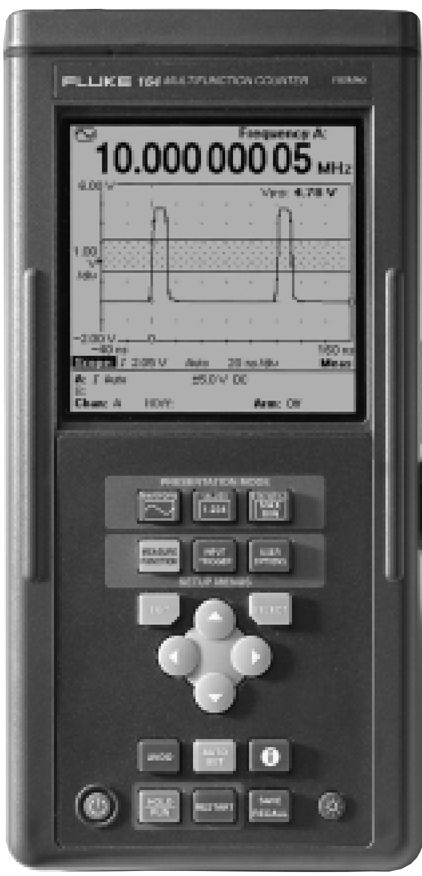
FLUKE®

Fluke 164

2.7 GHz MultiFunction Counter

Technical Data



View, Measure and Analyze with confidence

Fluke's new MultiFunction Counter is more than just a high accuracy top-performance counter; it adds a wideband DVM and displays waveform information like an oscilloscope. Three different presentation modes let you VIEW, MEASURE and ANALYZE your signal. These presentation modes supply measuring data, as seen from different perspectives, giving more insight and confidence.

- **In the WAVEFORM Mode, the bright LCD display shows the input signal and trigger level, so you can see that what you are measuring is correct. At the same time you can read off the measurement which is displayed at up to 10 digits resolution.**
- **The VALUES mode displays up to 10 different signal parameters simultaneously, giving a wealth of information about the signal being measured.**
- **The STATISTICS mode gives statistical data over any number of readings up to 1 000 000, and reveals trends, jitter, drift, etc. It reduces random errors by statistical averaging, so enhancing accuracy.**

Best of all is the ease-of-operation of this new instrument. Simple menu selection and an intelligent AUTOSET makes everyone an expert user and takes all the hard work out of getting results. With just a few keystrokes, the MultiFunction Counter helps you to measure more with better results, faster and with less effort.

Now you can confidently VIEW, MEASURE and ANALYZE parameters like: Frequency, Period, Vmax, Vmin, Vpeak-peak, Pulse Width, Rise-/Fall Time, Duty Cycle, Time Interval, Phase, Burst Frequency, Vdc, true RMS Vac, Jitter and Totalize of Counts.

The MultiFunction Counter delivers high-resolution, high-accuracy readings of up to 10 digits. Accuracy is enhanced by a choice of high-stability oscillators, including TCXO and an ovenized oscillator. This is the ideal instrument for verification, alignment, calibration and analysis when you need accurate results. It is easier to use than a traditional counter, and more accurate than an oscilloscope is for timing and frequency measurements.

- Total signal characterization, with up to 10 parameters displayed simultaneously.
- 160 MHz / 2.7 GHz frequency counting.
- Up to 10-digits resolution.
- 1 ns single-shot time resolution. 0.01° phase resolution.
- See signals up to 50 MHz and read voltages, including true-RMS.
- Confident triggering through visual waveform verification.
- High-stability timebases, including ovenized crystal oscillator.
- Easy to learn, easy to use, easy to get results.
- AUTOSET for foolproof results.
- Handheld, rugged, battery operation: Ideal for field use.
- 3 Years warranty, 40 000 hours MTBF.
- RS-232 interface for programmability and downloading of data.
- Optional FlukeView® for Windows® to analyze, document and store your results.

New technique captures fast transitions more effectively

Figure 1a shows the MultiFunction Counter's Transitional-Sampling™. From the start trigger point, many time intervals are measured at different trigger levels, scanned over the entire waveform. This technique concentrates sample data on transitions, where high time resolution is most needed. Vertical resolution is defined by the 8-bit trigger level DACs, supplying 256 vertical steps.

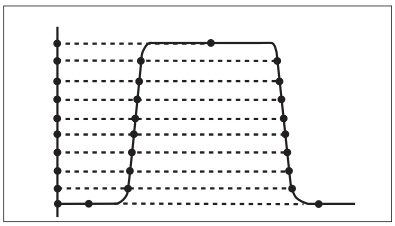


Figure 1a. This drawing shows how the MultiFunction Counter's unique Transitional-sampling™ concentrates sample data on transitions, obtaining a high time resolution of <1ns in all time base positions (>1 GSa/s effective sample rate).

