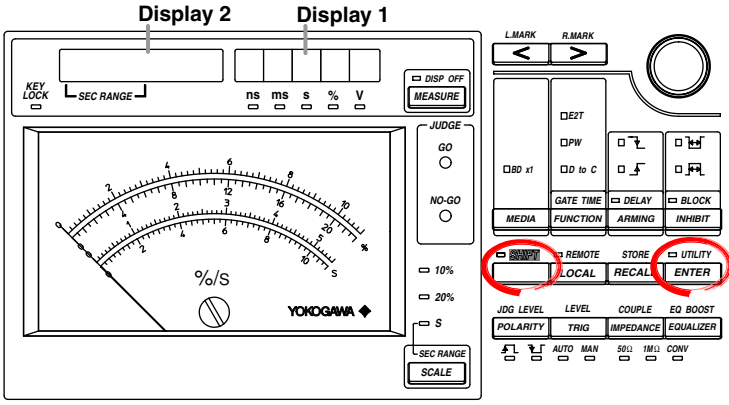
1. Set the modulation frequency of the FG300 according to the values in the table below.
2. Measure the pulse width of the modulated signal on the TA220, and confirm that the standard deviation σ (jitter) is within the allowable range. The average value is the reference value.

Test Results

FG modulation frequency	Standard deviation σ (jitter)		Average	
	Measured value	Judgment criteria	Measured value	Reference value
1.0 Hz		1.0 ns or less		62.5±1 ns
1.0 kHz		1.0 ns or less		62.5±1 ns
5.0 kHz		20 ns or less		62.5±1 ns
10.0 kHz		60 ns or less		62.5±1 ns

12.7 Version Display

Procedure



The phrase, "**rotary knob & <>**" is used in the following explanation to instruct the user to enter numerical setting values using the knob and arrow keys. For details on this procedure, see section 3.7.

1. Press **SHIFT+ENTER (UTILITY)**. The Utility menu is shown on Display 2.
2. Turn the **rotary knob** to display System in Display 2.
3. Press **>**. init, ROMver, or LEDbrit is displayed.
4. Turn the **rotary knob** to display ROMver in Display 2. The firmware version (ROM version) is displayed in Display 1.

Explanation

It is important to know the version of the firmware when making inquiries regarding malfunctions or installed options.

12.8 Replacing the Power Fuse

WARNING

- To prevent electric shock or fires, use a fuse of the specified rating in terms of current, voltage, and type.
- Make sure to turn OFF the instrument and unplug the power cord before replacing the fuse.
- Do not short the fuse holder.
- A fuse is placed on only one end of the power supply line.

Fuse Rating

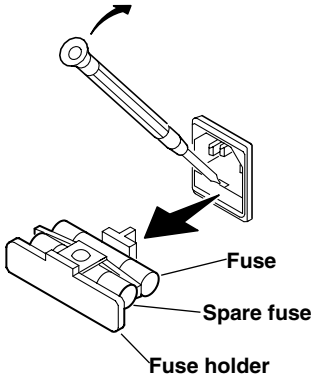
The power supply fuse used by this instrument has the following specifications.

Maximum rated voltage	250 V
Maximum rated current	5 A
Type	Time lag
Specifications	UL/VDE
Part No.	A1114EF

Replacement Method

Replace the fuse according to the following steps.

1. Turn OFF the power switch.
2. Unplug the power cord from the power connector.
3. Insert the tip of a flathead screwdriver into the indentation on the fuse holder located near the power connector. Turn the driver in the direction of the arrow, and remove the fuse holder.
4. Remove the blown fuse from the tip of the fuse holder.
5. Install a new fuse into the fuse holder, then reinsert the fuse holder into its original location.



12.9 Recommended Replacement Parts

The one-year warranty applies only to the TA220 (starting from the day of delivery) and does not cover any other items nor expendable items (items which wear out). The replacement period for expendable items varies depending on the conditions of use. Refer to the table below as a general guideline. Contact your nearest YOKOGAWA dealer for replacement parts.

