

## A REVOLUTION IN TIME & FREQUENCY ANALYSIS

- Fastest: 250k measurements/s to internal memory and 2k/s via GPIB
- Highest resolution: 12 digits/s (freq.), 100 ps (time), 0.001° (phase)
- 14 digits display
- Frequency range: 300 MHz standard; 3, 8 and 14 GHz optional
- Unique ease-of-use:  
Multi-parameter display and graphical presentation of results
- USB and GPIB as standard
- Outstanding performance/price ratio



With the new CNT-90 timer/counter/analyzer, Pendulum Instruments now offers **The Ultimate Tool** for measurement, analysis and calibration of Frequency, Time Interval or Phase. Whether in test systems, on the R&D bench, in the calibration lab or out in the field, the CNT-90 is the state-of-the-art timer/counter/analyzer and outperforms any existing counter on the market. The CNT-90 is the worlds fastest timer/counter/analyzer and offers a unique ease-of-use with graphical display and improved control over measurement at an outstanding price.

### Outstanding Performance/Price ratio

The CNT-90 timer/counter/analyzer outperforms any counter on the market, independent of measurement task. The CNT-90 offers ultimate and unique control of measurement and is the choice for all needs and budgets - giving you outstanding performance for the price of a standard counter.

### Leading World-Class Performance

The basic performance of the CNT-90 is World-leading compared to competition:

- *2k individual triggered measurements per second via GPIB/USB* the CNT-90 can save you up to 90% testing time (and thus money) in test systems by increased throughput.

- *High resolution* is vital for R&D and production testing. CNT-90 meets this requirement with 100 ps single shot or 12 digits/s, thus following very small time and frequency changes. That is 2 more digits than other interpolating counters. Obtained values are displayed with up to 14 digits.

- *Modulation Domain Analysis* is performed by capturing very fast frequency changes in real time, thanks to the high 250k measurement speed and the large memory depth of 750k readings.

- For *calibration* purposes, results are quickly obtained. The CNT-90 offers very

high accuracy through very stable *internal OCXO time base*, very low systematic time interval A-B error and of course very high resolution.

- *Wide frequency range*, up to 14 GHz, covers most frequency measurement needs from DC to microwave. There is no need to invest in a separate microwave counter.

### Ease-of-Use

The *menu-oriented settings* reduce the risk for mistakes. Valuable signal information given as numerical results with *multi-parameter display* removes the need for other instruments like DVM's and Scopes.

The *graphical presentation* of results (histograms, trends, modulation domain etc) gives a much better understanding of random signal distribution and measurement changes vs time, from slow drift to fast jitter and modulation.

The intelligent *Auto-trigger* automatically sets optimum trigger level and hysteresis, adapted to the actual input signal.

### Excellent connectivity to computers

The CNT-90 is delivered with both USB- and GPIB high-speed interfaces as standard. This eliminates the need to invest in an extra GPIB interface for your PC since USB is present everywhere.

### Plug-and-Play in existing test systems

The GPIB interface comes in two modes: SCPI/1999 plus a 53131A emulation mode for easy implementation in test systems originally designed for other brands.

This instant "plug-and-play" feature facilitates the exchange of the timer/counter/analyzer and reduces the need to re-program existing system commands.

### Improved control over measurement start/stop

CNT-90 takes the art of measurement to the top with features such as arming, adjustable arming delay, trigger hold-off and limit qualifying.

Arming enables full control of both start and stop of the measurement of time or frequency in complex signals.

Frequency burst parameters are automatically detected due to the adjustable arming delay and trigger hold-off, both with 10 ns resolution.

The feature limit qualifying skips unwanted parameter values.

The state-of-art CNT-90 is the revolution - it is the only tool for time & frequency measurement, analysis and calibration you will ever need.

