Table 1.1 - 1995/1996 Specifications

GENERAL DESCRIPTION

The 1995/1996 system universal counter utilizes a microprocessor-controlled multiple register data acquisition IC for counting and timing to 200 MHz (1.3 GHz on the 1996 with Input C). The counter provides the following measurement functions: frequency, frequency ratio, period, 1-ns resolution time interval, automatic pulse parameters (including duty cycle and slew rate), phase, and totalize. Time interval averaging is available via software-derived functions.

The frequency range on Inputs A and B is 0 to 200 MHz; 40 MHz to 1.3 GHz on Input C using an additional board. Trigger levels on Inputs A and B can be set manually via the front panel keypad or via auto-trigger with 50% trigger points. The DC offset component of the input signal may be tracked by auto-triggering in between readings in the manual mode (peak tracking). Use of a timing error correction (TEC) technique permits measurements with 9-digit resolution in one second and a single-shot time-interval resolution to 1 ns.

The counter is housed in a 3.5" high X 19" wide full-rack X 19" deep standard corporate enclosure. Total weight does not exceed 22 lbs (10 kg). Unit is adaptable to rack or bench top use.

INPUT CHARACTERISTICS

Inputs A and B

Channel Input:	Start/stop channels for each input provide common measurements for Input A and Input B.
Frequency Range:	
DC Coupled	0 to 200 MHz
AC Coupled	20 Hz to 200 MHz
Sensitivity, Sine Wave:	25 mV rms to 100 MHz 50 mV rms to 200 MHz
Sensitivity, Pulse (Frequency Mode):	150 mV p-p; 2.5 ns min. width with 75 mV overdrive.
Sensitivity, Pulse (T.I. Mode):	75 mV p-p; 5 ns min. width with 35 mV overdrive.
Hysteresis:	Sensitivity reduces by X 4 (nominally). Dynamic range bandwidth limited to approximately 50 MHz.

Filter:	Independently selectable Input A and Input B; 100 kHz, nominal. Greater than 20 db attenuation from 10-200 MHz.

Note: The Filter and Hysteresis functions may be combined to increase noise immunity.

Dynamic Range (X1):	75 mV to 10V p-p to 25 MHz 75 mV to 5V p-p to 100 MHz 150 mV to 2.5V p-p to 200 MHz
Signal Operating Range (X1):	-5V DC to +5V DC
Crosstalk at 100 MHz:	500 mV rms*

*Sine wave into either input will not trigger the other input.

Triggering:

Trigger Level Ranges:	5, 50, 250V peak (X1, X10, X50)
Trigger Level:	Adjustable to ±100% of input voltage range with a resolution of 0.2% of input range (10 mV on X1). Level is displayed on front panel.
Trigger Slope:	+ or -, selectable with digital hysteresis compensation.
Trigger Level Setting Accuracy ($25^{o}C \pm 1^{o}C$) (X1 range)	± 1% of trigger level ±10 mV
Trigger Level Temperature Coefficient (X1 range)	± .5 mV/^{o}C

Auto-Trigger

Frequency Range:	DC and 30 Hz to 100 MHz (AC or DC Coupled), usable to 200 MHz
Minimum Amplitude:	150 mV p-p
Accuracy of Trigger Level Readout:	Same as "Read Amplitude Peak" accuracy
Response Time:	650 ms typical 1s maximum

Note: The Auto-Trigger function is independent of the input-signal duty cycle.

Table 1.1 - 1995/1996 Specifications (Cont'd)

Coupling:	AC or DC, independently selectable
Impedance:	
High, Separate and Common	1 megohm shunted by 40 pF (nominal)
50 Ohm	50 ohms nominal
Damage Level:	
1 megohm input impedance	X1: 260V (DC + AC rms) DC to 2 kHz 5 X 10^5/f, 2 kHz - 100 kHz 5V rms, 100 kHz - 200 MHz X10,X50: 260V (DC + AC rms) DC to 20 kHz 5 X 10^5/f, 20 kHz to 100 kHz 50V rms, 100 kHz to 200 MHz
50 ohm input impedance	5V rms (DC to 200 MHz)
Input C	
Frequency Range:	40 MHz to 1.3 GHz
Sensitivity, Sine Wave:	10 mV rms to 1.0 GHz 100 mV rms to 1.3 GHZ
Dynamic Range:	40 dB to 1 GHz 20 dB to 1.3 GHz
Impedance:	50 ohms nominal, AC-coupled
VSWR	2:1 at 1 GHz
Maximum Operating Input:	1V rms
Maximum Input: (without damage)	7V rms (fuse-protected)
Input D (Gate Control Input)	
Sensitivity, Pulse:	300 mV p-p; 50 ns min. width with 150 mV overdrive

Table 1.1 - 1995/1996 Specifications (Cont'd)

