spectracom

CNT-91 & CNT-91R

Timer/Counter/Analyzer & Calibrator

pendulum

- **Continuous Data Streaming over the bus during, not after, measuring**
- **Zero-dead-time frequency/period measurements**
- **Fast GPIB/USB bus speed; 4k meas/sec in talker only mode 15k meas/sec in block mode**
- **High resolution 50 ps-time; 12 digits/sec-frequency**
- **Graphic display; numerical statistics, histogram, trend & modulation domain**
- **250k meas/sec to internal memory 3.75M stored measurement results**
- **Programmable Pulse Output from 0.5 Hz to 50 MHz**
- **Integrated Rubidium atomic clock (model CNT-91R)**

The Pendulum CNT-91 zero-dead-time counter features continuous data streaming of measurements over GPIB/USB during, not after, measuring; creating a dynamic measurement/analysis system, a first in the counter industry! The CNT-91 is a unique frequency analyzer, outperforming any universal timer/counter.

Highest Performance Ever

- High GPIB/USB bus speed reduces test time in ATE test systems. Individual measurements up to 4k meas/sec in talker only mode. Fast Block measurements with continuous data streaming.
- Zero-dead-time counting provides period/frequency back-to-back measurements and the correct calculation of Allan Deviation.
- High resolution is critical for R&D and production testing. 50 ps single shot (time) or 12 digits/sec. (frequency) resolution allows capturing very small time and frequency changes, displayed to14 digits.
- Modulation Domain Analysis (MDA). With TimeView™ SW, the CNT-91 becomes a high-performance MDA. Thanks to the high measurement speed (250k meas/sec.) and large memory depth (3.75M) of these, very fast frequency changes in real time can be captured.
- CNT-91's integrated programmable pulse output offers 0.5Hz to 50 MHz fast rise time signals as a reference frequency output,external pacing/trigger source, or general purpose pulse source.

Outstanding Measurement Tool

The CNT-91 timer/counter/analyzer outperforms every counter on the market, 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 53131/53132 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.

The high-performance CNT-91 is the only tool you need for time & frequency measurement, analysis, and calibration.

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CNT-91R Frequency Calibrator/Analyzer

The CNT-91R Frequency Calibrator/Analyzer is an all-inclusive high performance calibrator of frequency sources, that combines the high resolution measurements and advanced analysis of CNT-91, with a built-in ultra-stable Rubidium atomic reference clock. Its compact format, and its short warm-up time, makes the CNT-91R an ideal transportable one-box frequency calibrator/analyzer.

Excellent Graphical Presentation

One of the great features of the CNT-91 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.

CNT-91/91R vs CNT-90 selection chart

Feature	CNT-91/91R	CNT-90
Graphic display of trend, histogram, modulation domain	yes	yes
Frequency resolution	12 digits/sec	12 digits/sec
Time resolution (single shot)	50 ps	100 ps
Voltage resolution	1mV	2.5mV
Measurement speed to internal memory	250k meas/sec 3.75M results	250k meas/sec 750k results
Talker only output (GPIB/USB)	4k meas/sec	no
Individually triggered measurements	650/sec	500/sec
Block transfer speed	15k meas/sec	5k meas/sec
Freq, period, time, phase, volt, duty c, pulse w, rise time	yes	yes
Totalize, TIE	yes	no
Programmable pulse output	yes	no
Continuous measurements	yes	no
Timebase CNT-91	OCXO (opt)	OCXO (opt)
Timebase CNT-91R	Rubidium	OCXO (opt)

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 meas. are only available as auxiliary parameters.

