CNT-81 & CNT-81R

Timer/Counter/Calibrators

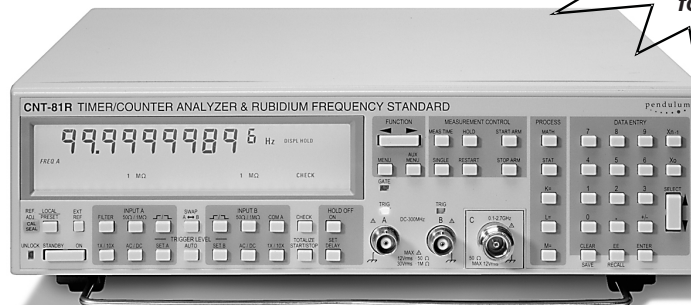**NOW with 8 GHz option and TimeView for Windows**

Ultimate Time & Frequency calibration & analysis

- Fast: 8000 measurements/s

- High resolution: 1ps (time) 11 digits/s (freq.), 0.001° (phase)

- Rubidium stability: 0.0001 ppm

- High trigger resolution: 1.25 mV

- Advanced arming/hold-off

- Modulation Domain Analysis SW

- EMC-immunity for noisy environments

- Ideal for fast test systems, R&D and calibration laboratoires

- 8 GHz option for microwave IRF testing

With the CNT-81 series of counters and analyzers, Pendulum now offers the ultimate tools 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 (portable calibration). The series comprises 2 models; the ultra-high performance CNT-81 and the ultimate CNT-81R including a built-in Rubidium time-base reference.

Frequency calibration

The CNT-81 and CNT-81R can directly calibrate any application specific frequency up to 8 GHz. They are ideal for calibrating e.g. the timebase oscillator of other instruments, like frequency counters and synthesisers. The Rubidium timebase of CNT-81R allows frequency calibration of even the highest possible specified oven oscillators. For a total uncertainty of 10^{-10}, just connect the unknown frequency to the counters input and wait for a second.

Each individual 1s-measurement has a 5×10^{-11} resolution. The built-in statistics averaging improves resolution further, and the std dev indicator gives added information about the stability of the unknown frequency.

Time Interval calibration

For the calibration of time-intervals the CNT-81 provides leading performance due to the fast 50 ps single shot time resolution (1 ps averaged) and the high trigger level resolution of 1.25 mV.

The systematic start-stop channel difference is only 500 ps, which can be further reduced by calibrating the input channel difference.

Phase calibration

With CNT-81 you can measure phase differences on signals of up to 160 MHz with a resolution better than 0.01° (below 30

Selection Chart	CNT-81	CNT-81R
Frequency, burst, time interval, phase, Vp-p	●	●
Frequency range (standard)	300 MHz	300 MHz
Frequency resolution (1s gate time)	11 digits	11 digits
Time interval resolution (single/average)	50/1 ps	50/1 ps
Vp-p (and trigger level) resolution	1.25 mV	1.25 mV
Arming/Hold-off delay by time and events	●	●
Hold-off resolution	10 ns	10 ns
Best timebase stability/month	3×10^{-9}	5×10^{-11}
No. of 10 MHz +5 MHz reference outputs	1+0	6+1
Measurement speed: GPIB	250/s	250/s
to internal memory	8 k/s	8 k/s
Statistics calc.: mean, std, dev. and max/min	●	●
TimeView Documenting and Analysis SW	●	●
2.7 GHz HF-input	Option 10	Option 10
8 GHz RF-input	Option 13	Option 13

MHz). This gives you outstanding resolution in measurements like laser positioning and calibration of phase meters. Calibration procedures exist that provide outstanding accuracy, with an uncertainty below 0.1°.

Ideal for fast test systems

In manufacturing test systems two things are important; EMC-immunity and speed. CNT-81 offers excellent EMC-shielding and the highest throughput for any commercially available counter. The speed is impressive 8000/s to internal memory, and 250/s for individually triggered measurements via

GPIB. Up to 20 complex measurement set-ups can be locally stored in the counter's non-volatile set-up memory and instantly recalled via a short bus command. This enables new measurement tasks to be executed one after the other at a very-high rate. A complete cycle "setup-measure-transfer" takes less than 8 ms.

