

# CNT-104S

## Multi-channel Frequency Analyzer

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DATA SHEET

NEW PRODUCT

- Four channel 400 MHz Frequency Analyzer - plus optional RF-channel up to 24 GHz
- NEW measurement modes: 4 parallel counters in one box; Multi-stop Time Interval
- Gap-free zero-dead-time frequency/period measurements
- Ultra-high resolution: Time: <7 ps; Freq.: 12-13 digits/s
- Ultra-high meas. speed: up to 20M meas./s to internal memory
- Fast bus speed; 170k meas/s in block mode
- Graphic touch screen display for settings and display of values, statistics (numeric and distribution graph), trend & modulation domain
- Touch screen can be mouse controlled and/or controlled via web-server from anywhere in the world
- Intelligent and easy-to-use



The Pendulum CNT-104S is a revolutionary new concept for super-performance multi-channel frequency and time-interval analysis in a bench-top unit. You can track parallel frequency, phase or time simultaneously on 4 input channels on the large graphic screen. These instruments feature gap-free measurements, and have <7 ps resolution time resolution, up to 13 digits/s frequency resolution, and a measuring speed of 20M results/s. CNT-104S can replace and outperform any existing Timer/Counter/Analyzer on the market.

### Highest Performance for R&D and metrology

- The ultra-high single-shot resolution gives better insights in the design under test, faster results in phase comparisons between clocks, more accurate calibration, and allows capture of very small time/phase changes. Track and compare 4 parallel signals with 7 ps resolution/timestamp, at a speed of 50 ns between samples in each channel.
- Gap-free, zero-dead-time counting provides back-to-back measurements without losing any cycle, even for very long measurements.
- The CNT-104S is also a high-performance Modulation Domain Analyzer (MDA). Thanks to the high speed of up to 20M meas./s for 4 parallel signals, very fast frequency or phase/time changes can be captured in real time.
- CNT-104S has a unique 4-channel design, plus an optional RF input. All channels perform parallel, independent, and gap-free time-stamping of the input signal. This allows for new measurements that earlier required many instruments, like phase comparison of 4 atomic clocks, without the need for a switch. And Multi-stop Time-Interval measurements (1 start and 3 stop events) for time-of-flight measurements in physical research.

### Save money in production test

- The 4-channel design enables 4 parallel frequency measurements. One CNT-104S can replace 4 existing frequency counters in a test system at a lower cost/counter.
- Using the option 22/05 rackmount adapter, you will have 8 parallel frequency counters in a 19", 2U high rack space.
- Choose between Ethernet, WLAN\*, or USB\*\* as a communication interface to a PC/Laptop/Tablet, or to the test system controller.
- High bus speed reduces test time in ATE test systems. Perform fast block measurements up to 170k meas/s. Test time is reduced compared to existing solutions, and time is money.

\* Requires an external USB WiFi dongle

\*\* Later availability. USB full SW functionality will be available as future SW upgrades for early purchased units

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## Easy-to-understand Graphical Presentation

One of the great features of the CNT-104S is the graphic display with its menu oriented settings. The non-expert can easily make correct settings without risking costly mistakes.

Valuable signal information, given in multi-parameter displays, removes the need for other instruments like DVM's and Scopes for quick signal verification.

Measured values are presented as both numerics and graphics. The graphical presentation of results (distribution, trends etc.) gives a 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. The same data set can be viewed in Numerical, Statistics, Distribution and Time-line views. It is very easy to capture and toggle between views of the same data set.



View 4 signals simultaneously on screen. 4 instruments in one!

## Modulation Domain Analysis

The CNT-104S features built-in modulation domain analysis, displaying frequency changes vs. time, on one to four input channels.

Thanks to the high resolution, and the high measurement speed of down to 50 ns between individual samples in each channel, you can follow and verify for example:

- FM, FSK, BPSK, PWM, PPM and other time, phase or frequency modulation schemes
- Frequency sweep
- Frequency transients
- Frequency settling in oscillators, VCOs and PLLs
- Synthesizer switching
- Frequency instability, incl. jitter
- Frequency hopping agile communication



View fast FM, or any time/phase/frequency modulation, on screen, on one or more channels

## Full flexibility for remote control

The CNT-104S comes as standard with a Gbit Ethernet interface for remote control and data transfer.

Using a WiFi dongle in the front panel USB port, enables you to connect CNT-104S to your local wireless network.

A USB 2.0 communication interface is HW ready from start, with later full SW capabilities, via free future SW upgrade.