Frequency A, B, C

Mode: Normal, back-to-back
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 meas time (normal)
11 digits in 1s meas time (back-to-back)
Aux. Parameter (A, B): 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, avg., back-to-back
Range:
Input A, B: 2.5 ns to 1000 sec. (single, avg.)
4µs to 1000 sec. (back-to-back)
Input C (option): 10 ns down to 330,
125, 70 or 50 ps
Resolution: 50 ps (single); 12 digits/s (avg)
Aux. Parameter (A, B): Vmax, Vmin, Vp-p

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

Range: (10^{-9}) to 10^{11}
Input Frequency: *Input A, B:* 0.1Hz to 400MHz
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:* 0ns to $+10^{6}$ sec.
Smart Calculation: -10^{6} sec. to $+10^{6}$ sec.
Resolution: 50 ps (single)
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^{6} 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^{6} sec.
Trigger Levels: 10% and 90% of signal Vp-p
Min. Pulse Width: 1.6 ns
Aux. Parameters: Slew rate, Vmax, Vmin

Time Interval Error (TIE) A, B

Normalized period back-to-back measurements, calculated as $TIE(k) = k \cdot T_{REF} - \Sigma T_i$, when
T_i = individual period back-to-back and
T_{REF} = reference period value

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)

Totalize A, B

Mode: Tot A, Tot B, Tot A+B, Tot A-B, Tot A/B
Range: 1 to 10^{10} counts
Freq range: up to 160 MHz
Start control: Manual, start arming
Stop control: Manual, stop arming, timed
Aux. Parameters: Other Tot functions

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: 1mV
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: 35 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:
1MΩ//20 pF or 50 Ω (VSWR ≤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: 35 mVrms
Attenuation: x1, x10
Dynamic Range (x1):
30 mV p-p to 10 V p-p within ±5V window
Trigger Level: Read-Out on display
Resolution: 1mV
Uncertainty (x1): ±(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 300MHz
Time: Min hysteresis window (hysteresis compensation)
Frequency: One third of input signal amplitude
Analog LP Filter: Nominal 100 kHz, RC-type.
Digital LP Filter:
1Hz to 50 MHz cut-off frequency
Max Voltage Without Damage:
1MΩ: 350 V (DC+AC pk) to 440 Hz, falling to 12 Vrms at 1MHz. *50Ω:* 12 Vrms
Connector: BNC

Input C (Option 10)

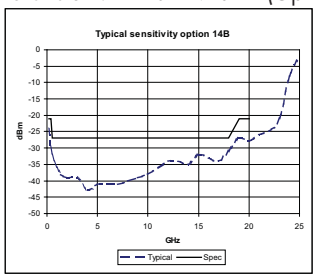
Operating Input Voltage Range:
100 to 300 MHz: 20 mVrms to 12 Vrms
0.3 to 2.5 GHz: 10 mVrms to 12 Vrms
2.5 to 2.7 GHz: 20 mVrms to 12 Vrms
2.7 to 3.0 GHz: 40 mVrms to 12 Vrms
Prescaler Factor: 16
Impedance: 50 Ω nominal, VSWR <2.5:1
Max Voltage without Damage:
12 Vrms, pin-diode protected
Connector: 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 Ω 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 Ω 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 ≥1kΩ
Reference Output:
10 MHz; >1Vrms sine into 50 Ω
Arming Input: Arming of all meas functions
Impedance: Approx. 1kΩ
Freq. Range: DC to 80 MHz
Pulse Output:
Programmable via front/GPIB/USB.
Mode: Pulse out, Gate open, Alarm out
Period: 20 ns – 2sec., in 10 ns increments
Pulse width: 10 ns – 2sec., in 10 ns increments
Output: TTL-levels in 50 Ω, rise time 2ns
Rear Panel Measurement Inputs:
A, B, C (opt. 11/90)
Impedance: 1MΩ//50 pF or 50 Ω (VSWR ≤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 10^9 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_0)

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, plus pulse output connector
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 1999, 53131A/53132A compatibility mode
Interface Functions:
SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, E2
Max. Measurement Rate:
GPIB: 15k readings/s (block mode)
4k readings/s (talker only mode)
650 readings/s (individual GET trig'ed)
To Internal Memory: 250k readings/s
Internal Memory Size: Up to 3.75M readings.