Impedance:	10 kilohms shunted by ≤ 35 pF
Damage Level:	± 20V (DC + AC peak)
Triggering	
Trigger Levels:	TTL or zero-crossing, selectable via special function or through GPIB interface
Trigger Slope:	+ or -, selectable via special function or GPIB
FREQUENCY MEASUREMENT	
Inputs A & B	
Range:	
Input A: (B selectable through Special Function 21 or GPIB)	0 to 200 MHz
LSD Displayed:	(1 ns/Gate Time) X Frequency (i.e., 9 digits in one second)
Resolution:	±(1 X LSD) ± 1.4 X (Trigger Error*/Gate Time) X Frequency
Accuracy:	± Resolution ± Time Base Error.
Gate Time:	
Range:	Selectable from 200 ns to 100 sec.
Resolution:	≥ 1 ms, 0.1% < 1 ms, 0.1 µs
Input C (1996 only)	
Range:	40 MHz to 1.3 GHz
LSD Displayed:	(1 ns/Gate Time) X Frequency
Resolution:	(LSD)
Accuracy:	± Resolution ± Time Base Error

* Refer to Definitions, Trigger Error

Table 1.1 - 1995/1996 Specifications (Cont'd)

PERIOD MEASUREMENT	
Range:	5 ns to 1.0 X 10^7 s
LSD Displayed:	(1 ns/Gate Time) X Period
Resolution:	± (1 X LSD) ± 1.4 X (Trigger Error*/Gate Time) X Period
Accuracy:	± Resolution ± Time Base Error
TIME INTERVAL MEASUREMENT	
Input Configuration:	
Separate:	Input A start/Input B stop Input B start/Input A stop (through Special Function 21 or GPIB)
Common:	Input A or Input B start and stop
Range:	-3 ns to 1.0 X 10^7 sec
LSD Displayed:	1 ns (100 ps using Average mode)
Resolution:	± (1 X LSD) ± (Start Trigger Error*) ± (Stop Trigger Error*)
Accuracy:	± (Resolution) ± (Time Base Error) X TI ± (Trigger Level Timing Error**) ± 2ns
Time Interval Delay:	Programmable 200 ns to 100 s
Delay Resolution:	≥1 mSec, 0.1% <1 mSec, 0.1 µs
Delay Accuracy:	Same as Delay Resolution
RISE/FALL TIME	
Range:	5 ns to 25 ms
Minimum Pulse Height:	250 mV p-p
Minimum Pulse Width:	15 ns at signal peaks

* Refer to Definitions, Trigger Error
** Refer to Definitions, Trigger Level Timing Error

Table 1.1 - 1995/1996 Specifications (Cont'd)

LSD Displayed:	Same as Time Interval Specification
Resolution:	Same as Time Interval Specification
Accuracy:	Same as Time Interval Specification with Trigger Level Timing Error** computed at 10% and 90% trigger points
PULSE WIDTH	
Range:	5 ns to 33 ms (10^7 s for manually set trigger levels)
LSD Displayed:	Same as Time Interval Specification
Resolution:	Same as Time Interval Specification
Accuracy:	Same as Time Interval Specification with Trigger Level Timing Error** computed at 50% trigger points
DUTY CYCLE	
Range:	0.01% to 99.99%
Frequency Range:	30 Hz to 100 MHz (to DC for manually set trigger levels)
LSD Displayed:	0.01% or 1 ns/period x 100% (whichever is greater)
Resolution:	$\frac{\text{Pulse Width Resolution}}{\text{Period}} \times 100\%$
Accuracy:	$\pm \text{LSD} \pm \left(\frac{\text{Pulse Width Accuracy}}{\text{Period}}\right) \times 100\%$
SLEW RATE	
Range:	10V/s to 2 X 10^9 V/s
Transition Time Range:	5 ns to 30 ms
Minimum Pulse Height:	250 mV p-p

** Refer to Definitions, Trigger Level Timing Error

Table 1.1 - 1995/1996 Specifications (Cont'd)

LSD Displayed:	$\frac{1\text{ ns}}{\text{Transition Time}} \times \text{Slew Rate (to 3 digits)}$
Resolution:	$\pm\left[\frac{(\text{Stop Trig Level}-\text{Start Trig Level}) + 10\text{ mV}}{0.9 \times (\text{Transition Time}-\text{Transition Time Resolution})} - \text{Slew}\right]$
Accuracy:	$\pm\left[\frac{(\text{Stop Trig Level}-\text{Start Trig Level}) + 20\text{ mV}}{0.9 \times (\text{Transition Time}-\text{Transition Time Accuracy})} - \text{Slew}\right]$

FREQUENCY RATIO MEASUREMENT

Ratio A/B (software)
(Ratio B/A is available via Special Function 21)

Range:

Input A	0 to 200 MHz
Input B	0 to 200 MHz

Accuracy: $\pm$ (Accuracy of F_A)/F_A $\pm$ (Accuracy of F_B)/F_B

Where F_A and F_B are the frequencies of input signals A and B, respectively.