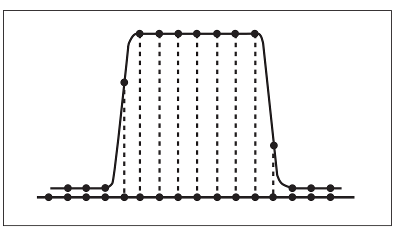


Figure 1b. By comparison, this drawing shows Time Sequential sampling, which is traditionally used in DSOs. Only a few samples are taken on transitions, creating the risk that very narrow pulses will be missed.

Unique capabilities to measure Low Duty Cycle signals

Unlike DSOs, Transitional-Sampling™ resolution does not depend on time-base settings, and captures down to 6 ns narrow pulses with < 1ns time resolution at all time-base settings. This offers a unique capability to measure low duty cycle signals. For example, figures 2a and 2b show a 1 µs radar pulse. Figure 2a shows two cycles of the 1 ms pulse period, while simultaneously the pulse width is measured with 5 digits resolution. Figure 2b views the pulse shape, while the frequency (or another parameter) is measured with very high accuracy.

WAVEFORM presentation mode

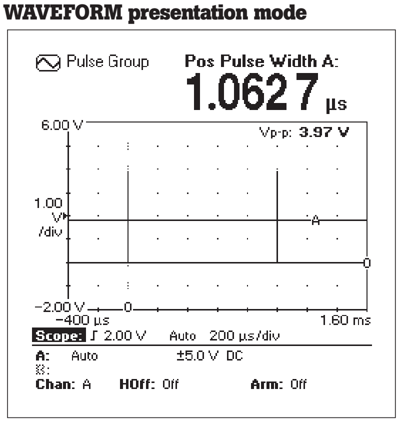


Figure 2a. Despite a 1÷1000 low duty cycle, the MultiFunction Counter displays the pulse width with high accuracy.

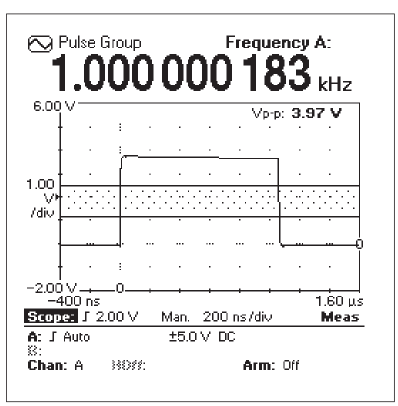


Figure 2b. This screen shows all the pulse details yet is 1000 x faster than in figure 2a. Simultaneously the frequency is measured with 10 digits resolution.

VALUES presentation mode

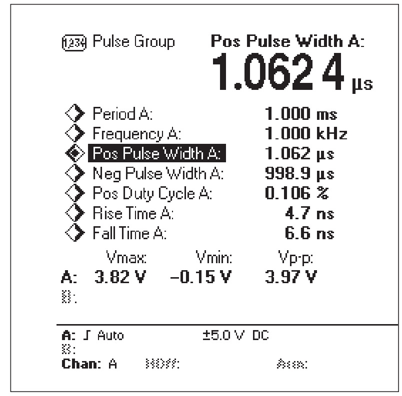


Figure 2c. In the VALUES presentation mode, all signal parameters can be shown simultaneously, without the need for setting changes per measurement. Any parameter can be selected as "primary", to be displayed at the top of the screen in large numerals and with full resolution.

Analyze with Statistics

A single keystroke gives statistical data such as the Mean, Maximum, Minimum, Max-Min and Standard Deviation of a number of samples. By definition, the Standard Deviation of Time Interval samples gives the RMS jitter. The Max-Min represents the peak-peak jitter. For FM frequency measurements, the Max-Min returns the peak-to-peak deviation of the frequency, while MEAN gives the carrier frequency.

STATISTICS presentation mode

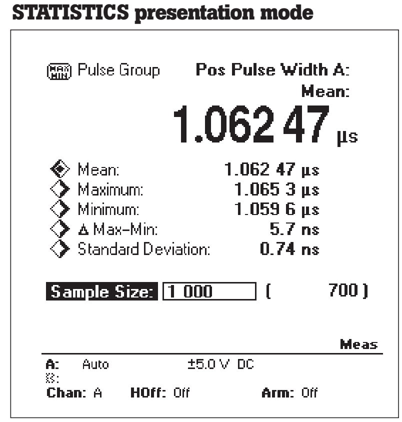


Figure 2d shows how STATISTICS reveals much more about the signal than a single measurement ever could. E.g. jitter, drift, wander or modulation.

