YOKOGAWA

704210
Time Interval Analyzer
TA320

TA320 (704210)
213 × 132 × 392mm 5kg
(8-3/8 × 5-1/4 × 15-1/2" 11.0 lbs)

★
Safety Standards; EN61010-1
EMC Standard; EN50081-1
EN55022 Class B
EN61326
EN61000-3-2
EN61000-3-3

The TA320 is a time interval analyzer which can continuously measure the period, pulse width and time interval of signals that vary with time, at a maximum rate of 14 Msamples/second. The measurement display resolution is 100 ps and the maximum sample size is 99,999,999 samples. The instrument can also perform simultaneous measurement of positive and negative pulse widths as well as duty measurement. The large liquid crystal display panel employs a touch screen, permitting measurement and data analysis to be carried out by means of smooth, intuitive operations. The screen update rate is fast, enabling the results of analysis to be displayed immediately. The instrument is a half-width compact type and is also light, hence it occupies little space and can also be moved about easily. The TA320 can be used for a wide range of applications from the research laboratory to product line and maintenance.

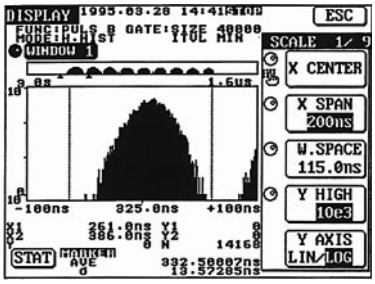
FEATURES

- **Maximum continuous sampling rate 14 MS/s**
- **100 ps measurement resolution**
- **Light and compact design**
- **Simple operation by means of touch screen**
- **Maximum sample size of 99,999,999**
- **Two choices of sampling modes**
  The TA320 has two sampling modes: "time stamp mode" and "hardware histogram mode."
  The time stamp mode allows the user to measure both variables and the time that measurements are taken.
  Thus, the user can analyze variations in measured variables with time. The hardware histogram mode allows the user to sample up to 99,999,999 (10^8-1) data items, enabling high-speed statistical computation of massive amounts of data.
- **A wealth of display formats**
  Four types of display formats are available: histogram, time variation, list and statistics.
- **3.5" Floppy disk drive**
  The user can save panel setup information and TIFF format screen image data, as well as measured data values, on floppy disks.
- **External arming and external gating functions**
  The external arming function allows control of the time to start measurement by means of external input signals. In addition, the external gating function is available to control the measurement time.
- **Inhibit function**
  This function allows control of the time period that inhibits input signals from being captured.
- **Multi-window function**
  The analyzer presents a maximum of 16 different histogram windows, enabling data analyses of rectangles, one by one, occurring in multiple numbers in a histogram.

FUNCTIONS

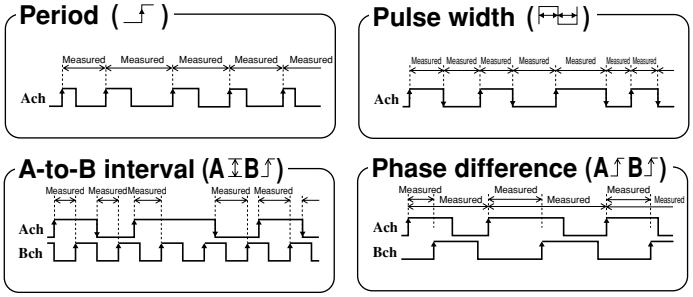
■ **MULTI-WINDOW FUNCTION which assists in analyzing pulse width modulation**
This function can create a maximum of 16 windows to permit data analysis for each peak of a number of generated histograms. As an example of use, this function is extremely effective for analyzing pulse width modulated data that is employed in an optical disk.

- **Panorama Display Function**
  This function indicates the particular part of a number of generated histograms that is currently displayed on the screen. It is convenient when used in combination with the multi-window.



Example of panorama display screen
The pointer (▲) indicates the part of the overall display at the top of the screen that is displayed in the current window.
(* The multi-window function and the panorama display function are effective in the hardware histogram mode.)

■ **EXAMPLES OF MEASUREMENT FUNCTIONS**



The TA320 has two sampling modes, the time stamp mode and the hardware histogram mode. In the time stamp mode, the measurement values and the times at which they occur are each measured, enabling the variation of the measurement results with time to be analyzed using a time variation display. In the hardware histogram mode, a maximum of 99,999,999 items of data are sampled, and statistical calculations of a large number of samples are performed at high speed, enabling histogram analysis to be performed.