Ratio A/B (hardware)

Range:

Input A	0 to 100 MHz
Input B	0 to 100 MHz

Table 1.1 - 1995/1996 Specifications (Cont'd)

LSD Displayed: $\frac{\text{Ratio}}{F_A \text{ X Gate Time}}$

Where F_A is the higher frequency, connected to the numerator input

Resolution: $\pm \text{LSD} \pm \frac{T_B \text{ X Ratio}}{\text{Gate Time}}$

Where T_B is the denominator trigger error on lower frequency Input B

Accuracy: Same as Resolution

Ratio C/B (hardware)
(Ratio C/A is available via Special Function 21)

Range:

Input C: 40 MHz to 1.3 GHz

Input B: 0 to 100 MHz

LSD Displayed: $\frac{\text{Ratio}}{F_C \text{ X Gate Time}} \text{ X } 64$

Where F_C is Input C frequency.

Resolution: $\pm \text{LSD} \pm \frac{T_B \text{ X Ratio}}{\text{Gate Time}}$

Where T_B is denominator trigger error on lower frequency Input B

Accuracy: Same as Resolution

Ratio C/B (software)

Range:

Input C: 40 MHz to 1.3 GHz

Input B: 0 to 200 MHz

Table 1.1 - 1995/1996 Specifications (Cont'd)

Accuracy:	(± Accuracy of F_C/F_C) ± (Accuracy of F_B)/F_B

Where F_C and F_B are the frequencies of input signals C and B, respectively.

TOTALIZE A BY B

(Totalize B by A available via Special Function 21)

Range:	0 to 100 MHz
Start/Stop:	Input B or manual via Special Function 61
LSD Displayed:	1 Count
Resolution:	LSD
Accuracy:	Same as Resolution

PHASE A RELATIVE TO B

(Phase B relative to A available via Special Function 21)

Range:	0 to 360°
Minimum Signal:	150 mV p-p using Auto-Trigger function 25 mV rms Manual Trigger settings
LSD Displayed:	0.1° to 1 MHz 1° to 10 MHz 10° to 100 MHz
Resolution:	$\pm$ LSD $\pm$ $\frac{\text{TI Resolution} \times 360^\circ}{\text{PERIOD A}}$
Accuracy:	$\pm$ LSD $\pm$ $\frac{\text{TI Accuracy} \times 360^\circ}{\text{PERIOD A}}$

GATE TIME

Range:	200 ns to 100 sec
LSD Displayed:	3 Digit Display

Table 1.1 - 1995/1996 Specifications (Cont'd)

TIME BASE (See Option 04E)	
Frequency:	10 MHz
Aging:	< 1 ppm per month < 2 ppm for first year
Temperature Stability:	± 10 ppm over the range 0° to 50°C, referenced to 25°C
External Standard Input:	
Frequency:	1, 5, 10 MHz
Level:	Min., 500 mV rms, Max., 5V rms
Impedance:	1 kilohm
Internal Standard Output:	
Frequency:	10 MHz
Level:	>1V p-p into 50 ohms
ARMING	
Start Arm:	
Input:	Inputs A, B or D, selectable via Special Functions 82.0-83.3
Start Arm:	(+) or (-) edge, selectable via special function applied to external arm input allows counter to start a measurement cycle

Table 1.1 - 1995/1996 Specifications (Cont'd)

External Gate:	
Input:	Inputs A, B or D, selectable via Special Functions 85.0-88.3
Start Arm:	(+) or (-) edge, selectable via special function applied to external arm input allows counter to start a measurement cycle
Stop Arm:	(+) or (-) edge, selectable via special function applied to external arm input allows counter to stop measurement cycle
Synchronous Window Auto-Trigger: (Syn. Wind. AT)	
Input:	Inputs A, B or D, selectable via Special Functions 91.0-94.3
Start/Stop Edges:	(+) or (-), selectable via special function applied to external arm input allows the auto-trigger function to establish the (+) and (-) signal peaks and trigger level only during the period when the arming signal is present

PEAK SIGNAL MEASUREMENT

The auto-trigger function may be used to determine and indicate the peak maximum, peak minimum, and peak-to-peak values of the measurement signal applied to Inputs A or B.