USB Interface

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

Calibration

Mode: Closed case, menu controlled
Calibration Frequencies:
0.1, 1, 5, 10, 1.544 and 2.048 MHz

General Specifications

Environmental Data

Class: MIL-PRF-28800F, Class 3
Operating Temp: 0°C to +50°C (CNT-91)
0°C to +45°C (CNT-91R)
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

Basic Version:
90 to 265 Vrms, 45 to 440 Hz, <40 W
CNT-91R: *Warm-up (12 minutes):*
90 to 265 Vrms, 45 to 440 Hz, <60 W
Operating: 90 to 265 Vrms, 45 to 440 Hz, <50 W

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-91: 400 MHz, 50 ps Timer/Counter including Standard Time Base
CNT-91R: 400 MHz, 50 ps Timer/Counter including Rubidium Time Base
Included with Instrument: 3 years product warranty, line cord, user documentation on CD, and Certificate of Calibration

Input Frequency Options

Option 10: 3GHz Input C
Option 13: 8GHz Input C
Option 14: 15 GHz Input C
Option 14B: 20 GHz Input C

Time Base Options (CNT-91 only)

Option 19/90: MediumStability 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 (replaces front panel inputs)
Option 22/90: Rack-Mount Kit
Option 27: Carrying Case - soft
Option 27H: Heavy-duty Hard Transport Case
Option 29/91: TimeView 3 Modulation Domain Analysis SW for CNT-91/CNT-91R
Option 90/01: Calibration Certificate with Protocol; Standard oscillator
Option 90/06: Calibration Certificate with Protocol; Oven oscillator
Option 90/07: (CNT-91R only) Calibration Certificate with Protocol; Rubidium 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

Time Base Options

Option model	STD	19/90	30/90	40/90	CNT-91R
Time base type:	Standard	OCXO	OCXO	OCXO	Rubidium
Uncertainty due to: - Aging: per 24h per month per year - Temperature variations: 0°C to 50°C 20°C to 26°C (typ. values)	 n/a <$5x10^{-7}$ <$5x10^{-6}$ <$1x10^{-5}$ <$3x10^{-6}$	 <$5x10^{-9}$ (1) <$6x10^{-8}$ <$2x10^{-7}$ <$5x10^{-8}$ <$2x10^{-8}$	 <$5x10^{-10}$ (1) <$1x10^{-8}$ <$5x10^{-8}$ <$5x10^{-9}$ <$1x10^{-9}$	 <$3x10^{-10}$ (1) <$3x10^{-9}$ <$1.5x10^{-8}$ <$2.5x10^{-9}$ <$4x10^{-10}$	 n/a <$5x10^{-11}$ (1) <$3x10^{-10}$ typ <$1x10^{-10}$ <$2x10^{-11}$
Short-term stability: τ =1s (root Allan Variance) τ =10 s	not specified	<$1x10^{-10}$ <$1x10^{-10}$	<$1x10^{-11}$ <$1x10^{-11}$	<$5x10^{-12}$ <$5x10^{-12}$	<$1x10^{-11}$ <$1x10^{-11}$
Power-on stability: - Deviation vs. final value after 24 h on time, after a warm-up time of:	n/a 30 min	<$1x10^{-7}$ 30 min	<$1x10^{-8}$ 10 min	<$5x10^{-9}$ 10 min	<$5x10^{-10}$ 12 min
Typical total uncertainty, for operating temp. 20°C to 26°C, at 2σ (95%) confidence interval: - 1 year after calibration - 2 years after calibration	 <$7x10^{-6}$ <$1.2x10^{-5}$	 <$2.4x10^{-7}$ <$4.6x10^{-7}$	 <$0.6x10^{-7}$ <$1.2x10^{-7}$	 <$1.8x10^{-8}$ <$3.5x10^{-8}$	 <$3.5x10^{-10}$ <$7x10^{-10}$

(1) After 1 month of continuous operation

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