The two counters comply of course to SCPI, which facilitates easy updating of new test hardware without the penalty of time-consuming SW-rewriting.

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Modulation Domain Analysis

The analysis PC-SW *TimeView* converts the CNT-81/CNT-81R to a high performance modulation domain analyzer. In the modulation domain you can view rapid frequency changes vs. time, e.g. modulation, sweep, freqiency setting, channel hopping etc.

The 16-bit DOS program is standardly included with all CNT-81/81R.

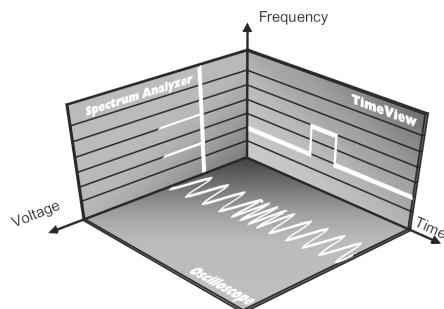The 32-bit Windows program is an optional accessory (option 29).

Figure 1: The modulation domain (f vs. t) complements the time (V vs. t) and the frequency (V vs. f) domains
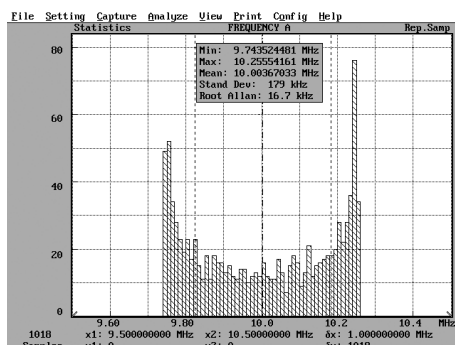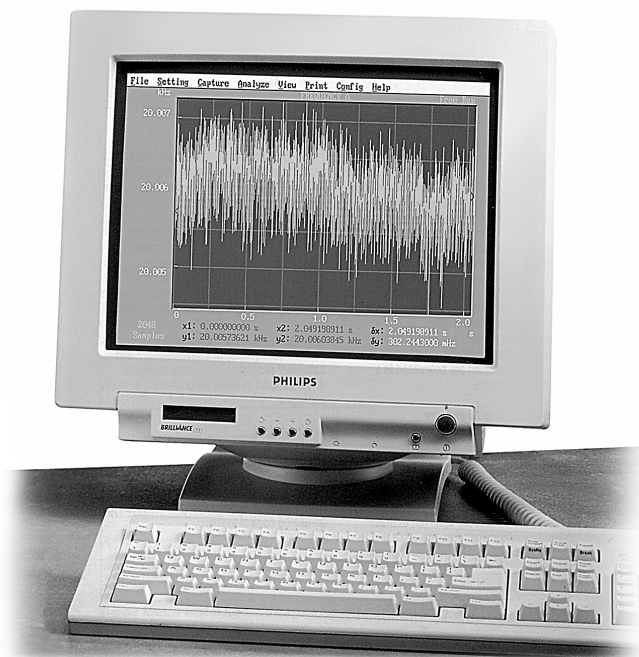

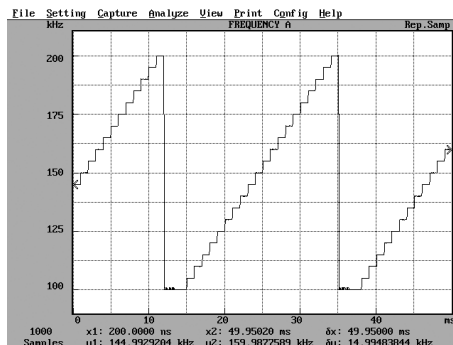*Figure 2: Jitter (rms and peak-peak) and noise is quantified in distribution histograms.*

Figure 4: Linearity of frequency sweep can be verified in the modulation domain (frequency vs. time).