You can access and control the instrument from your lab bench, or from anywhere in the world, using the integrated web server interface function.

## Very flexible configuration

The CNT-104S can be configured as you like it to fit performance demands and/or budget.

- Add an optional extra channel C for RF frequency measurements. Choose either a 3, or 10 GHz basic HW (The 10 GHz channel is SW key upgradable to 15, 20, or 24 GHz)
- Choose between 3 timebase oscillator options; TCXO and 2x OCXO
- Add an optional 0.5 Hz to 100 MHz pulse generator (SW license key)
- Add optional TIE measurement function (SW license key)

## Outstanding ease-of-use

The big color touch screen with its intuitive menus, lets you make your settings via a simple finger touch. Alternatively you can connect a wireless mouse to the front USB host port, and make your settings via mouse clicks on screen instead. Or you can use the web-server interface to control CNT-100 from a large PC-screen.

The intelligent AUTO SET will help you to make best settings for each measurement function.

You do not even need to be close to your instrument. The web server functionality lets you connect to the CNT-100 over Ethernet, view the front panel, and control the measurements and read results via a few mouse clicks.

When adjusting a frequency source to given limits, the graphic display gives fast and accurate visual calibration guidance.

You can pan and zoom in graphs to view individual samples with cursor read-outs.

Any measured signal can be smoothed, to reveal underlying trends in the presence of excessive noise.

The NEW CNT-104S Multi-channel Frequency Analyzer outperforms every existing benchtop frequency counter and time interval analyzer on the market, independent of measurement task.

**The super-high-performance CNT-104S is the optimal tool you need for time & frequency measurement, analysis, and calibration.**

## Measuring Functions

### Display modes

**Values/Statistics:** Numeric display of Measurement values or Statistics parameters with large digits. Values mode also display auxiliary parameter values (with less resolution).

**Time-line/Distribution:** All measurements are displayed graphically. Multi-channel graphs are color-coded. Statistics values are also displayed beneath the graphs.

### Resolution

Measure up to 4 input signals in parallel with 7 ps resolution per timestamp (Period single, Time Interval, Pulse width, Rise/Fall time, Duty cycle, TIE), or 12 digits/s (frequency and period average).

### Smart Frequency/Period avg. calculation mode

Basic resolution for frequency and period average is 12 digits in 1s measuring time. Statistics resolution enhancement algorithm (*smart mode*) gives up to one extra result digit depending on input signal and measurement setting.

### Frequency A, B, D, E

**Mode:** *Parallel measurements* on up to 4 inputs.

Back-to-back, with or without smart calculation

**Range:** 0.001 Hz to 400 MHz

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

### Frequency C (option)

**Mode:** Back-to-back, with or without smart calculation

**Range:** See input C

**Aux. Parameter:** Period C

### Frequency Ratio (A,B,C,D, or E) / (A,B,C,D, or E)

**Mode:** *Parallel measurements* on 2 or 4 inputs.

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

**Input Frequency:** See input A,B,D,E and C

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

### Period A, B, C, D, E average

**Mode:** *Parallel measurements* on up to 4 inputs.

Back-to-back, with or without smart calculation

**Range:** See (Frequency specifications)<sup>1</sup>

**Aux. Parameter:**

- Ch. A, B, D, E: Vmax, Vmin, Vp-p
- Ch. C: Frequency C

### TIE A, B, C, D, E (Option 151)

**Mode:** *Parallel measurements* on up to 4 inputs.

Back-to-back. Displayed value is:

**Accumulated period - Expected accumulated period**

**Freq range:** See Frequency specifications

**Aux. Parameter:** Ref Frequency, MTIE

### Period A, B, D or E single

**Mode:** *Parallel measurements* on 1 or 2 inputs.

**Range Input A, B:** 2.5 ns to 1000 sec.

**Aux. Parameter (A, B):** Vmax, Vmin, Vp-p

### Time Interval A, B, D, E (single or continuous)

**Mode:** *Parallel timestamping* of trigger events on up to 4 inputs on continuous or single-shot signals.

**Start and stop channel(s):** any of A, B, D, E

**Note:** each input can produce 1 or 2 trigger events with individual trigger level and slope

**Accumulated Time Interval:** ON or OFF (adding or subtracting one start channel period to the Time Interval, when required)