Part Name	Recommended Replacement Period
Cooling fan	30000 hours
Backup battery (lithium battery)	5 years
Meter	10 years

13.1 Measurement Input, Trigger, Equalizer, and PLL

Item	Specifications
Number of channels	1 (RF input, 1-7 modulation signals)
Internal jitter†, ††	150 ps rms
RF input	
Connector type	BNC
Input coupling	Select AC or DC When AC-coupled: low-band cutoff frequency 33 Hz (typical value‡)
Input Impedance	Select 1 MΩ or 50 Ω, 20 pF (typical value‡)
Minimum input pulse width	10 ns
Maximum input voltage	5 Vrms
Input range	When equalizer and AGC are both OFF: 0.1 Vp-p to 5 Vp-p When equalizer or AGC is ON: 0.1 Vp-p to 0.7 Vp-p
Triggers	Trigger Mode Select auto mode, manual mode, or auto + manual mode. Polarity • For pulse width jitter measurement: Select from and . • For D-to-C jitter measurement: Select from , , and . When in Auto mode Band 10 kHz 1st order integral type feedback method When in Manual mode • When measurement function is pulse width, and equalizer and AGC are both OFF Slice level setting range: –2.000 V to 2.000 V; setting resolution: 1 mV; accuracy†: ±(4% of measured value + 10 mV) • Other than the above: Slice level range: –1000 to 1000, resolution: 1 When in Auto + Manual mode Offset level range: –1000 to 1000, resolution: 1
Equalizer	
Conventional equalizer (Blu-ray Disc standard Part1 Ver. 1.0 compliant)	Frequency characteristics† 16.5 MHz: 5.8±0.3 dB (gain with 100 kHz as a reference) Low band cutoff frequency: 10 kHz Boost amount setting range: 3.0 to 9.0 dB, setting resolution: 0.1 dB, accuracy: ±0.3 dB Group delay characteristics Maximum group delay deviation ≤ (typical value‡), range: 3.0 MHz ≤ f ≤ 22 MHz
PLL clock regeneration	Synchronizable signal†: Basic clock is 1-7 modulation signals equivalent to 64 to 68 MHz PLL characteristics: fn = 8 kHz, ζ = 2.0
PLL hold	Clock signal regeneration duration: inhibit period + 220 μs (typical value‡)
AGC	Amplitude fluctuation correction
DC clamp	During inhibit, low band cutoff frequency set from 10 kHz to 3 MHz

†. Measured value under standard operating conditions as described in General Specifications after the warm-up time has elapsed.

††. Value obtained with the equalizer turned OFF and with the trigger error and trigger level timing error excluded.

- Trigger Error

$$\frac{\sqrt{X^2 + E_n^2}}{S.R}$$

X: Signal noise (2 mVrms) within the input amplifier bandwidth (100 MHz)
E_n: Noise in the signal being measured
S.R: Slew rate of the signal being measured

- Trigger Level Timing Error

$$\pm\left(\frac{15\ \text{mV}}{\text{Slew rate of the start signal}} - \frac{15\ \text{mV}}{\text{Slew rate of the stop signal}}\right) \pm \frac{\text{Trigger level setting accuracy}}{\text{Slew rate of the start signal}} \pm \frac{\text{Trigger level setting accuracy}}{\text{Slew rate of the stop signal}}$$

‡. The typical value is a representative or standard value. It is not strictly guaranteed.

13.2 Measurement Function

Item	Specifications
Measurement update rate†	Minimum 50 ms (when measurement function is D-to-C jitter, data signal slope is both rising and falling, and the gate time is 30 ms) However, it is 2 ms when D-to-C high speed calculation†† is ON:
Pulse width jitter	
	Measuring range (upper and lower limit range of the pulse width to be measured) Setting range for pulse width lower limit: 0.00 to 998.99 ns, setting resolution 0.01 ns Setting range for pulse width upper limit: 1.00.00 to 999.99 ns, setting resolution 0.01 ns
D-to-C jitter (phase difference between the data and clock signal)	
	Setting range: 0 to T ns (T: clock period), 0 to 20% (jitter ratio)
D-to-C jitter excluding 2T‡	Setting range: 0 ns to Tns (T: clock period), 0 to 20% (jitter ratio)
Level measurement	Measuring range: 100 mVp-p to 2 Vp-p (3 mVp-p resolution) Measurement accuracy: ±(5%+10 mV) (for measurement of amplitude 1 Vp-p, 100 kHz sinewave)

† Measured value under standard operating conditions as described in General Specifications after the warm-up time has elapsed.
†† The D-to-C high speed calculation function is not available on products with suffix code -BDS.
‡ D-to-C jitter excluding 2T cannot be measured by products with suffix code -BDS.