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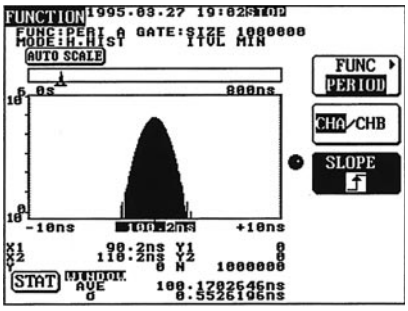
■ A WEALTH OF DISPLAY FORMATS

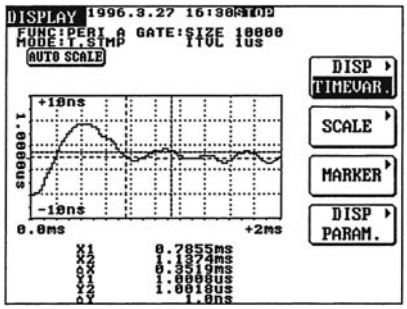
● **Histogram Display**

This display is effective for analyzing fluctuations of measurement values when performing jitter analysis, for example.



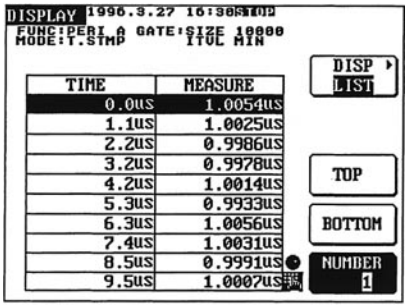
● **Time Variation Display**

This display is effective for analyzing the variation with time of the measurement data.



● **List Display**

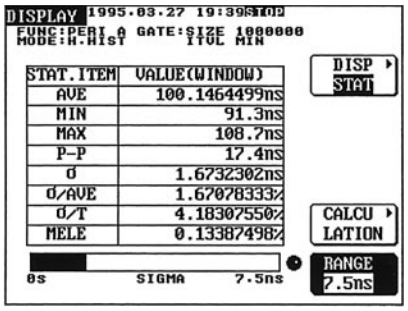
In the time stamp mode, the variation of the measurement data with time is indicated by numerical values. In the hardware histogram mode, the number of times each measurement data occurs is indicated by a numerical value.



TIME	MEASURE
0.0us	1.0054us
1.1us	1.0025us
2.2us	0.9986us
3.2us	0.9978us
4.2us	1.0014us
5.3us	0.9933us
6.3us	1.0056us
7.4us	1.0031us
8.5us	0.9991us
9.5us	1.0007us