## Revolutionary Graphical Presentation

One of the unique features of the CNT-90 is the graphical display and the menu oriented settings. The non-expert can easily make correct settings without risking costly mistakes. The multi-parameter display with additional auxiliary measurement values such as  $V_{\max}/V_{\min}/V_{p-p}$  in frequency measurements, and frequency/attenuation/phase measurements, eliminates the

need for extra test instruments and provides you direct answers to frequently asked questions, like “What is the attenuation and phase shift of this filter?” Measurement values are presented both numerically and graphically. The graphical presentation of results (histograms, trends etc.) gives a much better understanding of the nature of jitter. It also provides you with a much better view of

changes vs time, from slow drift to fast modulation (trend plot). Three statistical views of the same data set can be viewed: Numerical, Histogram and Trend. It is very easy to capture and toggle between views of the same data (see figure 4, 5&6). When adjusting a frequency source to given limits, the graphic display gives fast and accurate visual calibration guidance.



Figure 1: Display showing phase value, frequency, attenuation  $V_A/V_B$ , and auxiliary parameters.



Figure 4: Display showing different statistical parameters viewed at the same time.



Figure 2: Measure function selection menu, shown with measured results.



Figure 5: Display showing the trend (signal over time) of sampled data.



Figure 3: Input parameter setting menu shown with measured result.



Figure 6: The same result as in figure 5, now displayed as a histogram.

## Additional Technical Features

CNT-90 not only offers leading World-Class performance, it is the ultimate tool for more specialized measurement. Some more unique features of the CNT-90 are:

- *Zero dead-time technique* and continuous time-stamping of trigger events. Fast time-stamping of trigger events enables capture of ALL individual periods, back-to-back without dead-time, up to 250k measurements/s. This feature is very valuable in mechanical (e.g. rotational encoder testing) and medical (e.g. nerve impulse/respiratory cycles) measurements.

- *SMART Time Interval measurements through single-pass technique.* Unlike traditional methods where you needed to define the start and stop channel on beforehand (e.g. Time A-B), you can now let CNT-90 detect start and stop automatically. No more false results due to the stop signal occurring before the start signal.

- *TRUE Phase and Duty Cycle measurements through single-pass technique.* Traditional methods calculate Phase as  $(\text{Time Interval A-B})/\text{Period} \times 360^\circ$  and Duty Cycle as  $(\text{Pulse width})/\text{Period}$  where Time Interval A-B, Pulse Width and Period were measured separately, and not simultaneously. The single-pass phase and duty cycle measurement in CNT-90 enables TRUE phase measurements between signals with a varying frequency. This feature is very valuable to verify the relative phase between quadrature output pulses ( $90^\circ$ ) from rotational encoders, where rotation speed may vary during the measurement.

- *Limit qualifying* lets the user accept or reject measurement values inside or outside set limits. This is a very handy tools for making correct calculation of statistical parameters e.g. to verify the rms jitter of digital pulses that appear in discrete clusters (e.g. in CD-players or HDB3-coded data). By setting limits you can isolate one cluster in the calculation.

- *Measurement pacing* sets an accurate sample rate for the measurement, ensuring that samples are taken at exact and equi-distant intervals. Setting e.g. the pacing time to 600s (one measurement every 10 minutes for a 24 hr monitoring period), reduces the amount of data to 144 measurement samples equally spread over the day.

- Hysteresis compensation in Time Interval measurements reduces trigger level error from the typical 15-20 mV found in most counters on the market today, down to typ 2.5 mV. This means 6-8 times improved trigger precision in critical time interval measurements.

**If CNT-90 can't make the measurement, no other counter can!**

## CNT-90 Specifications

### Measuring Functions

All measurements are displayed with a large *main parameter* value and smaller *auxiliary parameter* values (with less resolution). Some measurements are only available as auxiliary parameters.

#### Frequency A, B, C

##### Range:

Input A, B: 0.001 Hz to 300 MHz

Input C (option): Up to 3 GHz, 8 GHz or 14 GHz

**Resolution:** 12 digits in 1s measuring time

**Aux parameters:** Vmax, Vmin, Vp-p

#### Frequency Burst A, B, C

Frequency and PRF of repetitive burst signals can be measured without external control signal and with selectable start arming delay.

**Functions:** Frequency in burst (in Hz)  
PRF (in Hz)  
Number of cycles in burst

##### Range:

Input A, B, C: See Frequency spec.