Accurate Phase Measurements

Figures 3a and 3b show how a Multi-Function Counter performs, where by contrast both a Phasemeter and a scope or DVM would be required.

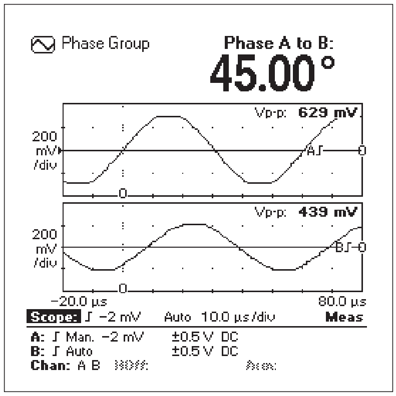


Figure 3a. The signal on channel B represents the output signal from a filter network, that is delayed in phase with respect to the input signal A.

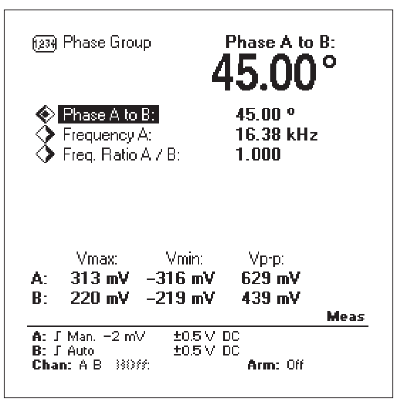


Figure 3b. The Vp-p values of the output and input signals indicate a ratio of 439mV ÷ 629mV = 0.7 i.e. at the frequency where the output signal B is 3dB down versus the input signal A. The frequency and the phase delay are measured simultaneously with high accuracy.

Advanced trigger features

The Model 164's special trigger features enable you to capture a particular signal out of a stream of pulses, by ignoring unwanted signals. An example would be measurements on mechanical relays and switches. Contact bounce at the beginning of the signal does not normally allow a traditional counter to measure the pulse width digitally. Start and stop at the first trigger event would result in an erroneous measurement of only the first bouncing contact closure. Trigger Hold-Off enables the MultiFunction Counter to ignore "stop-triggering" over a pre-settable time of 200 ns to 1.6 s.

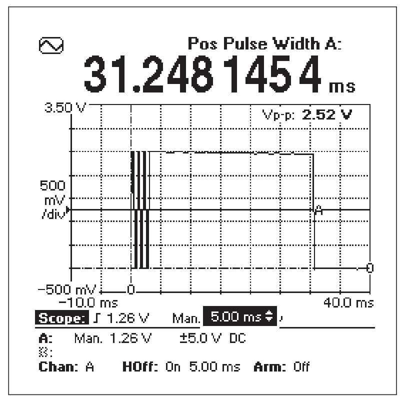


Figure 4. Despite contact bounce, the relay-"ON" time is measured, thanks to the set 5 ms trigger Hold-Off time. This allows accurate adjustments of relays and switches.

Frequency Measurements with Error-free triggering

Frequency measurements on basic signals are best made with AUTO Trigger.

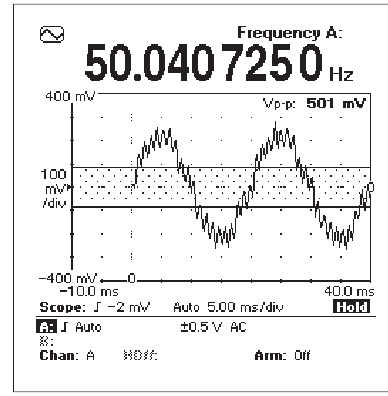


Figure 5a. The MultiFunction Counter gives correct results even on a noisy signal. AUTO Trigger centers the trigger level at 50% of amplitude and adjusts the trigger hysteresis band (noise immunity band) to 33% of the input amplitude to provide optimal noise immunity.

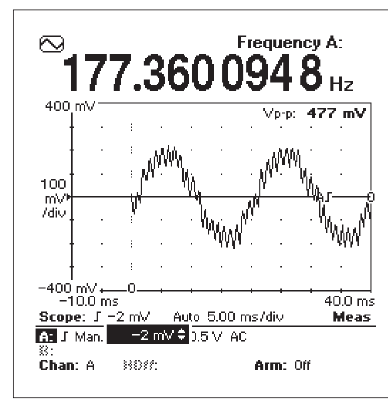


Figure 5b. By comparison, this figure shows how too high a sensitivity in a traditional counter could give erroneous results. Too high a trigger sensitivity means that noise forces the input signal to cross the trigger level (very narrow hysteresis band) more than once per input cycle and cause false counts.