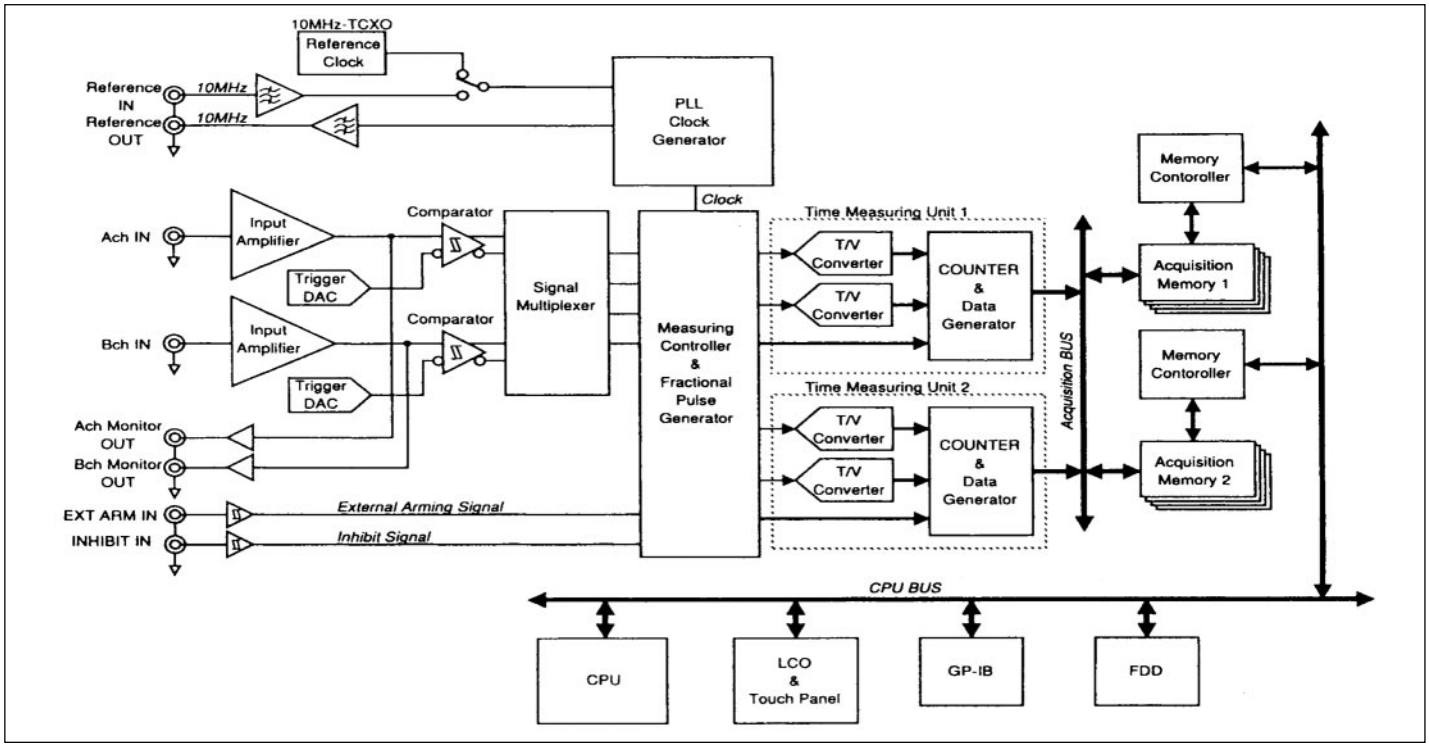
● **Statistical Display**

This display indicates the data resulting from statistical calculations. The standard deviation (σ) is indicated as a bar graph at the bottom of the screen.



STAT.ITEM	VALUE(WINDOW)
AVE	100.1464499ns
MIN	91.3ns
MAX	108.7ns
P-P	17.4ns
σ	1.6732302ns
σ/AVE	1.67078333%
σ/T	4.18307550%
MELE	0.13387498%

■ BLOCK DIAGRAM OF THE TA320



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■ **APPLICATION EXAMPLE**

- **System for Evaluation of DVD-use Media**
- **Others**
  - Evaluation of infrared wireless communication (IrDA)
  - Evaluation of polygon scanner
  - Servo motor rotational speed irregularity and starting characteristics

(This photograph shows the **TA320** connected to the **DL1540L** and the DDU-1000 D6 optical disk drive unit, courtesy of PULSTEC.)

SPECIFICATIONS

Specifications Related to Inputs/Outputs

● Inputs to A and B Channels

Item	Specifications	
Input impedance*1	50 Ω /1 MΩ (input capacitance: 20 pF)	
Frequency characteristics (-3 dB)*1	100 MHz	
Input coupling	DC/AC (input impedance: 1 MΩ: cutoff frequency 35 Hz; : 50 Ω: cutoff frequency 680 kHz)	
Operating voltage range	–5 to + 5 V	
Maximum input voltage	50 Ω: 5 Vrms 1 MΩ: 40 V (DC + ACpeak) (DC ≤ input frequency ≤ 100 kHz) 3.5/f (MHz) + 5 V (DC + ACpeak) (100 kHz < input frequency ≤ 100 MHz)	
Amplifier noise*1	400 µVrms	
Sensitivity	100 mVp-p	
Minimum input pulse width	10 ns	
Trigger level	Voltage rangesetting	+5 to –5 V
	Accuracy *2	±(10 mV + 4% of setpoint)
	Resolution	5 mV
Auto trigger	Input signal condition	1 kHz to 50 MHz
	Method	Singe/Repeat
	Setpoint time*1	0.7 s

● External Arming Input (the terminal is shared by external gating inputs)

Item	Specifications
Impedance*1	10 kΩ
Coupling	DC
Trigger level	TTL
Maximum voltage range	–8 to +13 V (DC+ ACpeak)
Minimum input pulse width	30 ns
Setup time	70 ns (In order for arming input to be valid, it must precede the measured signal by no less than 70 ns.)