##### Minimum burst duration:

40ns (80ns above 160 MHz)

##### Minimum pulses in burst:

Input A or B: 3 (6 above 160 MHz)

Input C: 3 x prescaler factor

**PRF range:** 0.5 Hz to 1 MHz

**Start Delay Range:** 10 ns to 2s, 10 ns resolution

**Aux parameters:** PRF, number of cycles in burst

#### Period A, B, C Average

##### Range:

Input A, B: 3.3 ns to 1000s

Input C: 330 ps to 10 ns (option 10)

125 ps to 5 ns (option 13)

**Resolution:** 100 ps (single); 12 digits/s (average)

**Aux parameters:** Vmax, Vmin, Vp-p

#### Ratio A/B, B/A, C/A, C/B

**Range:**  $(10^{-9})$  to  $10^{11}$

##### Input Frequency:

Input A, B: 0.1 Hz to 300 MHz

Input C (option): Up to 3 GHz, 8 GHz or 14 GHz

**Aux parameters:** Freq 1, Freq 2

#### Time Interval A to B, B to A, A to A, B to B

##### Range:

Normal calculation: -5 ns to  $+10^6$ s

Smart calculation:  $-10^6$ s to  $+10^6$ s

**Resolution:** 100 ps

**Min. Pulse width:** 1.6 ns

**Smart Calculation:** Smart Time Interval to determine sign (A before B or A after B)

#### Positive and Negative Pulse Width A, B

**Range:** 1.6 ns to  $10^6$ s

**Min. Pulse width:** 1.6 ns

**Aux parameters:** Vmax, Vmin, Vp-p

#### Rise and Fall Time A, B

**Range:** 700 ps to 1000s

**Trigger levels:** 10% and 90% of signal amplitude

**Min. Pulse width:** 1.6 ns

**Aux parameters:** Slew rate, Vmax, Vmin

#### Phase A Relative B, B relative A

**Range:**  $-180^\circ$  to  $+360^\circ$

**Resolution:**  $0.001^\circ$  to 10 kHz,  
decreasing to  $1^\circ > 10$  MHz

Resolution can be improved via averaging (Statistics)

**Frequency Range:** up to 160 MHz

**Aux parameters:** Freq (A), Va/Vb (in dB)

#### Positive and Negative Duty Factor A, B

**Range:** 0.000001 to 0.999999

**Frequency Range:** 0.1 Hz to 300 MHz

**Aux parameters:** Period, pulse width

#### Vmax, Vmin, Vp-p A, B

**Range:** -50V to +50V, -5V to +5V

Range is limited by the specification for max input voltage without damage (see input A, B)

**Frequency Range:** DC, 1 Hz to 300 MHz

**Mode:** V max, V min, V p-p

**Resolution:** 2.5mV

**Vmax Aux parameters:** Vmin, Vp-p

**Vmin Aux parameters:** Vmax, Vp-p

**Vp-p Aux parameters:** Vmin, Vmax

#### Time stamping A, B

Raw time stamp data together with pulse counts on input A or B, accessible via GPIB or USB only.