Manual Trigger
Special applications with composite or complex signals often require manual trigger setting. The MultiFunction Counter gives full control over triggering. The trigger level can be set and is visible as cursor-lines on the waveform, see figures 6a and 6b.

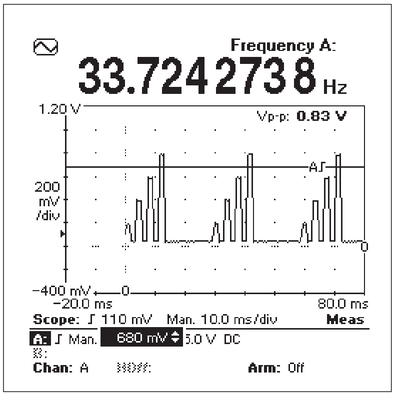


Figure 6a. Frequency measurement with manual trigger level setting, where only the last pulse in each pulse-burst triggers the counter. This means you can measure the repetition frequency of the burst reliably.

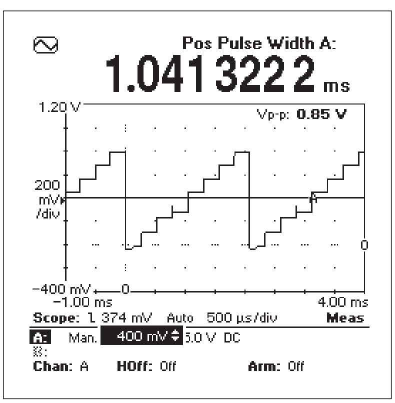


Figure 6b. When making a pulse width measurement, for instance to check the linearity of a DAC, the trigger level can be set and monitored to accurately measure the pulse width at each step on a stair case signal.

Automatic Burst Measurements

Amongst frequency measurements, measurements on bursts are the most difficult ones to perform. One may want to measure the pulse- or carrier frequency inside the burst i.e. the "Burst frequency", or the "Burst repetition frequency". **The MultiFunction Counter is unique in offering fully automatic triggering on burst signals.**

Burst frequency
Burst frequency measurements require a measurement that is synchronized with the presence of the burst. Some counters feature external arming and arming delay to synchronize the start of a measurement with an external signal. A requirement is that the measuring time be set shorter than the burst duration and that the counter has a high resolution to obtain the accuracy required. The MultiFunction Counter measures Burst Frequencies fully automatically.

Burst repetition frequency
Burst repetition frequency measurements require that only one count per burst is counted. Trigger Hold-Off can prevent a counter from being triggered more than once per burst. Figures 7a and 7b show how the MultiFunction Counter automatically measures both the Burst Frequency (cycles inside the burst) and the Burst Repetition Frequency. Thanks to the high resolution, the readout is in 6 digits despite the fact that the "narrow" burst of 106µs contains only 12 cycles.

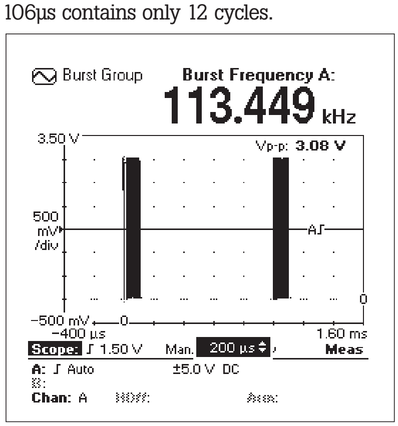


Figure 7a. An automatically measured burst frequency of 113.449 kHz.

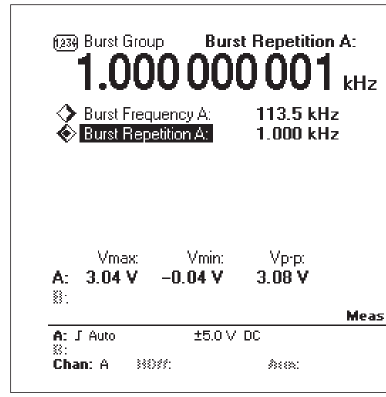


Figure 7b. The MultiFunction Counter measures automatically and shows simultaneously both the burst frequency and the burst repetition frequency.