Figure 6: The 9 different pulse width clusters, corresponding to the 9 different pit lenghts (T3-T11) in a CD-recording.
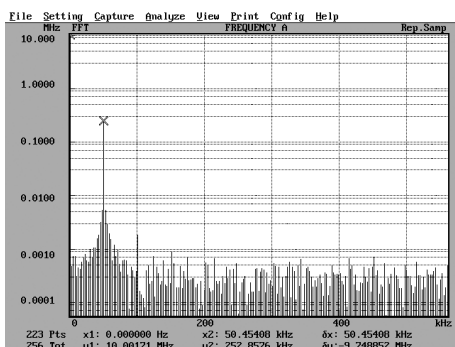

Figure 3: The FFT-diagram reveals the modulation frequency, whether intended or unwanted.
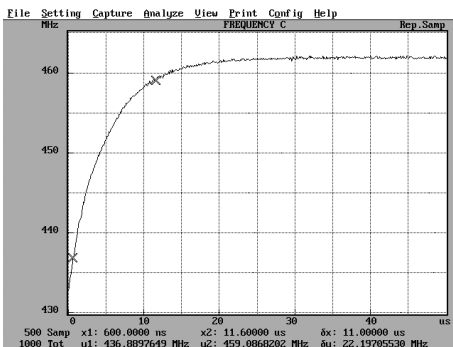

Figure 5: Repetitive samplings gives an effective sampling rate of 10 Msa/s. This VCO has a frequency switching time of approx. 10.7 us.
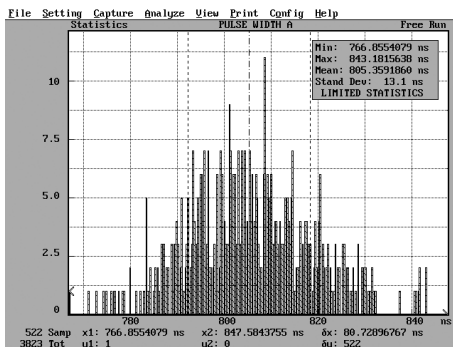

Figure 7: Zoom in on T3-cluster displays an rms-jitter of 13 ns, which is OK for an audio CD.

CNT-81 & CNT-81R Specifications

Measuring Modes

Inputs A and B can be swapped internally in all modes except Rise and Fall Time.

Frequency A, B, C

Range:

Input A:	up to 300 MHz
Input B:	up to 100 MHz
Input C (option):	100 MHZ to 2,7 GHz (option 20)
Input C (option):	300 MHz to 8 GHz (option 13)
Resolution:	11 digits in 1s measuring time

Frequency Burst A, B, C

Frequency and PRF of burst signals down to 1µs (CH. A and B) or 50 µs (Ch. C) can be measured without external control signals.

Period A

Range:	3.3 ns to 10^{10}s
Resolution:	11 digits in 1s measuring time

Frequency Ratio A/B, C/B

Range:	10^{-9} to 10^{15}

Time Interval A to B

Range:	0 ns to 10^{10} s
Resolution:	
Single shot:	50 ps (1 ps average)

Pulse Width A

Range:	3 ns to 10^{10} s

Rise and Fall Time A

Range:	3 ns to 10^{10}s

Phase A Relative B

Range:	-180 to +360°
Resolution:	0,01°

Duty Factor:

Range:	0.000001 to 1.000000

Totalize A, B

Range:	0 to 10^{17}, 0 to 10^{10} in A-B modes
Modes:	A Gated by B
	A Start/Stop by B
	Manual gating A minus B
	Time gating A minus B

V max, V min, Vp-p A, B

Range:	-50V to + 50V
Frequency Range:	up to 100 MHz
Resolution:	1.25 mV

Inputs and Outputs

Inputs A and B

Coupling:	AC or DC
Impedance:	1MΩ/15pF or 50Ω/(VSWR$\leq$2:1)
Max. channel timing difference:	500 ps
Max. sensitivity:	20 mV rms, <100 MHz
Attenuation:	x1or x10
Var. hysteresis A:	30 mVp-p to 10Vp-p hup to 120 MHz
Triggerpegel:	read-out on display
Range:	(x1):-5V to +5V
	(x10): -50V to +50V
Resolution (x1):	1.25 mV
AUTO-Trigger Level:	Trigger level is automatically set to 50% point of input signal (10% and 90% for Rise/Fall Time, 75% and 25% for variable hysteresis A)
Min. Frequency:	Settable from 1 Hz and upwards. Default=100 Hz
Low Pass Filter A:	100 kHz
Digital LP Filter:	1 Hz to 10 MHz using trigger Hold-Off