● External Inhibit Input

Item	Specifications
Input impedance*1	10 kΩ
Input coupling	DC
Trigger level	TTL
Maximum input voltage range	–8 to +13 V (DC + ACpeak)
Minimum input pulse width	30 ns
Setup time	70 ns (In order for inhibit input to be valid, it must precede the measured signal by no less than 70 ns.)

● Monitor Outputs A and B

Item	Specifications
Outputs impedance*1	50 Ω
Outputs signal level*3	Approximately 1/4 of the input signal (within ±5 V)

● Reference Input

Item	Specifications
Frequency range	10 MHz ± 10 Hz
Impedance	1 kΩ min.
Coupling	AC
Voltage level	1 Vp-p min.
Maximum voltage range	–10 to + 10 V

● Reference Output

Item	Specifications
Frequency*1	10 MHz
Impedance*1	50 Ω min.
Coupling	AC
Voltage level*1	1 Vp-p min.

Note: All inputs are diode-protected and terminal grounds are connected to the enclosure's ground.
*1: Typical value.
*2: The value when the warm-up time has expired under the reference operating conditon with the coupling and input impedance set at DC and 1 MΩ, respectively.
*3: The value when the output is received into 50 Ω at a 1 MΩ input impedance.

Specifications Related to Measurement

● Sampling Modes

Item	Specifications
Time stamp mode	Acquires measurements along with "time stamp" data, which represent the time that the respective measurements occurred, to record a set of these data as time-series data.
Hardware histogram mode	Records measurements as the frequency data for a histogram.

● Sampling

Item	Specifications	
	Time stamp mode	Hardware histogram mode
Maximum sampling rate	Continuous 14 M samples/s (71-ns intervals); 7 M samples/s (142-ns intervals) in the case of phase difference and duty ratio measurements	
Sampling period	MIN (71ns) 1, 2, 4, 10, 20, 40, 100, 200, 400 µs, 1, 2, 4 ms. The total sampling time is 320 seconds, including the time for arming.	The total sampling time is 320 seconds.
Maximum sample size	Duty ratio and phase difference measurements: 16,000 samples Other emasurements: 32,000 samples	99,999,999 samples, (10^8-1) excluding duty ratio and phase difference measurements

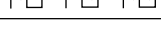
● Measurement Refresh Rate (hardware histogram mode only)

Item	Specifications
Refresh rate*1, *2	400 ms

● Period

Item	Specifications	
	Time stamp mode	Hardware histogram mode
Measuring range	30 ns to 100 ms	30 ns to 3.2 µs
Display resolution	100ps	The larger value, either 100 ps or $\frac{\text{the histogram span setting}}{200}$
Resolution*1	±300 ps rms ± $\sqrt{2}$ × trigger error	The larger value, either ±300 ps rms or display resolution, ± $\sqrt{2}$ × trigger error
Accuracy*1	±300 ps rms ±$\sqrt{2}$ × trigger error ±(timebase frequency stability × measured period) ±300-ps systematic error	
Trigger slopes		

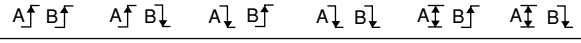
● Pulse Width

Item	Specifications	
	Time stamp mode	Hardware histogram mode
Measuring range	30 ns to 100 ms	30 ns to 3.2 µs
Display resolution	100 ps	The larger value, either 100 ps or $\frac{\text{the histogram span setting}}{200}$
Resolution*1, *3	±300 ps rms ± rising trigger error ± falling trigger error	The larger value, either ±300 ps rms or display resolution, ± rising trigger error ± falling trigger error
Accuracy*1	±300 ps rms ±(timebase frequency stability × measured pulse width) ± trigger level timing error ±1-ns systematic error	
Trigger slopes	 22T*4	

● Duty Ratio (time stamp mode only)

Item	Specifications
Measuring range	0 to 99.999% (pulse width: 71 ns to 100 ms)
Display resolution	The larger value, either 0.001% or $\frac{\text{loops}}{\text{Period}}$ × 100%
Resolution*1	$\pm\left(\frac{\text{measured pulse width} + \lvert\text{pulse-width resolution}\rvert}{\text{measured period} - \sqrt{2} \times \lvert\text{pulse-width resolution}\rvert} - \text{measured duty ratio}\right)$
Accuracy*1	$\pm\left(\frac{\text{measured pulse width} + \lvert\text{pulse-width accuracy}\rvert}{\text{measured period} - \sqrt{2} \times \lvert\text{pulse-width accuracy}\rvert} - \text{measured duty ratio}\right)$
Trigger slopes	