13.3 Gate Time, Arming, Block Sampling, and Inhibit

Item	Specifications
Gate time	When D-to-C high speed calculation† is OFF Setting range: 1 to 1000 ms, setting resolution: 1 ms When D-to-C high speed calculation† is ON Setting range: 2 to 1000 ms, setting resolution: 2 ms
Arming	
Arming source	Internal arming Arming source is a signal internal to the instrument External arming Arming source is an external signal applied to the arming signal input terminal (EXT ARM IN). Input terminal specifications: see section 13.5
Arming slope (only during external arming)	Select ⌐↑ or ↓¬ .
Arming delay (only during external arming)	Setting range: 0.0 to 100.0 ms,. setting resolution: 0.1 ms
Block sampling	Available during external arming Block no. setting range: 1 to 99, setting resolution: 1 Maximum allowed number of blocks • When D-to-C high speed calculation† is OFF 5 seconds ÷ gate time (digits after the decimal point are ignored), or 99, whichever is smaller. • When D-to-C high speed calculation† is ON 1 second ÷ gate time (digits after the decimal point are ignored), or 99, whichever is smaller.
Inhibit	Inhibit signal is an external signal applied to the inhibit signal input terminal (INHIBIT IN). Input terminal specifications: see section 13.5 Effective period: 0.1 to 100 ms Polarity: Select ⌐↔¬ or ↔ .

† The D-to-C high speed calculation function is not available on products with suffix code -BDS.

13.4 Display

Item	Specifications
Meter (needle)	Item Jitter ratio, jitter Jitter ratio display scale Select 10% or 20%. Jitter display time range Select 0.5 ns, 1.0 ns, 5.0 ns, 10 ns, 50 ns, 0.1 µs, 0.5 µs, 1.0 µs, or 5.0 µs. Display accuracy: ±1.5% of FS
Display 1 (7-segment red LED)	Item Jitter ratio, jitter, average value, T (measuring range of pulse width, or clock period), no. of samples, boost amount†, delay time†, voltage level Jitter ratio display range: 0 to 20%, Display resolution: 0.01% Jitter display range: 0 to 99.999 ns, Display resolution: 0.001 ns Average display range: 0 to 999.99 ns, Display resolution: 0.01 ns Voltage level display range: 0 to 9.999 V, Display resolution: 0.001 V Unit: ns, ms, s, %, V
Display 2 (dot matrix green LED)	Item • Setup menu (setting parameters) • Meaning of numbers displayed in Display 1 • Time range types when selecting time range on the meter • Boost amount or delay time (when these are displayed, Display 1 shows the jitter ratio)
Display ON/OFF	The numerical value/alphabetical character display and units indicators on displays 1 and 2 can be turned ON or OFF simultaneously.

† When pressing the MEASURE key to switch the numerical value display, the numerical value is displayed in Display 2.

13.5 Input/Output on the Rear Panel

Item	Specifications
External arming signal input (EXT ARM IN)	
Connector type	BNC
Input impedance	10 kΩ (typical value†)
Input coupling	DC
Input level	TTL level
Allowable input voltage range	–5 to 10 V (DC+ACpeak)
Minimum pulse width	30 ns
Inhibit signal input (INHIBIT IN)	
Connector type	BNC
Input impedance	10 kΩ (typical†)
Input coupling	DC
Input level	TTL level
Allowable input voltage range	–5 to 10 V (DC+ACpeak)
Minimum pulse width	30 ns
Jitter ratio DC output (JITTER DC OUT)	
Connector type	BNC
Output impedance	600 Ω (typical value†)
Output coupling	DC
Output mode	Select jitter ratio DC output or determination output.
Output filter	Average coefficient setting range: 1 to 10, setting resolution: 1 (output filter is disabled when D-to-C high speed calculation†† is ON)
Jitter ratio output range	Setting range: 0.00 to 100.00%, setting resolution: 0.01%
Determination output	Range of determination level: 0.00% to 25.00%, resolution: 0.01%
Correction coefficient α	Range: 0.0001 to 9.9999, resolution: 0.0001
Correction coefficient β	Range: –9.999 to 9.999%, resolution: 0.001%
Output level‡	0 to 5 VDC, Default setting: 0.2 V/%
Output level accuracy‡, ‡‡	±10 mV
RF signal voltage level DC output (LEVEL DC OUT)	
Connector type	BNC
Output impedance	600 Ω (typical value†)
Output coupling	DC
Output mode	Select voltage level DC output or determination output
Output filter	Setting range of average coefficient: 1 to 10, setting resolution: 1
Voltage level DC output range	Setting range: 0.000 to 5.000 V, setting resolution: 0.001 V
Determination output	Setting range of determination level: 0.000 to 5.000 V, setting resolution: 0.001 V
Output level‡	0 to 5 VDC, Default setting: 1 V/Vp-p
Output level accuracy‡, ‡‡	±10 mV
RF signal monitor output (MONITOR OUT)	
Connector type	BNC
Output impedance	50 Ω (typical value†)
Output coupling	DC
Output level‡‡†	Approximately 1/2 the RF signal (within ±5 V)
Equalized RF signal monitor output (EQUALIZED OUT)	
Connector type	BNC
Output impedance	50 Ω (typical value†)
Output coupling	DC
Output level‡‡†	• Approximately 1/2 the RF signal (within ±5 V) when the equalizer is OFF and AGC is OFF. • Approximately 0.4 to 0.7 Vp-p (within ±1 V) when the equalizer is OFF and AGC is ON.
Data signal output (SLICED RF OUT)	
Connector type	BNC
Output impedance	50 Ω (typical value†)
Output coupling	DC
Output level‡‡†	Approximately ±0.4 V

