

# CNT-90

## Timer/Counter/Analyzer

pendulum

- 250k measurements/s to internal memory, 750k stored measurements results
- Fast GPIB/USB bus speed, 5k meas/s – block mode
- Resolution: 12 digits/s (freq.), 100 ps (time), 0.001° (phase)
- 14 digits display
- Frequency range: 400 MHz as standard. 3, 8, 15 and 20 GHz optional
- Ease-of-use: Multi-parameter display and graphical presentation of results
- Outstanding performance/price ratio



The Pendulum CNT-90 timer/counter/analyzer is an ultimate tool for measurement, analysis and calibration of Frequency, Time Interval or Phase. The CNT-90 is a high-performance counter with a fast measurement speed to 250,000 measurements/s, and time interval measurement resolution to 100 ps. The CNT-90 offers ease-of-use including graphical display and improved display and improved control over measurement at an outstanding price.

### Leading Performance

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

- With 5k measurement results transferred per second (block mode) 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 (time) or 12 digits/s (frequency). Obtained values are displayed with up to 14 digits.
- Modulation Domain Analysis is performed by capturing fast frequency changes with up to 250k Samples/s.
- For calibration purposes, the CNT-90 offers very high accuracy through stable internal OXCO time base, low systematic time interval A-B error and high resolution.
- Wide frequency range to 20 GHz covers most CW and burst microwave frequency measurement needs. There's no need to invest in a separate microwave counter.

### Outstanding Performance/Price Ratio

The high performance CNT-90 timer/counter/analyzer outperforms all counters on the market (except Pendulum CNT-91), independent of measurement task.

- The graphic presentation of results – histogram, trend line, numerical statistics, modulation domain – provide a clearer understanding of random signal distribution and measurement changes over time – from slow drift to fast jitter, and modulation.
- Both USB and GPIB interfaces are standard. With USB you won't need to invest in a GPIB interface card for your PC. The GPIB operates in either SCPI/GPIB or 53131 emulation mode, for plug-and-play replacement in existing ATE systems.
- Wide frequency range – to 20 GHz – offers microwave CW frequency measurements and very short burst measurements down to 40 ns.
- Menu-oriented settings reduce the risk of mistakes. Valuable signal information, given in multi-parameter displays, removes the need for other instruments like DVM's and Scopes.

### Additional Technical Features

CNT-90 does not only offer high-performance, it is an ultimate tool for more specialized measurement. Some great features of the CNT-90 are:

- Zero dead-time technique and continuous time-stamping of trigger events. This feature allows correct measurements of Allan Deviation and is very valuable in mechanical (e.g. rotational

encoder testing) and medical (e.g. nerve impulse/respiratory cycles) measurements where every single cycle must be measured.

- Limit qualifying a handy tool for making correct calculation of statistical parameters e.g. to verify the jitter of digital pulses that appear in discrete clusters (e.g. in CD-players or in HDB3-coded data). By setting limits you can isolate one cluster in the calculation.
- 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.

**Battery Option**

The CNT-90 has an optional battery pack with 90 Wh capacity, capable of mains-free operation for at least 4.5 hours.

In stand-by mode the battery pack can keep an OCXO warm and running for over 24 hours. Battery operation of a frequency counter/analyzer is valuable in three different applications:

- Mains-free operation in the field
- Transportation of high-stability OCXO to maintain stability, which gives instant use at destination without any warm-up time

- Battery backup acting as a built in UPS (Uninterrupted Power Supply)

**Excellent Graphical Presentation**

One of the great 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 auxiliary measurement values such as Vmax/Vmin/Vp-p in frequency measurements, and frequency/attenuation/phase, eliminates the need for extra test instruments and provides 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 Va/Vb, 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.