● A-to-B Interval

Item	Specifications	
	Time stamp mode	Hardware histogram mode
Measuring range	5 ns to 100 ms	5 ns to 3.2 µs
Display resolution	100 ps	The larger value, either 100 ps or $\frac{\text{the histogram span setting}}{200}$
Resolution*1, *5	±300 ps rms ±A-input trigger error ±B-input trigger error	The larger value, either ±300 ps rms or the display resolution, ± A-input trigger error ±B-input trigger error
Accuracy*1	±300 ps rms ±(timebase frequency stability × measured A-to-B interval) ± trigger level timing error ±1-ns systematic error	
Trigger slopes		
Conditon for continuous measurement*6	The B-to-A interval must be greater than 30 ns.	

● A-to-B-to-A Interval

Item	Specifications	
	Time stamp mode	Hardware histogram mode
Measuring range	A to B: 30 ns to 100 ms; B to A: 30 ns to 100 ms	A to B: 30 ns to 3.2 µs; B to A: 30 ns to 3.2 µs
Display resolution	100 ps	The larger value, either 100 ps or $\frac{\text{the histogram span setting}}{200}$
Resolution*1	±300 ps rms ± A-input trigger error ±B-input trigger error	The larger value, either ±300 ps rms or display resolution, ± A-input trigger error ± B-input trigger error
Accuracy*1	±300 ps rms ±(timebase frequency stability × measured A-to-B-to-A interval) ± trigger level timing error ±1-ns systematic error	
Trigger slopes		

● Phase Difference (time stamp mode only)

Item	
Measuring range	0 to 360 degrees (where, A to B: MIN (71 ns); B to A: 30 ns min.)
Display resolution	0.01 degree
Resolution*1	$\pm\left(\frac{\text{measured A-to-B interval} + \lvert\text{A-to-B interval resolution}\rvert}{\text{measured A-input period} - \sqrt{2} \times \lvert\text{A-to-B interval resolution}\rvert} - \text{measured phase difference}\right)$
Accuracy*1	$\pm\left(\frac{\text{measured A-to-B interval} + \lvert\text{A-to-B interval resolution}\rvert}{\text{measured A-input period} - \sqrt{2} \times \lvert\text{A-to-B interval resolution}\rvert} - \text{measured phase difference}\right)$
Trigger slopes	

*1: The value when, under the reference operating conditon, the warm-up time has expired.

*2: The value when the period of a 1-MHz sine wave is measured with an event size of 1000.

*3: The specificatin changes as shown below if the trigger slope makes a transition represented as ↔

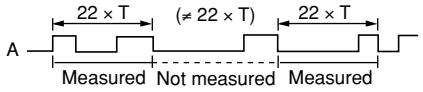
Time Stamp Mode	Hardware Histogram Mode
±300 ps rms ± rising trigger error ± falling trigger error ± trigger level timing error	The larger value, either ±300 ps rms or display resolution, ± rising trigger error ± falling trigger error ± trigger level timing error

The specification changes as shown below if the trigger slope is "22T":

Time Stamp Mode
±300 ps rms $\pm\sqrt{N}$ × (rising trigger error + falling trigger error + trigger level timing error)

N: The number of edges that has passed through during a time interval of 22× T.

*4: Measurement takes place only when an interval between the edges of a 22T input signal matches the time interval of 22× T.

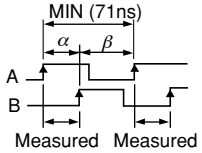


T: any value of time keyed in

*5: The specification changes as shown below if the trigger slopes make transitions represented as A↕ B↑ A↕ B↓ :

Time Stamp Mode	Hardware Histogram Mode
300 ps rms ± A-input trigger error ± B-input trigger error ± trigger level timing error	The larger value, either ±300 ps rms or the display resolution, ±A-input trigger error ± B-input trigger error ± trigger level timing error

*6: Conditions for continuous measurement



α: The A-to-B interval must be greater than 5 ns.
β: The B-to-A interval must be greater than 30 ns.