Item	Specifications
Clock signal output (CLOCK OUT)	
Connector type	BNC
Output impedance	50 Ω (typical value†)
Output coupling	DC
Output level‡‡†	Approximately ±0.4 V

† The typical value is a representative or standard value. It is not strictly guaranteed.
†† The D-to-C high speed calculation function is not available on products with suffix code -BDS.
‡ When the monitor equipment receives the signal at high impedance (approx. 1 MΩ).
‡‡ Measured value under standard operating conditions as described in General Specifications after the warm-up time has elapsed.
‡‡† When the monitor equipment receives the signal at 50 Ω.

13.6 Communication Interface

GP-IB

Item	Specifications
Electrical and mechanical specifications	Conforms to IEEE St'd.488-1978 (JIS C1901-1987).
Functional Specifications	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, and E1.
Protocol	Compliant with IEEE St'd 488.2-1992
Encoding	ISO (ASCII)
Mode	Addressable mode
Address	0–30
Clear remote mode	Remote mode can be cleared using the LOCAL key (except during Local Lockout).

Ethernet

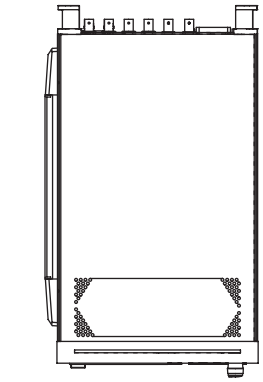
Item	Specifications
Connector type	RJ-45
Number of ports	1
Electrical and mechanical specifications	Conforms to IEEE 802.3
Transmission system	100BASE-TX/10BASE-T
Max. transmission rate:	100 Mbps
Protocol	TCP/IP
Port number	10001/tcp
Supported services	DHCP

13.7 General Specifications

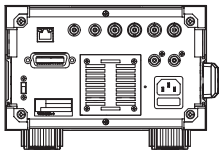
Item	Specifications
Standard operating conditions	
Ambient temperature:	23±5°C
Ambient humidity	50±10%RH
Error in supply voltage and frequency	Within 1% of rating
Warm-up time	Approx. 30 minutes.
Storage Environment	
Temperature	–20°C to 60°C
Humidity	20% to 80% RH (no condensation)
Operating Environment	
Temperature	5°C to 40°C
Humidity	20% to 80%RH (no condensation)
Rated supply voltage	100 to 120 VAC, 200 to 240 VAC
Permitted supply voltage range	90 V to 132 VAC, 180 V to 264 VAC
Rated power supply frequency	50/60 Hz
Allowable power supply frequency variation	48 to 63 Hz
Maximum power consumption	150 VA
Insulation resistance (between power supply and case)	10 MΩ or more (500 VDC)
Withstanding voltage (between power supply and case)	1500 VAC at 50/60 Hz for one minute
Signal ground	The ground of all input and output connectors are connected to the case ground. In addition, all input terminals are protected using a diode.
External dimensions	Approx. 213 (W) × 132 (H) × 350 (D) mm excluding projections.
Weight	Approx. 5 kg (main unit only)
Cooling method	Forced air
Installation position	Horizontal (stacking prohibited)
Battery backup	Setup information is backed up with the internal lithium battery
Keylock	Able to set key lock.
Recommended calibration interval	1 year