Input C (Option 20)

Frequency Range:	100 MHz to 2.7 GHz
Operating Input Voltage Range:	
0.1 to 0.3 GHz:	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
Impedance:	50Ω nominal, (VSWR<2.5:1)
Max Voltage Without Damage:	12V rms during 60s, PIN-diode protected
Connector:	N-type, female

Input C (Option 13)

Operating input voltage range:	
0.3 to 0.5 GHz	-21 to +30 dBm (20 mV rms to 7V rms)
0.5 to 3.0 GHz	-27 to +30 dBm (10 mV rms to 7V rms)
3.0 to 4.5 GHz	-21 to +30 dBm (20 mV rms to 7V rms)
4.5 to 6.0 GHz	-15 to +30 dBm (40 mV rms to 7V rms)
6.0 to 8.0 GHz	- 9 to +30 dBm (80 mV rms to 7V rms)
Impedance:	50Ω nom, VSWR<2:1
Connector:	N-type, female

Rear Panel Inputs and Outputs

Reference input:	1, 2, 5 or 10 MHz>200mV rms
Reference output:	
CNT-81:	1x10 MHz>0.5V rms sinewave into 50Ω load
CNT-81R:	6x10 MHz; 1x5 MHz>0.6V rms sinewave into 50Ω load
Arming input:	Most mesuring functions can be performed using arming
Gate output:	Gate open/gate closed signal
Trigger Level outputs:	Outputs for channel A and B trigger levels
Probe Comp. outputs:	Outputs for channel A and B to adjust for best pulse response when using probes for counter inputs
Analog output:	0 to 4.98V in 20 mV steps; proportional to 3 selected display digits

Auxiliary Functions

Trigger Hold Off

Time Delay Range:	60 ns to 1.34s, 10 ns resolution
Event Delay Range B:	2 to 2^{24}-1, max. 100 MHz

External Arming

Time Delay Range B, E:	200 ns to 1.6s, 100 ns resolution
Event Delay Range B:	2 to 2^{24}-1, max. 20 MHz

Statistics

Functions:	Maximum, Minimum, Mean and Standard Deviation
Sample Size:	1 to 2×10^{-9} samples

Mathematics

Functions:	(K*X+L)/M and (K/X+L)/M, X is urrent reading and
	K, L and M are constants; set via keyboard or as frozen reference value (X_o) or as value from preceding measurement (X_{n-1}).

Other Functions

Measure Time:	Single cycle, 80, 160, 320, 640, 1280 ns and 20 µs to 20s (to 400s for some functions)
Display Hold:	Freezes measuring result, until a new measurement is initiated via Restart.
Set-ups:	20 instrument setups can be saved and recalled from internal non-volatile memory. 10 can be user protected.
Display:	10-digit LCD with high-luminance back-light

CNT-81 & CNT-81R Specifications

GPIB Interface

Max Measurement Rate*
Via GPIB:	250 readings/s
To Internal Memory:	8k readings/s
Time Stamping:	125 ns resolution
Back-to-back-Period:	Up to 40k readings/s
	(100 ns resolution)
Internal Memory Size*:	Up to 6100 readings
Data Output:	ASCII, IEEE double precision floating point

TimeView™ Time & Frequency Analyse Software

TimeView is supported on both CNT-81 and CNT-81R models.

Versions:
DOS-version:	Standardly supported
Windows (32 bit) version:	Optional accessory (option 29)

Data capture modes and Measurement Rate*
Free-run sampling:	8k readings/s
Repetitive Sampling:	Up to 10 MSa/s
Back-to-back-Period:	Up to 40k readings/s
Waveform Capture:	Yes (vertical sampling)
Instrument control:	All front panel functions and some AUX MENU functions
Data Analysis:	Measurement data vs time
	FFT Graph
	Root Allan Variance
	Smoothing function
	Zoom function
	Cursor measurements
	Distribution Histogram
File Storage:	Setup and Measurement data

* Depending on measurement function and internal data format.