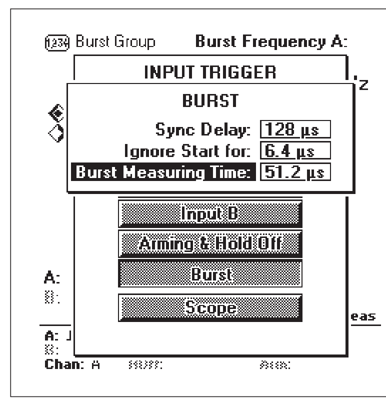


Figure 7c. The Burst settings, as automatically derived from the input signal (in figures 4a and 4b) by the green AUTO SET button.

INFO and Tutorial

By pressing the INFO key, On-Line information is given on any function or setting that is selected by the On-Screen cursor. A built-in Tutorial gives an overall explanation of the MultiFunction Counter, eliminating the need to carry a manual on-site.

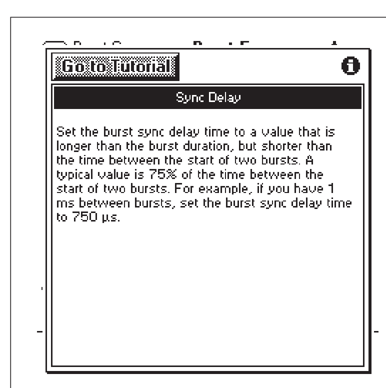


Figure 8. The Sync Delay INFO screen, showing a typical example of the information given.

Specifications

Presentation Modes

Waveform: Displays recurrent signals and trigger settings. Eliminates the need for a separate oscilloscope to verify the input signal and correct triggering. Displays additionally one selected timer/counter read-out with up to 10 digits resolution plus the input signal's Vp-p value.

Values: Up to 10 simultaneous readings of frequency, time and voltage, just like on a Counter, DVM and Phasemeter.

Statistics: Mean, Maximum, Minimum plus Peak-to-Peak and Standard Deviation of a selected number of samples; sample size: 2 to 10^6.

Timer/Counter Functions

Frequency limits: Minimum input frequencies specified below are with manual trigger setting and read-out in the VALUES and STATISTICS presentation modes. When using AUTO trigger or AC-coupled inputs, the minimum frequency is 20 Hz. Unless otherwise specified, the maximum frequency is 50 MHz (60 MHz typically) and the minimum pulse width is 6 ns, at set trigger level.

Frequency

Input A & B:	1µ Hz to 160 MHz (DC-coupled) 20 Hz to 160 MHz (AC-coupled)
Input C:	140 MHz to 2.7 GHz (164H/164T only)
Resolution:	9 digits/s

Burst Repetition Rate and Frequency in Burst

Frequency in Burst:

Input A & B:	1 Hz to 70 MHz
Input C:	140 MHz to 2.7 GHz (164H/164T only)
Resolution:	9 digits/s burst time

Burst Repetition Rate:

Input A & B:	up to 1 MHz
Input C:	up to 20 kHz (164H/164T only)
Resolution:	9 digits/s

Period

Input A & B:	6 ns to 10^6 s (1µ Hz to 160 MHz)
Input C:	370 ps to 7 ns (140 MHz to 2.7 GHz), (164H/164T only)
Resolution:	
Single cycle:	1 ns (A, B)
Multiple cycles averaged:	9 digits/s (A, B, C)

Frequency Ratio f_1/f_2

f_A/f_B, f_B/f_A, f_C/f_A, f_C/f_B:	10^{-9} to 10^9
Input A & B:	1µ Hz to 160 MHz
Input C:	140 MHz to 2.7 GHz (164H/164T only)

RPM

Input A & B:	1×10^{-5} RPM to 10^9 RPM (with 1 pulse/revolution)
Transducer scaling factor:	1 to 10^6 pulses/ rev

Time Interval

Input A & B:	0 ns to 10^7 s
Resolution:	1 ns

Positive/Negative Pulse Width

Input A & B:	6 ns to 10^7 s
Resolution:	1 ns

Rise/Fall Time

Input A & B:	6 ns to 10^7 s
Resolution:	1 ns
Pulse amplitude:	≥ 500 mVp-p

Duty Cycle

Input A & B:	0.000 1 to 99.999 9%
Frequency Range:	10 mHz to 50 MHz
Resolution:	0.000 1% or (Input Frequency / 1 GHz) x 100%, whichever is greater

Phase

Input A & B:	-180.00° to +360.00°
Frequency Range:	10 mHz to 50 MHz
Resolution:	0.01° or (Input Frequency / 1 GHz) x 360°, whichever is greater

Totalize of counts, manual and/or during set measuring time

Range:	0 to 10^{14} counts / up to 100 MHz
Manual mode:	Counts pulses simultaneously on inputs A and B.
Pulse-count displayed:	A, B, A-B or A+B
Start/Stop:	Run/Hold key
Timed mode:	Counts pulses on A, during set time: 200 ns to 15s
Pulse Width:	≥ 5 ns