**Max sample speed:** See GPIB specifications

**Max frequency:** 160 MHz

**Timestamp resolution:** 100 ps

## Input and Output Specifications

### Inputs A and B

#### Frequency Range:

DC-Coupled: DC to 300 MHz

AC-Coupled: 10 Hz to 300 MHz

**Impedance:** 1 M $\Omega$  // 20 pF or 50 $\Omega$  (VSWR $\leq 2:1$ )

**Trigger Slope:** Positive or negative

**Max. channel timing difference:** 500 ps

#### Sensitivity:

DC-100 MHz: 10 mV rms

100-200 MHz: 20 mV rms

200-300 MHz: 40 mV rms

**Attenuation:** x1, x10

**Dynamic Range (x1):** 30 mV p-p to 10V p-p within  $\pm 5$ V window

**Trigger Level:** Read-Out on display

**Resolution:** 2.5 mV

**Uncertainty (x1):**  $\pm(10$  mV + 1% of trigger level)

**AUTO Trigger Level:** Trigger level is automatically set to 50% point of input signal (10% and 90% for Rise/Fall Time)

#### AUTO Hysteresis:

**Time:** Min hysteresis window (hysteresis compensation)

**Frequency:** One third of input signal amplitude

**Analog noise reduction filter:** Nominal 100 kHz, RC-type.

#### Digital Low Pass Filter:

Variable 1 Hz to 50 MHz cut-off frequency

#### Max Voltage Without Damage:

1 M $\Omega$ : 350V (DC + AC pk) to 440 Hz, falling to 12V rms (x1) at 1 MHz

50 $\Omega$ : 12V rms

**Connector:** BNC

### Input C (Option 10)

#### Operating Input Voltage Range:

100 to 300 MHz: 20 mV rms to 12V rms

0.3 to 2.5 GHz: 10 mV rms to 12V rms

2.5 to 2.7 GHz: 20 mV rms to 12V rms

2.7 to 3.0 GHz: 40 mV rms to 12V rms

**Prescaler Factor:** 16

**Impedance:** 50 $\Omega$  nominal, VSWR  $< 2.5:1$

**Max voltage without damage:** 12V rms, pin-diode protected

**Connector:** Type N Female



## Input C (Option 13)

### Operating Input Voltage Range:

200 to 500 MHz: 20 mV rms to 7 V rms

0.5 to 3.0 GHz: 10 mV rms to 7 V rms

3.0 to 4.5 GHz: 20 mV rms to 7 V rms

4.5 to 6.0 GHz: 40 mV rms to 7 V rms

6.0 to 8 GHz: 80 mV rms to 7 V rms

Prescaler Factor: 256

Impedance: 50Ω nominal, VSWR <2.5:1

Max Voltage Without Damage: 7V rms

Connector: Type N Female

## Input C (Option 14) – (Later availability)

Frequency Range: 0.3 GHz to 14 GHz

## Rear Panel Inputs and Outputs

Reference Input: 1, 5, or 10 MHz; 0.1 to 5V rms sine; impedance ≥1 kΩ

Reference Output: 10 MHz; >1 Vrms sine into 50Ω

Arming Input: Arming of all measuring functions

Impedance: Approx. 1 kΩ

Frequency Range: DC to 80 MHz

Rear panel measurement inputs: A, B, C (option)

Impedance: 1 MΩ//50 pF or 50Ω (VSWR ≤ 2:1)

Connectors: Type N female for rear input C  
BNC for all other inputs/outputs

## Auxiliary Functions

### Trigger Hold-Off

Time Delay Range: 20 ns to 2s, 10 ns resolution

### External Start and Stop Arming

Modes: Start, Stop, Start and Stop Arming

Input channels: A, B or E

Max rep. Rate for Arming signal:

Channel A,B: 160 MHz

Channel E: 80 MHz

Start Time Delay Range: 20 ns to 2s, 10 ns resolution

### Statistics

Functions: Maximum, Minimum, Mean,  
Δmax-Min, Standard Deviation and  
Allan Deviation

Display: Numeric, histograms or trend plots

Sample Size: 2 to 2 x 10<sup>9</sup> samples

Limit qualifier: OFF or Capture values  
above/below/inside or outside limits

Measurement pacing

Pacing time range: 2 us to 1000s

## Time Base Options

Option model:	std	30/90	40/90
Time base type:	Standard	OCXO	OCXO
Uncertainty due to:			
-Ageing.	per 24h per month per year	n.a. $<5 \times 10^{-7}$ $<5 \times 10^{-6}$ $<1 \times 10^{-5}$ $<3 \times 10^{-6}$	$<5 \times 10^{-10} (1)$ $<1 \times 10^{-8}$ $<5 \times 10^{-8}$ $<5 \times 10^{-9}$ $<1 \times 10^{-9}$
-Temperature variation: 0°C-50°C 20°C-26°C (typ. values)			$<3 \times 10^{-10} (1)$ $<3 \times 10^{-9}$ $<1.5 \times 10^{-8}$ $<2.5 \times 10^{-9}$ $<4 \times 10^{-10}$
Short term stability:	$\tau = 1\text{ s}$	not specified	$<1 \times 10^{-11}$
(root Allan Variance)	$\tau = 10\text{ s}$		$<5 \times 10^{-12}$ $<5 \times 10^{-12}$
Power-on stability			
-Deviation vs final value after 24hr on time, after a warm-up time of:	n.a. 30 min	$<1 \times 10^{-8}$ 10 min	$<5 \times 10^{-9}$ 10 min
Typical total uncertainty, for operating temperature 20°C to 26°C, at $2\sigma$ (95%) confidence interval:			
- 1 year after calibration	$<7 \times 10^{-6}$	$<0.6 \times 10^{-7}$	$<1.7 \times 10^{-8}$
- 2 years after calibration	$<1.2 \times 10^{-5}$	$<1.2 \times 10^{-7}$	$<3.4 \times 10^{-8}$