## 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:* 0.002 Hz to 400 MHz

*Input C (option):* Up to 3, 8, 15 or 20 GHz

#### Resolution:

12 digits in 1s measuring time (normal)

**Aux. Parameters:** Vmax, Vmin, Vp-p

### Frequency Burst A, B, C (opt. 14/14B)

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)

**Range:** *Input A, B, C:* See Frequency spec.

**Minimum Burst Duration:** Down to 40 ns

#### 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 1MHz

**Start Delay:** 10 ns to 2sec., 10 ns resolution

**Aux. Parameter:** PRF

### Period A, B, C

**Mode:** Single, Average

#### Range:

*Input A, B:* 2.5 ns to 1000 sec. (single, average)

*Input C (option):* 10 ns down to 330, 125, 70 or 50 ps

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

**Aux. Parameters:** Vmax, Vmin, Vp-p

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

**Range:** (10<sup>-9</sup>) to 10<sup>11</sup>

#### Input Frequency:

*Input A, B:* 0.1 Hz to 400 MHz

*Input C (option):* Up to 3, 8, 15 or 20 GHz

**Aux Parameters:** Freq 1, Freq 2

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

**Range:** *Normal Calculation:* Ons to +10<sup>6</sup> sec.

*Smart Calculation:* -10<sup>6</sup> sec. to +10<sup>6</sup> sec.

**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:** 2.3 ns to 10<sup>6</sup> sec.

**Min. Pulse Width:** 2.3 ns

**Aux. Parameters:** Vmax, Vmin, Vp-p

### Rise and Fall Time A, B

**Range:** 1.5 ns to 10<sup>6</sup> sec.

**Trigger Levels:** 10% and 90% of signal Vp-p

**Min. Pulse Width:** 1.6 ns

**Aux. Parameters:** Slew rate, Vmax, Vmin

### Positive and Negative Duty Factor A, B

**Range:** 0.000001 to 0.999999

**Freq. Range:** 0.1 Hz to 300 MHz

**Aux. parameters:** Period, pulse width

### Phase A Relative B, B Relative A

**Range:** -180° to +360°

**Resolution:** Single-cycle: 0.001° to 10 kHz, decreasing to 1° >10 MHz. Resolution can be improved via averaging (statistics)

**Freq. Range:** up to 160 MHz

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

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

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

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

**Freq. Range:** DC, 1Hz to 300 MHz

**Mode:** Vmax, Vmin, Vp-p

**Resolution:** 2.5 mV

**Uncertainty (5V range, typical):**

*DC, 1Hz to 1kHz:* 1% +15 mV

*1kHz to 20 MHz:* 3% +15 mV

*20 to 100 MHz:* 10% +15 mV

*100 to 300 MHz:* 30% +15 mV

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

### Time stamping A, B, C

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

**Max Sample Speed:**

See GPIB specifications

**Max Frequency:** 160 MHz

**Timestamp Resolution:** 70 ps

## Input and Output Specifications

### Inputs A and B

**Frequency Range:**

*DC-Coupled:* DC to 400 MHz

*AC-Coupled:* 10 Hz to 400 MHz

#### Impedance:

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

**Trigger Slope:** Positive or negative

**Max. Channel Timing Difference:** 500 ps

**Sensitivity:** *DC-200 MHz:* 15 mVrms

*200-300 MHz:* 25 mVrms

*300-400 MHz:* 100 mVrms

**Attenuation:** x1, x10

**Dynamic Range (x1):** 30 mV p-p to

10 V p-p within  $\pm$ 5V window

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

**Resolution:** 3mV

**Uncertainty (x1):**  $\pm$ (15 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:

**Freq. range:** 1Hz to 300 MHz

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

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

**Analog LP Filter:** Nominal 100kHz, RC-type.

**Digital LP Filter:** 1Hz to 50 MHz cut-off frequency

#### Max Voltage Without Damage:

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

**50 $\Omega$ :** 12 Vrms

**Connector:** BNC

### Input C (Option 10)

**Operating Input Voltage Range opt. 10:**

*100 to 300 MHz:* 20 mVrms (-21 dBm) to 12 Vrms

*0.3 to 2.5 GHz:* 10 mVrms (-27 dBm) to 12 Vrms

*2.5 to 2.7 GHz:* 20 mVrms (-21 dBm) to 12 Vrms

*2.7 to 3.0 GHz:* 40 mVrms (-15 dBm) to 12 Vrms

**Prescaler Factor:** 16

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

**Max Voltage without Damage:**

12 Vrms, pin-diode protected

**Connector:** Type N Female

### Input C (Option 13)

**Operating Input Voltage Range:**

*200 to 300 MHz:* 40 mVrms to 7Vrms (typ.)