If the trigger slopes make transitions represented as A↑ B↑

Notes: The trigger error, rising trigger error, falling trigger error, A-input trigger error, and B-input trigger error are represented by:

$$\frac{\sqrt{X^2 + En^2}}{S.R}$$

X: Noise of the input amplifier
En: Signal noise at a frequency within the bandwidth (100 MHz)
S.R: The slew rate of a signal being measured [V/s]

The trigger level timing error is represented by:
±(15 mV/start signal's slew rate – 15 mV/stop signal's slew rate) ± trigger level setting accuracy/start signal's slew rate ± trigger level setting accuracy/stop signal's slew rate

Specifications Related to Functions

● Display Formats

Item	Specifications	
	Time stamp mode	Hardware histogram mode
Display formats	Histogram *1 Time variation*2 List (time stamps, measurements and data numbers)*2 Statistics (statistical data)*3	Histogram*1 List (measurements and their frequencies) Statistics (statistical data)*3

● Statistical Computation (for statistics and histogram formats only)

Item	Specifications	
	Time stamp mode	
Maximum value	MAX = [Xi] max	MAX = [Xi] max
Minimum value	MIN = [Xi] min	MIN = [Xi] min
Average	$AVE = \frac{1}{n}\sum_{i=1}^{n} Xi$	$AVE = \frac{1}{n}\sum_{i=1}^{n} Xi \times probability_i$
Sandard deviation*4	$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Xi–AVE)^2}$, where n = the number of samples	$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Xi–AVE)^2 \times probability_i}$ where n = the number of histograms
Peak-to-peak	P–P = MAX – MIN	P–P = MAX – MIN
Flutter	$\sigma/AVE = \frac{\sigma}{AVE} \times 100\%$	$\sigma/AVE = \frac{\sigma}{AVE} \times 100\%$
Jitter 1*5	$\sigma/T = \frac{\sigma}{Ts} \times 100\%$	$\sigma/T = \frac{\sigma}{Ts} \times 100\%$
Jitter 2*5	$MELE = \frac{\lvert AVE–X_{CENTER}\rvert}{Ts} \times 100\%$	$MELE = \frac{\lvert AVE–X_{CENTER}\rvert}{Ts} \times 100\%$

*1: The user can view up to two statistical values.

*2: The time resolution in the time stamp mode is 100 ns both for the X-axis of the time-based variation format and for the time stamps of the list format.

*3: Allows the display of all statistical values and viewing of a bar-graph representation of standard deviations.

*4: Standard deviation–when in pulse width measurement with a trigger slope of ↔

$\frac{\sigma_p + \sigma_a}{2}$

σ_a = Standard deviation for a fransition represented as "↓ to ↑"
σ_p = Standard deviation for a transition represented as "↑ to ↓"

*5: Ts = Any constant keyed in

X_{CENTER}: The center value in a window in a case where the multi-window function is in use

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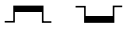
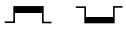
● **Arming (a function that specifies the time to begin one-block measurement)**

Item	Specifications	
	Time Stamp Mode	Hardware Histogram Mode
Arming source		
Internal	Measurement begins when the internal system of measurement goes into the ready state.	
External	Measurement begins as triggered by the edge of an external input signal.	
Arming delay	Measurement begins, after a delay as long as the preset number of events or event time, only when the arming source is external.	
Range of event delay setpoint	Measurement begins after a delay as long as the preset number of event. 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8/ 9/ 10/ 20/ 30/ 40/ 50/ 60/ 70/ 80/ 90/ 100/ 200/ 300/ 400/ 500/ 600/ 700/ 800/ 900/ 1,000/ 2,000/ 3,000/ 4,000/ 5,000/ 6,000/ 7,000/ 8,000/ 9,000/ 10,000/ 20,000/ 30,000	
Range of time delay setpoint	Measurement begins after a delay as long as the preset time. 1 µs to 5 ms (exclusive) (in 200-ns increments) 5 ms to 1 s (in 1-ms increments)	
Slopes		

● **Gating (a function that specifies the range of one-block measurement to be carried out)**