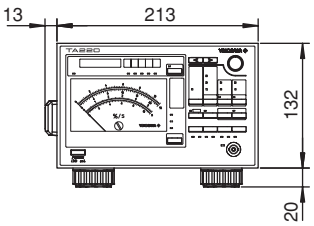
13.8 Dimensional Drawings

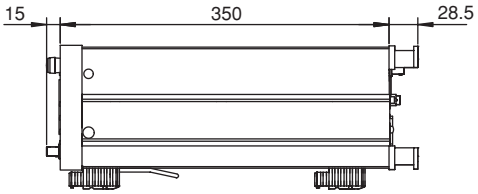
Units: mm



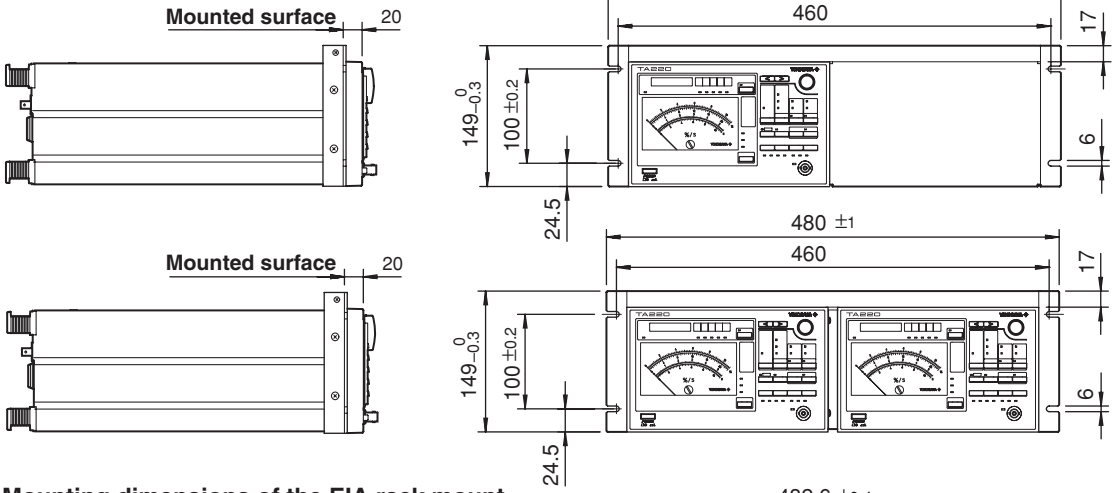
Rear View



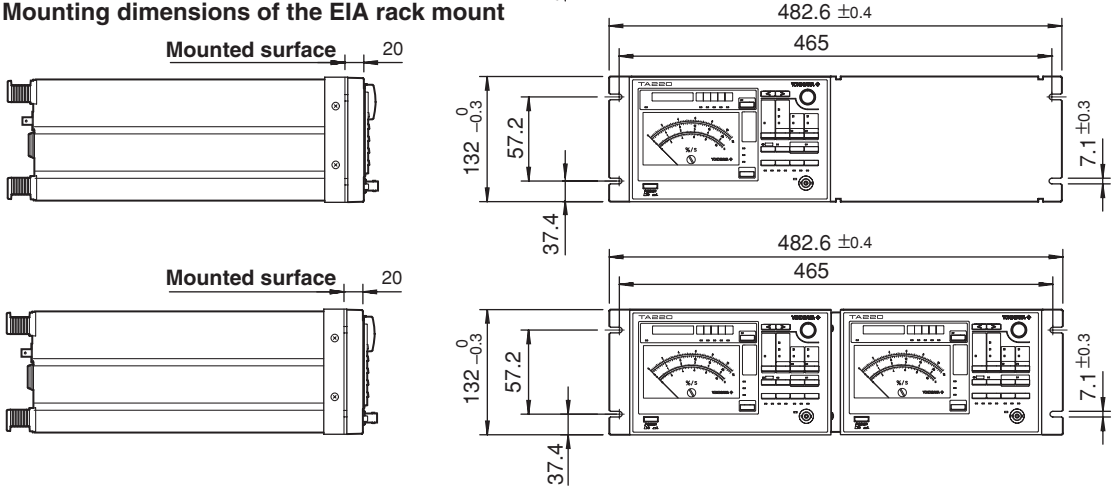




● **Mounting dimensions of the JIS rack mount**



● **Mounting dimensions of the EIA rack mount**



Caution: Make sure to have adequate support for the bottom of the instrument.
Allow at least 80 mm of space around the instrument for ventilation.

If not specified, the tolerance is ±3%. However, if less than 10 mm, the tolerance is ±0.3 mm.

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