**Range:** -1000s to +1000s

**Min. Pulse width:** 1.5 ns

**Channel-to-channel offset:** <50ps after calibration

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

**Mode:** *Parallel measurements* on 1 or 2 inputs.

**Range:** 1.5 ns to 1000 sec.

**Repetition rate:** up to 300 MHz or single-shot events

**Resolution:** <10 ps per calculated result

### Rise / Fall Time A, B, D, E

**Mode:** *Parallel measurements* on 1 or 2 inputs of

Rise OR Fall time, or

**Mode 2:** *Single* input measurement of Rise AND Fall time on the same pulse.

**Range:** 1.5 ns to 1000 sec.

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

### Positive and negative Slew Rate A, B, D, E

**Mode:** *Parallel measurements* on 1 or 2 inputs

**Calculation:** (Rise or Fall Time)/(80% of Vp-p)

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

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

**Mode:** *Single* input measurement

**Range:** 0.000001 to 0.999999

**Repetition rate:** up to 300 MHz or single-shot events

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

### Phase A Relative B, B Relative A

**Mode:** Intended for phase shift or delay measurements of two signals with identical frequency

**Accumulated Phase:** OFF or ON (adding or subtracting 360° to the Phase, when required)

**Range:** -180° to +180° (Acc. Phase is OFF)

**Resolution:** 0.00003° to 100 kHz, decreasing to 0.03° >100 MHz. (10k sample statistics averaging)

**Freq. Range:** up to 300 MHz

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

### Totalize A, B, D, E

**Inputs:** 1 or any 2 of inputs A, B, D, or E

**Mode:** Tot Ch1, Tot Ch2, Tot Ch1+Ch2, Tot Ch1-Ch2, Tot Ch1/Ch2

**Range:** 1 to 10<sup>10</sup> counts

**Freq range:** up to 300 MHz

**Start control:** Manual, start arming

**Stop control:** Manual, stop arming, timed

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

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

**Freq. Range:** DC, 1Hz to 200 MHz

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

**Resolution:** 1 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 200 MHz: 30% +15 mV

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

## Input Specifications

### Inputs A, B, D and E

**Frequency Range:**

- DC-Coupled: DC to 400 MHz
- AC-Coupled: 10 Hz to 400 MHz

**Impedance:** 1MΩ // 40 pF or 50 Ω (VSWR ≤2:1 typ.)

**Trigger Slope:** Positive or negative

**Channel-channel skew:** <50 ps (after calibration)

**Sensitivity (typical):**

- DC-400 MHz: <35 mVrms (PreAmp =OFF)
- DC-100 MHz: 15 mVrms (PreAmp = ON)
- 100-200 MHz: 25 mVrms (PreAmp = ON)
- 200-400 MHz: 35 mVrms (PreAmp = ON)

**Attenuation:** x1, x10

**Dynamic Range (x1):**

PreAmp = OFF: 0.04 to 10 Vp-p within ±5V window

PreAmp = ON: 0.01 to 2 V p-p within ±1V window

**Trigger Level:** Read-out in menu

- Resolution: 1mV
- Uncertainty (x1): ±(15 mV + 1% of trigger level)
- AUTO Trigger Level set to 50% point of input signal (10% and 90% for Rise/Fall Time)

**Auto sensitivity (frequency, period average, TIE only) - hysteresis window setting peak-peak:**

- one third of input signal amplitude

**Analog LP Filter:** Nominal 10 or 100kHz selectable.

**Max Voltage Without Damage:**

- 1MΩ: 350 V (DC + AC pk) to 440 Hz, falling to 12 Vrms at 1MHz.
- 50 Ω: 12 Vrms

**Connector:** BNC

### Input C (Option 10)

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

- 100 to 300 MHz: -21 dBm to +35 dBm
- 0.3 to 2.5 GHz: -27 dBm to +35 dBm
- 2.5 to 2.7 GHz: -21 dBm to +35 dBm
- 2.7 to 3.0 GHz: -15 dBm to +35 dBm

**Prescaler Factor:** 16

**Impedance:** 50 Ω nominal, VSWR <2.5:1 typ.

**Max Voltage without Damage:** +35 dBm

**Connector:** Type N Female

### Input C (Option 110)

**Freq. Range:** 0.1 to 24 GHz; SW license enabled to 10, 15, 20 or 24 GHz

**Operating input voltage range:**

- 150 to 300 MHz: -15 to +27 dBm
- 300 to 500 MHz: -21 to +27 dBm
- 0.5 to 7.5 GHz: -27 to +27 dBm
- 7.5 to 20 GHz: -24 to +27 dBm
- 20 to 22 GHz: -21 to +27 dBm
- 22 to 24 GHz: -15 to +27 dBm