Item	Specifications	
	Time Stamp Mode	Hardware Histogram Mode
Event gating	The analyzer measures as many data items as the preset number of events.	
Configurable Number of events	Duty ratio and phase difference measurements: 1 to 16,000 Other measurements: 1 to 32,000	1 to 99,999,999
End of measurement	Sampling ends if 320 seconds elapse before the preset number of events is reached.	
Time gating	The analyzer measures data for as long a period as the preset gate time.	
Onfigurable setpoint of time	1 µs to 5 ms (exclusive) (in 200-ns increments) 5 ms to 10 s (in 1-ms increments)	
End of measurement	Sampling ends if the number of samples reaches 32,000 before the gate time expires.	Sampling ends if the number of samples reaches 99,999,999 (10^8-1) before the gate time expires.
External gating	The timeframe of measurement is determined by a signal applied to the arming terminal.	
Allowable timeframe	1 µs to 320 s	
End of measurement	Sampling ends if the number of samples reaches 32,000 before the gate time expires.	Sampling ends if the number of samples reaches 99,999,999 (10^8-1) before the gate time expires.
Polarities		

● **Inhibit** (a fuction that specifies the timeframe during which the analyzer inhibits input signals from being captured)

Item	Specifications
Allowable timeframe	1 µs to 320 s
Polarities	

● **Multi-window** (a function that presents two or more different histogram windows–available only in the hardware histogram mode)

Item	Specifications
Functions	Period, pulse width, A-to-B interval and A-to-B-to-A interval
Configurable number of windows	1 to 16
Setup of center value and span	AUTO/MANUAL

● **Histogram Data Addition** (hardware histogram mode only)

Item	Specifications
Histogram data addition	The user can add data values to a histogram a round its center value for display on the screen only when the multi-window function (AUTO) is selected. The statistical computation is implemented according to a new array of data including the added data values.

Timebase

Item	Specifications
Internal reference frequency	10-MHz temperature-compensated crystal oscillator (TCXO)
Frequency stability	Aging rate: ±1.5 ppm/year Temperature characteristics: ±2.5 ppm over 5 to 40°C (with the reference point a +25°C)
External adjustment	Available

General Specifications

Item	Specifications
Memory	Non-volatile memory, allowing storage of and access to ten kinds of panel information.
Floppy disk drive	Size: 3.5" Quantity: 1 Format: MS-DOS (640, 720 KB, 1.2 or 1.44 MB)
GP-IB communication	Compatible with IEEE Standard 488-1978 (JIS C 1901-1987) Functional specifications: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1 and C0 Protocol: Compatible with IEEE Standard 488.2-1987
Reference operating condition	Ambient temperature: 23±2°C Ambient humidity: 50±10%RH Supply voltage: Within 1% of rated voltage
Warm-up time (Approx.)	30 minutes (until all specifications are fulfilled)
Operating temperature range	5 to 40°C
Operating humidity range	20 to 80%RH
Torage temperature range	-20 to 60°C
Ated supply voltage range	100 to 240 V AC
Range of supply voltage variation	90 to 264 V AC
Rated supply frequency range	50 to 60 Hz
Range of rated supply frequency variation	48 to 63 Hz
Power consumption	125 VA max.
External dimensions (Approx.)	213(W)×132(H)×392(D) (mm) 8-3/8(W)×5-1/4(H)×15-1/2(D) (inch)
Weight (Approx.)	5 kg (main unit only)
Display	4.7" STN monochromeLCD (320×240 pixels)

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AVAILABLE MODELS

Model	Suffix Code	Description
704210		**TA320** Time Interval Analyzer
Power Cord	**-D**	UL, CSA Standard
	-F	VDE Standard
	-R	AS Standard
	-Q	BS Standard
	-H	GB Standard

● Optional Accessories

Part Name	Model	Suffix Code	Specifications	Order Q'ty
BNC cable	**366924**		BNC-BNC (1 m)	1
BNC cable	**366925**		BNC-BNC (2 m)	1
Rack mounting kit	**751533**	**-E3**	For EIA single unit installation (one **TA320** Unit)	1
Rack mounting kit	**751534**	**-E3**	For EIA multiple unit installation (two **TA320** units)	1
Rack mounting kit	**751533**	**-J3**	For JIS single unit installation (one **TA320** unit)	1
Rack mounting kit	**751534**	**-J3**	For JIS multiple unit installation (two **TA320** units)	1

● Application Software

Model	Description
704216	Optical Disk Jitter Analysis Software for **TA320** and **TA520**
704223	Optical Disk Inter Symbol Interference Analysis Software for **TA320**, **TA520** and **TA720**

DIMENSIONS

Unit: mm (inch)