Totalize of counts, with external control signal

Input A & B:	0 to 10^{14} counts / up to 100 MHz
Measurement modes:	Counts pulses on input A, between start and stop pulse on B or during gate signal on B
Pulse Width:	≥ 5 ns

Measuring time and synchronization

Measuring Time

Multiple cycles: Averaged during 200 ns to 15s with 100 ns resolution. Used for Frequency, RPM, Period Average and Ratio. Also used for Totalize of pulses with timed stop.
Single cycle: Used for Single Period A & B, Time Interval, Pulse Width and Rise/Fall times.
Display time: Measuring time or 200 ms whichever is greater.
HOLD / RUN: HOLD freezes last result. RESTART starts new measurement.

Additional Trigger Control

Normally, measurements are immediately started/stopped by the first input event that meets the trigger conditions. Arming, Arming Delay and Hold-Off are additional trigger control features that enable the counter to measure at a specific point in a stream of pulses on input A, by ignoring triggering during a set delay time and/or as long as an additional trigger condition on input B has not been fulfilled.
Arming ON: Start triggering is enabled directly after an external arming signal has triggered the arming input B. Applies to Frequency, Period or Pulse Width measurements.
Start Arming Delay: 200 ns to 5s. After arming, an additional delay is inserted before the instrument can be start-triggered for a new measurement.
Trigger Hold-Off: 200 ns to 5s. Stop triggering is inhibited during the set trigger Hold-Off time. Applies to Time Interval, Pulse Width, and Rise/Fall Time measurements.

Voltage Functions

Tolerances: Uncertainties specified apply from 10% to 100% of full range - and from18°C to 28°C, after 30 minutes warm-up time. Add (specified uncertainty) x 0.1/ °C at $<$ 18°C or $>$ 28°C. Confidence level corresponds to 2σ for a normal Gaussian distribution ($>$ 95%).

Peak Voltage
(V max, V min, V p-p)

Voltage range	
A & B:	500 mV, 5.00V, 50.0V
Frequency Range:	20 Hz to 50 MHz
Uncertainty:	
20 Hz to 2 kHz	2% + 0.2% of range
2 kHz to 5 MHz	4% + 0.2% of range
5 MHz to 20 MHz	10% + 1% of range
20 MHz to 50 MHz	25% + 1% of range

DC Voltage

Voltage Range	
A & B:	500 mV, 5.00V, 50.0V
Uncertainty:	2% + 0.2% of range

AC or AC+DC True-rms Voltage

Voltage Range	
A & B:	300 mV, 3.00V, 30.0V
Peak voltages:	500 mV, 5.00V, 50.0V
Frequency Range:	1 Hz to 10 MHz
Uncertainty (sine):	
20 Hz to 50 Hz	2% + 0.2% of range (DC + AC), 4% + 0.2% of range (AC coupled)
50 Hz to 2 kHz	2% + 0.2% of range
2 kHz to 5 MHz	4% + 0.2% of range (4% + 2% of range in 300 mV range)
5 MHz to 10 MHz	10%+1% of range (10% + 2% of range in 300 mV range)

Crest Factor: Any signal tolerated within Vp limits. Instrument calibrated for sinewaves. For other signals, with crest factors up to 3.0, add 2% + 2% of range (typically).

Multiple Parameter Display

Automatic waveform characterization with simultaneous display of all parameters, relevant for selected signal type:

Signal type	Parameters displayed simultaneously
SINE like signals:	Frequency, Period, Vmax, Vmin, Vp-p
PULSE like signals:	Frequency, Period, Positive Pulse Width, Negative Pulse Width, Rise Time, Fall Time, Duty Cycle, Vmax, Vmin, Vp-p.
BURST	Burst Frequency, Burst Repetition Rate, Vmax, Vmin, Vp-p.

Waveform Display Function

Displays the waveform of recurrent input signals. Eliminates for most signals the need for a separate oscilloscope to verify the input signal and correct triggering. Uses the same inputs A & B as for Timer/ Counter and Volt modes. For viewing complex signal patterns, dynamically changing signals or low amplitude signals, a fully featured oscilloscope can be expected to give a better signal representation.

Transitional Sampling™ (HF):

(Vertical Sampling) The waveform is captured by measuring Time vs. Voltage samples. Measured time intervals start at the set start trigger point and stop at consecutive stop trigger points, scanned over the entire signal.