Display:	Individual 3-digit displays for Inputs A and B.
Frequency Range:	DC and 30 Hz to 25 MHz
Dynamic Range:	.15 to 10V p-p (X1 attenuation)
Resolution:	10 mV (X1 attenuation)
Accuracy:	± 5% of peak-to-peak voltage ± 20 mV for sine waves
	± 2% of peak-to-peak voltage ± 20 mV for pulses > 20-ns wide and ≥ 5 ns rise time

Table 1.1 - 1995/1996 Specifications (Cont'd)

STATISTICS	
Sample Size:	2 to 9999
Standard Deviation:	Displays Standard Deviation of sample size (n)
Average:	Displays Average (mean) value of sample size (n)
Highest:	Using Special Function 51, the highest value in sample size (n) is displayed
Lowest:	Using Special Function 52, the lowest value in sample size (n) is displayed

MATH

Applies to all counting/timing measurement functions. Note Math Function is applied prior to Statistics Function.

$$\text{Display} = \frac{\text{Reading} - X}{Z} Y$$

Where X, Y and Z are constants entered and stored via the keyboard.

Constant (X, Y or Z) Range:	± 0.000000001E-9 to ± 9999999999E9
Power-Up Condition:	X = 0 Y = 1 Z = 1

GPIB INTERFACE

Standard:	IEEE-STD-488-1978
Programmable Controls	All front panel controls with the exception of Power
Universal Commands:	Trigger, Clear, Remote, Local, Local Lockout, Require Service
Data Output Format:	Refer to Tables 4.5 and 4.7
Data Output Rate:	150 readings/second, maximum

Table 1.1 - 1995/1996 Specifications (Cont'd)

NON-VOLATILE MEMORY	
Up to 10 complete front-panel settings may be stored for subsequent recall.	
GATE OUT	
A TTL-compatible signal is provided from a rear-panel BNC connector coincident with the measurement gate.	
TRIGGER LEVEL OUTPUTS	
Start and stop levels are available on the rear panel from BNC connectors for calibration purposes only.	
DISPLAY	
LED: 10 digit display, character size 0.43". Exponent digit, character size 0.43"	
When measurement exceeds 10 digits, the least significant 10 digits are displayed, and the overflow indicator is lit.	
TEMPERATURE PERFORMANCE	
Operating Temperature:	$0^{\circ}C$ to $+50^{\circ}C$
Storage Temperature:	$-40^{\circ}C$ to $+75^{\circ}C$
POWER REQUIREMENTS:	100, 120, 220, 240V rms ± 10% 50 to 400 Hz ± 10% 80 VA
DIMENSIONS:	88.9 mm (3.5 in) High X 427.0 mm (16.8 in) Wide X 475 mm (18.7 in) deep
WEIGHT:	10 kg (22 lb.)

Table 1.1 - 1995/1996 Specifications (Cont'd)

OPTIONS

Option 01 Rear-Panel Inputs

Option 04E High-Stability Oven Oscillator

Proportionally controlled ovenized Internal Frequency Standard

Frequency:	10 MHz
Aging:	$< 5 \times 10^{-10}$ per day at time of shipment
Temperature Stability:	$< 7 \times 10^{-9}$ over the range 0°C to 50°C
Line Voltage Stability:	$< 5 \times 10^{-10}$ two minutes after a 10% line voltage change

Option 60

Rack mounting kit (fixed)

Option 65

Rack mounting kit (slides)

DEFINITIONS

LSD Least Significant Digit

Trigger Error

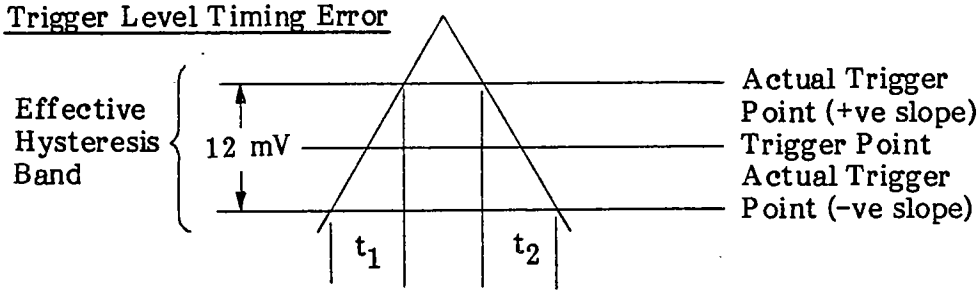
$$\text{Trigger error (Seconds)} = \frac{\sqrt{(e_i^2 + e_n^2)}\ \text{(Volts)}}{\text{Input Slew Rate at Trigger Point (V/sec)}}$$

where e_i = input amplifier rms noise, 250 µV rms max

e_n = input signal rms noise in 250 MHz bandwidth

Table 1.1 - 1995/1996 Specifications (Cont'd)

Trigger Level Timing Error



Timing Error = (Trigger Level Error (V))/ Input Slew Rate at START trig point (V/sec) - (Trigger Level Error (V))/Input Slew Rate at STOP trig point (V/sec)
(Seconds)