**Prescaler Factor:** 64

**Impedance:** 50 Ω nominal, VSWR <2.0:1 typ.

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

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

**Connector:** 2.92 mm, SMA compatible Female

## Rear Panel Inputs and Outputs

### Reference Input

**Frequency:** 1, 5, or 10 MHz; 0.1 to 5Vrms sine

**Impedance:** 50Ω (nom.)

### Reference Output

**Frequency:** 10 MHz

**Output impedance:** 50 Ω

**Amplitude:** 1Vrms sine into 50 Ω (nom.)

### Arming Input

Arming of all measuring functions

- Impedance: Approx. 1kΩ
- Freq. Range: DC to 240 MHz
- Trigger level: approx. 1.5V fixed
- Trigger slope: Pos. or neg. selectable

### Programmable Pulse Output (Option 132)

**Pulse mode:** Pulse generator, Gate open, Alarm

**Period range:** 10ns-2s in 2ns steps

**Pulse width range:** 6ns-2s in 2ns steps

**Rise time:** 2.5 ns (nom.)

**Output impedance:** 50 Ω (nom.)

**Output level:** 5V HCMOS in open output

## Auxiliary Functions

### Trigger Hold-Off

**Time Delay Range:** 20 ns to 2 s in 10 ns steps

### External Start and Stop Arming

#### Modes:

- Start Arming
- Stop Arming
- Ext. Gate (combined Start and Stop Arming)

**Arming channels:** A, B, D, E or rear panel ARM

**Arming delay to first trigger ready:** <5 ns (typ.)

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

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

### Statistics

**Functions:** Maximum, Minimum, Mean,  $\Delta$ max-min, Standard Deviation and Allan Deviation

**Display:** Numeric or frequency distribution graph

**Sample Size:** 2 to  $16 \times 10^6$  samples

**Max. sample rate:**

- up to 140 kSa/s calculated
- up to 20 MSa/s captured

### Limit alarm

Graphical indication of limits with Pass/Fail message on front panel,

**Limit Qualifier:** OFF or Capture values above, below, inside or outside limits

### Sample Interval (Gate time)

The Sample Interval sets the measuring time (gate) in Freq./Period modes, the timing gate in Tot timed measurements, and the time between measurements/samples in all other modes

**Range:** OFF or 50 ns to 1000 sec.

### Mathematics

**Functions:** OFF, (K\*X-L)/M, (K/X-L)/M, X/M-1

X is current reading, and K (Scale factor), L (Nulling value) and M (Reference value) are constants

### Other Functions

**Timebase Reference:** Internal, External or Auto-selected

**Restart:** Aborts current measurement and starts a new

**Run/Hold:** Switch between RUN (continuous measurements) and HOLD (Freezes result, until a new measurement is initiated via Restart)

### Save and Recall Settings and Measurements

**Stored Instrument Set-ups:** 20 instrument setups can be saved/recalled. 10 can be user protected.

## Time Base Options

Option model	STD	30	40
Time base type:	TCXO	OCXO	OCXO
Uncertainty due to:			
-Aging per 24h per month per year	n/a	<5x10 <sup>-10</sup> (1) <1x10 <sup>-8</sup> <5x10 <sup>-8</sup>	<3x10 <sup>-10</sup> (1) <3x10 <sup>-9</sup> <1.5x10 <sup>-8</sup>
-Temperature variations: 0°C to 50°C 20°C to 26°C (typ. values)	<5x10 <sup>-7</sup> not specified	<5x10 <sup>-9</sup> <1x10 <sup>-9</sup>	<2.5x10 <sup>-9</sup> <4x10 <sup>-10</sup>
Short-term stability: $\tau = 1s$ (root Allan Variance) $\tau = 10s$	<1x10 <sup>-9</sup> (typ.)	<1x10 <sup>-11</sup> <1x10 <sup>-11</sup>	<5x10 <sup>-12</sup> <5x10 <sup>-12</sup>
Power-on stability: Deviation vs. final value after 24 h on time, after a warm-up time of:	<1x10 <sup>-6</sup> 5 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 2 $\sigma$ (95%) confidence interval: -1 year after calibration -2 years after calibration	<1.2x10 <sup>-6</sup> <2.4x10 <sup>-6</sup>	<6x10 <sup>-8</sup> <1.2x10 <sup>-7</sup>	<1.8x10 <sup>-8</sup> <3.5x10 <sup>-8</sup>