*300 to 500 MHz:* 20 mVrms to 7Vrms

*0.5 to 3.0 GHz:* 10 mVrms to 7Vrms

*3.0 to 4.5 GHz:* 20 mVrms to 7Vrms

*4.5 to 6.0 GHz:* 40 mVrms to 7Vrms

*6.0 to 8 GHz:* 80 mVrms to 7Vrms

**Prescaler Factor:** 256

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

**Max Voltage Without Damage:** 7Vrms

**Connector:** Type N Female

### Input C (Option 14 and 14B)

**Freq. Range:** 0.25 to 15 GHz (opt. 14)

0.25 to 20 GHz (opt. 14B)

**Operating input voltage range:**

*250 to 500 MHz:* -21 to +27 dBm

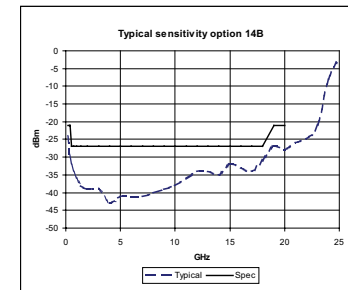
*0.5 to 15 GHz:* -27 to +27 dBm

*15 to 18 GHz:* -27 to +27 dBm (Option 14B only)

*18 to 20 GHz:* -21 to +27 dBm (Option 14B only)

**Prescaler Factor:** 128

**Impedance:** 50  $\Omega$  nominal, VSWR  $<$ 2.0:1



**AM tolerance:** > 90% within sensitivity range

**Max Voltage Without Damage:** +27 dBm

**Connector:** Type precision N Female

### Rear Panel Inputs and Outputs

**Reference Input:** 1, 5, or 10 MHz;

0.1 to 5Vrms sine; impedance  $\geq$ 1 k $\Omega$

**Reference Output:** 10 MHz;

>1Vrms sine into 50  $\Omega$

#### Arming Input:

Arming of all measuring functions

**Impedance:** Approx. 1k $\Omega$

**Freq. Range:** DC to 80 MHz

**Rear Panel Measurement Inputs:**

A, B, C (opt. 11/90)

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

**Connectors:** SMA female for rear input C, BNC for all other inputs/outputs

## Auxiliary Functions

### Trigger Hold-Off

**Time Delay Range:** 20 ns to 2sec.,

10 ns resolution

### External Start and Stop Arming

**Modes:** Start, Stop, Start and Stop Arming

**Input Channels:** A, B or E-rear panel

**Max Rep. Rate for Arming Signal:**

*Channel A,B:* 160 MHz

*Channel E:* 80 MHz

**Start Time Delay Range:**

20 ns to 2sec., 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:* 4μs to 500 sec.

**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 1000 sec. 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 measurement 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:** 20 instrument setups can be saved/recalled from internal non-volatile memory. 10 can be user protected.  
**Result Storage:** Up to 8 measurements of max 32k samples can be stored in local memory for later downloading.  
**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 199953131A compatibility mode  
**Interface Functions:** SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, E2

**Time Base Options**

Option model	STD	19/90	30/90	40/90
Time base type:	Standard	OCXO	OCXO	OCXO
Uncertainty due to:				
- Aging per 24h per month per year	n/a	<5x10 <sup>-9</sup> (1)	<5x10 <sup>-10</sup> (1)	<3x10 <sup>-10</sup> (1)
- Temperature variations: 0°C to 50°C 20°C to 26°C (typ. values)		<5x10 <sup>-6</sup>	<2x10 <sup>-7</sup>	<1.5x10 <sup>-8</sup>
Short-term stability: τ = 1s (root Allan Variance) τ = 10 s	not specified	<1x10 <sup>-10</sup>	<1x10 <sup>-11</sup>	<5x10 <sup>-12</sup>
Power-on stability: - Deviation vs. final value after 24 h on time, after a warm-up time of:	n/a 30 min	<1x10 <sup>-7</sup> 30 min	<1x10 <sup>-8</sup> 10 min	<5x10 <sup>-9</sup> 10 min
Typical total uncertainty, for operating temperature 20°C to 26°C, at 2σ (95%) confidence interval: - 1 year after calibration - 2 years after calibration		<7x10 <sup>-6</sup> <1.2x10 <sup>-5</sup>	<2.4x10 <sup>-7</sup> <4.6x10 <sup>-7</sup>	<0.6x10 <sup>-7</sup> <1.2x10 <sup>-7</sup> <1.8x10 <sup>-8</sup> <3.5x10 <sup>-8</sup>