1) After 1 month of continuous operation

## Mathematics

Functions: (K\*X+L)/M and (K/X+L)/M. X is  
current reading and K, L and M are  
constants; set via keyboard or as  
frozen reference value (X<sub>0</sub>)

## Other Functions

Measuring Time: 20 ns to 1000s for Frequency, Burst  
and Period Average. Single cycle for  
other measuring functions

Timebase Reference: Internal, External or Automatic

Display Hold: Freezes result, until a new measure-  
ment is initiated via Restart

Limit alarm: Graphical indication on front panel  
and/or SRQ via GPIB

Limit values: Lower limit, Upper limit

Settings: OFF or Alarm if value is  
above/below/inside or outside limits

On alarm: STOP or CONTINUE

Display: Numeric + Graphic

Stored instrument set-ups: 17 instrument setups can be  
saved/recalled from internal non-volatile  
memory. 10 can be user protected.

Display: Backlit LCD Graphics screen for  
menu control, numerical read-out and  
status information

Number of digits: 14 digits in numerical mode

Resolution: 320\*97 pixels

## GPIB Interface

Compatibility: IEEE 488.2-1987, SCPI 1999  
53131A compatibility mode

Interface Functions: SH1, AH1, T6, L4, SR1, RL1,  
DC1, DT1, E2

Max. measurement Rate

Via GPIB: 2k readings/s, individually triggered

To Internal Memory: 250k readings/s

Internal Memory Size: Up to 750k readings.

## USB Interface

USB version: 1.1 Full

Max. measurement Rate: See GPIB data

## Calibration

Mode: Closed case, menu controlled

Cal. Frequencies: 0.1, 1, 5, 10, 1.544 and 2.048 MHz

## General Specifications

### Environmental Data

Operating Temp: 0°C to +50°C

Storage Temp: -40°C to +70°C

Vibration: 3G at 55 Hz per MIL-PRF-28800F

Shock: Half-sine 40G per MIL-PRF-28800F  
Bench handling.  
Shipping container.

Reliability: MTBF 30 000 h

Safety: EN 61010-1 and EN 61010-2, CE

EMC: EN 55011 ISM Group 1, Class B;  
EN 61326 (1997); A1 (1998) in-  
creased test level according to EN  
55082-2; CE

### Power Requirements

Basic version: 90 to 265V rms, 45 to 440 Hz, <40W

### Dimensions and Weight

Width x Height x Depth:  
210x90x395 mm (8.25x3.6x15.6 in)

Weight: Net 4 kg (8.5 lb),  
Shipping 7 kg (15 lb)

## Ordering Information

### Basic Model

CNT-90 300 MHz, 100 ps Timer/Counter in-  
cluding Standard Time Base

Included with Instrument: 18 months product warranty,  
line cord, user documentation on CD,  
and Certificate of Calibration

### Input Frequency Options

Option 10 3 GHz Input C

Option 13 8 GHz Input C

Option 14\* 14 GHz Input C

### Time Base Options

Option 30/90 Very High Stability Oven Time Base;  
0.01 ppm/month

Option 40/90 Ultra High Stability Oven Time Base;  
0.003 ppm/month

### Optional Accessories

Option 11/90 Rear Panel Inputs

Option 22/90 Rack-Mount Kit

Option 27 Carrying Case - soft

Option 27H Heavy-duty hard transport case

Option 29/90\* TimeView for CNT-90

Option 90/01 Calibration certificate with protocol;  
Standard oscillator

Option 90/06 Calibration certificate with protocol;  
Oven oscillator

Option 90/00 Calibration certificate with protocol;  
Hold-over frequency ageing/week

Option 95/03 3 years extended warranty

Option 95/05 5 years extended warranty

\*Later availability Q3 2004

Specifications subject to change without prior notice

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Pendulum Instruments AB

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- Experts in time & frequency calibration,

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