<sup>1</sup>After 1 month of continuous operation

**Result Storage:** Measurements can be stored in local memory, on USB stick, or connected PC.

**Max. Measurement Speed and Storage size:**

20 MSa/s (1 to 4 inputs): 16k samples

12.5 to 3.125 MSa/s (1 to 4 inputs): 32M samples

### Display

**Display:** Graphic screen for menu control, numerical read-out, status information, plus distribution, trend and time-line graphs

**Resolution:** 1280x720 pixels

**Type:** Color Touch 5" TFT LCD display with backlight

**Front panel accessible tools:** Graph smoothing, pan and zoom, cursor read-out

## Remote interfaces

### Remote operation

**Programmable Functions:** All front panel accessible functions

**Max. measurement rate (depending on measurement settings):**

**Block mode:** up to 170k readings/s

**Individual results:** up to 170 readings/s

**To Internal Memory:** 20M readings/s

**Data Output format:** ASCII, IEEE double precision floating point, or packed

### USB interface

**USB version:** 2.0

**Connectors:**

**Rear panel:** 1x Type B; (Device) used for remote communication and data transfer both ways

**Front panel:** 2x Type A; (Host) used for FW updates, mouse/keyboard connect<sup>o</sup> on, external result storage

**Protocol:** USBTMC-USB488

### LAN interface

**Speed:** 10/100/1000 Mbps

**Capabilities:**

-Web server

-SCPI over HiSLIP protocol, compatibility with VISA

## Calibration of Timebase Oscillator

**Mode:** Closed case, electronic calibration, menu controlled. Calibration menu is password protected

**Ref. Cal. Frequencies:** 1, 5, 10, 1.544 or 2.048 MHz

## General Specifications

### Environmental Data

**Class:** MIL-PRF-28800F, Class 3

**Installation category:** II

**Operating Temp:** 0°C to +50°C bench-top,  
0°C to +40°C rack-mount

**Storage Temp:** -40°C to +71°C

**Vibration:** Random and sinusoidal according to MIL-PRF-28800F, Class 3

**Shock:** Half-sine 30G per MIL-PRF-28800F; Bench handling

**Transit drop test:** According to MIL-PRF-28800F

**Safety:** EN 61010-1:2011, pollution degree 2, installation/over voltage category II, measurement category I, CE, indoor use only  
CSA C22.2 No 61010-1-12

**EMC:** EN 61326-1:2013-06, increased test levels according to EN 61000-6-2:2008, Group 1, Class B, CE

### Power Requirements

**Max. Version:** 90 to 265 Vrms, 47 to 63 Hz, <70 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 3 kg (6.6 lb)

## Ordering Information

### Basic model

**CNT-104S:** 4-channel 400 MHz Frequency Analyzer, 7 ps resolution, std. TCXO timebase 1x10<sup>-6</sup>/year

### Input C Frequency Options

Option 10: 3 GHz Input C

Option 110: 10 GHz Input C (HW)

Option 110/15: SW upgrade from 10 to 15 GHz

Option 110/20: SW upgrade from 15 to 20 GHz

Option 110/24: SW upgrade from 20 to 24 GHz

### Timebase Oscillator Options

Option 30: Very High Stability, OCXO 5x10<sup>-8</sup>/year

Option 40: Ultra High Stability, OCXO 1.5x10<sup>-8</sup>/year

### Other options (SW license enabled)

Option 132: Programmable pulse output

Option 151: TIE measurement function

### Included with Instrument:

- 2 year product warranty<sup>1</sup>
- Line cord (*dependent on destination country*)
- Link to User documentation (PDF)
- Certificate of Calibration
- Important information document

<sup>1</sup>Warranty period may be extended to 3 years, at no cost, by registering the product

### Optional Accessories

- **Option 22/90:** Rack-Mount Kit- 1 unit
- **Option 22/05:** Rack-Mount Kit -2 units
- **Option 27:** Carrying Case - soft
- **Option 27H:** Heavy-duty Hard Transport Case
- **Option 90/03:** Calibration Certificate with Protocol; Standard TCXO oscillator
- **Option 90/06:** Calibration Certificate with Protocol; Oven oscillator
- **Option 95/05:** Extended warranty 2 extra years
- **OM-100:** User's Manual English (printed)<sup>2</sup>
- **PM-100:** Programmer's Manual English (printed)<sup>2</sup>
- **SM-100:** Service Manual English
- **GS-100-EN:** Getting Started English (printed)<sup>2</sup>

<sup>2</sup>Always available as download from the Pendulum website