(1) After 1 month of continuous operation

**Max. Measurement Rate:**

**GPIB:** 5k readings/s (block mode)  
 500 readings/s (individual GET trig'ed)  
**To Internal Memory:** 250k readings/s  
**Internal Memory Size:**  
 Up to 750k readings.

**USB Interface**

**USB Version:** 2.0 Full speed (11 Mbits/s)

**Calibration**

**Mode:** Closed case, electronic calibration, menu controlled  
**Cal. Frequencies:** 0.1, 1, 5, 10, 1.544 and 2.048 MHz

**Option 23/90 Battery Unit**

**Battery Type:** Lilon, 90 Wh  
**External DC input:** 10 to 18 V dc; max 6A  
**Operating temp. range:** 0 to 40°C  
**Storage:** -20 to +60°C, 1 month  
 -20 to +45°C, 3 months  
 -20 to +20°C, 1 year  
**Battery operating time (at 25°C):**  
*ON:* >4.5 hours  
*Stand-by:* >24 hours  
**Charging:** Automatically when AC or ext DC is connected  
**Battery status indicator:**  
 On-screen with low battery warning  
**Weight:** 2.3 kgs

**General Specifications**

**Environmental Data**

**Class:** MIL-PRF-28800F, Class 3  
**Operating Temp:** 0°C to +50°C  
**Storage Temp:** -40°C to +71°C  
**Humidity:** 5%-95% (10°C to 30°C)  
 5%-75% (30°C to 40°C)  
 5%-45% (40°C to 50°C)  
**Altitude:** 4,600 meters  
**Vibration:** Random and sinusoidal according to MIL-PRF-28800F, Class 3  
**Shock:** Half-sine 30G per MIL-PRF-28800F; Bench handling

**Transit drop test:** Heavy-duty transport case and soft carrying case tested according to MIL-PRF-28800F

**Reliability:** MTBF 30,000 hours (calculated)  
**Safety:** EN 61010-1, pollution degree 2, meas cat I, CSA C22.2 No 1010-1, CE  
**EMC:** EN 61326 (1997); A1 (1998), increased test levels according to EN 50082-2, Group 1, Class B, CE

**Power Requirements**

**Max. configuration:** 90 to 265 Vrms, 45 to 440 Hz, <40 W, <60 W if battery option

**Dimensions and Weight**

**Width x Height x Depth:** 210 x 90 x 395 mm (8.25 x 3.6 x 15.6 in)  
**Weight:** Net 2.7 kg (5.8 lb), Shipping app. 3.5 kg (app. 7.5 lb)

**Ordering Information**

**Basic Model**

**CNT-90:** 400 MHz, 100 ps Timer/Counter including Standard Time Base  
*Included with Instrument:* 3 years 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:* 15 GHz Input C  
*Option 14B:* 20 GHz Input C

**Oscillator Options**

*Option 19/90:* Medium Stability Oven Time Base; 0.06 ppm/month  
*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 23/90:* Battery Unit  
*Option 27:* Carrying Case - soft  
*Option 27H:* Heavy-duty Hard Transport Case  
*Option 29/90:* TimeView Modulation domain Analysis SW 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 aging/week  
*Option 95/05:* Extended warranty from 3 to 5 years  
*OM-90:* Users Manual English (printed)  
*PM-90:* Programmers Manual English (printed)  
*SM-90:* Service Manual English  
*GS-90-EN:* Getting Started English  
*GS-90-FR:* Getting Started French  
*GS-90-DE:* Getting Started German