Time Base Options

Model:	CNT-81	CNT-81	CNT-81	CNT-81R
Option: Stability:	Standard UCXO	Option 30 OCXO	Option 40 OXCO	- Rubidium
Ageing:				
per month	$<5\times10^{-7}$	$<1\times10^{-8}$	$<3\times10^{-9}$	$<5\times10^{-11}$*
per year	$<5\times10^{-6}$	$<7.5\times10^{-8}$	$<2\times10^{-8}$	$<2\times10^{-10}$
per 10 years	n.s.	n.s.	n.s.	$<1\times10^{-9}$
vs. temp:				
0°C-50°C	$<1\times10^{-5}$	$<5\times10^{-9}$	$<2.5\times10^{-9}$	$<3\times10^{-10}$
20°C-26°C (typ.)	$<3\times10^{-6}$	$<6\times10^{-10}$	$<4\times10^{-10}$	$<2\times10^{-11}$
Short term:				
τ=1s(Allan Dev.)	n.s	1×10^{-11}	5×10^{-12}	5×10^{-11}
Warm-up stability: *after warm-up time of:*	n.s. 30 min.	$<1\times10^{-8}$ 10 min.	$<5\times10^{-9}$ 10 min.	$<4\times10^{-10}$ 10 min.
Total uncertainty (2σ): (20°C -26°C)				
1 year after calibration	$<7\times10^{-6}$	$<1\times10^{-7}$	$<2.5\times10^{-8}$	$<2.5\times10^{-10}$
2 years after calibration	$<1.2\times10^{-5}$	$<2\times10^{-7}$	$<5\times10^{-8}$	$<5\times10^{-10}$

* After 1 month of continuous operation.

General Specifications

Environmental Data
Operating Temp:	0°C to 50°C
Storage Temp:	-40°C to 70°C
Safety:	CSA 22.2 Nr. 231, EN 61010-1, Cat. II pollution degree 2, CE
EMC:	EN 5501 1 ISM Group 1, Class B; EN 50082-2; FCC Part 15J Class A, CE

Power Line Requirements (at 25°C)
AC voltage:
CNT-81:	90 to 265V rms, 45 to 440 Hz
CNT-81R:	90 to 265V rms, 45 to 440 Hz

Power rating:
CNT-81:	Max. 35W
CNT-81R:	Max. 100W (6 min. warm-up);
	Max. 47W (cont. operation)

Mechanical Data
WxHxD:	315x86x395 mm (12.4x3.4x15.6 in)

Weight:
CNT-81:	Net 4 kg (8.5 lb)
	Shipping 7 kg (15 lb)
CNT-81R:	Net 4.8 kg (10.5 lb)
	Shipping 7.8 kg (16.8 lb)

Ordering Information

Basic models
CNT-81	Timer/Counter/Analyzer 300 MHz/50 ps, incl. Standard timebase (5×10^{-7}/Month) and Time&Frequency Software TimeView for DOS
CNT-81R	Timer/Counter/Calibrator 300 MHz/50 ps, incl. Rubidium timebase (5×10^{-11}/Month) and Time&Frequency Software TimeView for DOS
Included with Instrument	Power line cord
	Users documentation on CD-rom
	Certificate of Calibration

RF Input Frequency Options (CNT-81/81R)*
Option 13:	8.0 GHz Input C (CNT-81/81R)
Option 20:	2.7 GHz Input C (CNT-81/81R)

Time Base Options (CNT-81)*
Option 30:	Very-high stability Oven Time Base (1×10^{-8}/Monat)
Option 40:	Ultra-high stability Oven Time Base (5×10^{-9}/Monat)

Optional accessories*
Option 11:	Rear Panel Inputs
Option 22:	Rack-Mount Kit
Option 27:	Carrying Case
Option 27H:	Heavy Duty Hard Transport Case
Option 29:	TimeView for Windows 98/2000/XP/NT
OM-81:	Operators Manual (printed) for CNT-81/81R
PM-81:	Programmers Manual (printed) for CNT-81/81R
SM-81:	Service Manual (printed) for CNT-81/81R
NI 778416-01:	GPIB-USB interface from National Instruments
NI 778034-0:	PCMCIA-GPIB interface from National Instruments
NI 778209-0:	GPIB-ENET interface from National Instruments
NI 763061-01:	GPIB cable type X2 (1m) from National Instruments

Specifications subject to change without notice

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