Bandwidth:	50 MHz (-3 dB on Vp-p display)
Rise time:	3.5 ns.
Effective sampling rate:	1 GSa/s at >20ns/div 3 GSa/s at ≤20ns/div
Glitch detect:	≥6 ns repetitive pulses. Always active independently from time-base setting.

Time Sequential Sampling (LF)
(Horizontal Sampling)

Frequency Range:	1 Hz to 2 kHz
Sampling Rate:	Up to 40 kS/s

AUTO Sampling: Automatic selection between HF Transitional Sampling™ and LF Time Sequential, based on detected input signal frequency and pulse width.

Vertical deflection

Display Modes:	One or two input channels, automatic selection depending on selected measure function
Frequency response:	1 Hz to 50 MHz (-3dB in Vp-p display)
AC coupled:	20 Hz to 50 MHz (-3dB in Vp-p display)
Coupling:	AC/DC
Rise time:	3.5 ns (transitional sampling mode)
Display Voltage Range:	100 mV to 50V.
Sensitivity:	20 mV/div to 10V/div, auto scaling
Accuracy:	2% + 25 mV
Divisions:	8

Horizontal deflection

Time Coefficients: 5 ns/div to 0.2 s/div, AUTO or manual scaling
Accuracy: 1 ns + 1 pixel (transitional sampling) 25 µs + 1 pixel (time sequential sampling)
Divisions: 8 div + 2 div pre-trigger data (transitional sampling mode only)
Max. display length: 5 input signal cycles

Waveform Triggering

Sources: Input A or B, automatic selection, depending on selected MEASURE FUNCTION
Trigger sensitivity: 60 mVp-p to 10 MHz
90 mVp-p to 50 MHz
120 mVp-p to 75 MHz
Trigger level and slope: AUTO SET or manual

Inputs and Outputs

Input A & B

Frequency Range: Frequency limits for MEASURE FUNCTIONS and WAVEFORM display are separately specified; see Timer/Counter, Voltage and Waveform Functions.
Low Pass Filter: ≤ 100 kHz
Impedance: 1 MΩ / 15 pF
Trigger Level Range: ±500 mV, ±5.00V or ±50.0V
Resolution: 1, 10 or 100 mV
Uncertainty: ± 1% + resolution
Setting: AUTO, Manual
Read-out: Digital read-out, or with trigger lines on WAVEFORM display.

Trigger sensitivity, manual trigger setting:
± 0.5V/± 5V range: 20 mVrms sine (DC to 50 MHz)
40 mVrms sine (50 MHz to 160 MHz)
± 50V range: 200 mVrms sine (DC to 50 MHz)
400 mVrms sine (50 MHz to 160 MHz)

AUTO Trigger:
Level: Automatically set at 50% of input signal's Vp-p value, or at 10% and 90% of Vp-p for Rise/Fall Time measurements
Trigger hysteresis: In Frequency and Period Average modes, hysteresis is automatically set to approx. 33% of input signal's Vp-p value to provide optimal noise immunity. For all other functions, the hysteresis is equal to the specified trigger sensitivity (manual setting) up to 120 MHz. Above 120 MHz the trigger hysteresis increases to 100 mV (0.5V/5V range), and to 1V (50V range).
Min. Frequency: 20 Hz.

Maximum input voltage:
No instrument damage: 240Vrms up to 1 kHz, decreasing linearly to 6Vrms at 10 MHz.
Safe for user: 100Vrms (models 163/164 only), 30Vrms (models 164H/164T).
Floating voltage: All inputs: 300Vrms to ground, (models 163/164 only), 30Vrms (models 164H/164T)

Input C

(models 164H/164T only)
Frequency Range: 140 MHz to 2.7 GHz
Prescaler Factor: 64

Operating Input Voltage:
140 to 300 MHz: 20 mVrms to 5Vrms
0.3 to 2.1 GHz: 10 mVrms to 5Vrms
2.1 to 2.4 GHz: 20 mVrms to 5Vrms
2.4 to 2.7 GHz: 70 mVrms to 5Vrms
Impedance: 50Ω nominal, AC coupled, VSWR <2:1
Maximum Voltage Without Damage: 12Vrms, during 60s, PIN-diode protected

Ext. Reference Input

Frequency: 10 MHz
Voltage Range: 500 mVrms to 12Vrms
Impedance: Approx. 500Ω, AC coupled

Test signals output

Reference frequency: 10 MHz square-wave
Probe Compensation: 2 kHz square-wave
Gate Monitor: Gate open: low, gate closed: high

Test Signal Source:
Square-waves, selectable: 1 Hz, 50 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz and 5 MHz
Low- and high-duty cycle pulses: 1 kHz/0.2 µs and 1 kHz/999.9 µs.
Output levels: Fixed TTL: low = <0.4V, high = >1.8V into 50Ω

RS232 Data input/output

Connector: Isolated optical connector, for use with optional optical-to-RS232 adapter PM9080/001
Input: Full programmability via LEARN data strings and RECALL of up to 10 complete instrument settings.
Output: Measurement data, see also FlukeView®.

FlukeView®

SW 160/011 Optional FlukeView®; MultiFunction Counter software for Windows®
Documenting: Transfers waveforms and measurement data from MultiFunction Counter to a PC with the optional optical-to-RS232 adapter PM9080/001. Print out complete screens directly or store graphical data in a popular file format to import into word processor or spreadsheet programs.
Archiving: Waveform storage and retrieval with text annotations like measurement conditions and instrument set up.
Analysis: Log and graph readings to monitor and analyze signal variations and related events, reveal relationships and conditions that could otherwise remain hidden.

Auxiliary Functions

Statistics

Statistical functions: Maximum, Minimum, Mean, Standard Deviation and Peak-to-Peak Deviation (= Max-Min) of a selected number of samples, (not available in Totalize modes).

Error reduction: Random uncertainties for instance from noise and jitter can normally be reduced by $\sqrt{N}$, by averaging a number of measurement readings.

N (Sample Size):	2 to 1 000 000

Mathematics

Mathematics:	Display = (K x measurement result) + L.
Constants K and L:	0 to $\pm10^{\pm20}$, key-board entry in 12 digits resolution

Tutorial and INFO

Built-in Tutorial and context-sensitive INFO explain settings and operation

Save / Recall

Instrument set-ups:	10
Screen images:	1 (WAVEFORM, VALUES or STATISTICS)

General

Quality and maintenance

Quality control:	ISO 9001 quality system
Warrantee:	3 years parts and labor
MTBF	40 000 hours
Calibration:	Closed Case Calibration, recommended interval: 12 month

Display

Super Twisted Liquid Crystal with Cold Cathode Fluorescent backlight

Size:	84 x 84 mm, 4.7" diagonal
Resolution:	240 x 240 pixels
Brightness:	selectable, max. 50 cd/m^2
Contrast ratio:	adjustable, max. 1:15 (typical at 20°C)

Environmental Data

Temperature:

Operating:	0°C to 50°C
Storage:	-20°C to 70°C

Humidity:

Operating:	20°C to 30°C, < 90% RH non-condensing 30°C to 50°C, < 70% RH non-condensing
Storage:	< 95% RH

Altitude:

Operating:	< 3000 m (10 000 ft)
Storage:	< 12000 m (40 000 ft)
Vibration:	Up to 3G at 55 Hz, per MIL-T-28800E, Class 3
Shock:	Half-sine shock pulse 30G, per MIL-T-28800E, Class 3 CE
EMC:	Emission: EN 55011 ISM Group 1, Class A. CE
Susceptibility:	EN 50082-2

Safety

Safe Operation:	100Vrms to 10 kHz (model 164 only), 30Vrms (models 164H/164T).
Floating voltage:	All inputs: 300Vrms to ground, (model 164 only), 30Vrms (models 164H/164T).
Compliance:	EN 61010-1:1993, Cat. ll CE CSA CAN / CSA - C22.2 No.1010.1 - 92
AC/DC adapter:	UL: UL1310 Class 2 C22.2 No. 223

Power Supply

Line voltage adapter:	90 to 130Vrms or 190 to 255Vrms, 45 Hz to 440 Hz, 16 VA
Internal Ni-Cd Battery:	Type PM 9086, 4.8V
Typical operating time:	Pulse output and external reference input switched OFF, lowest backlight brightness level and full battery capacity.
Model 164:	2 1/4 hours
Model 164T:	1 3/4 hours
Model 164H:	1 1/2 hours
Charging Time:	3h typical, when instrument OFF
Alternate Battery:	4 alkaline, C cells (user supplied)
External DC Supply:	10V to 20V DC, 10W typical, 6W charging only
Input Connector:	5 mm power jack, DIN 45323

Mechanical Data

Dimensions: (H x W x L)	60 x 130 x 260 mm (2.4 x 5.1 x 10.2 in), excl. holster 65 x 140 x 275 mm (2.5 x 5.5 x 10.8 in), incl. holster
Weight:	1.5 kg (3.3 lb), excl. holster; 1.8 kg (4.0 lb), incl. holster
Transport weight:	3.4 kg (7.5 lb).

Uncertainty Timer/Counter Measurement

Uncertainty examples in table 1 and table 2 are a simplified way to quickly obtain the magnitude of accuracy for commonly made measurements. The figures are overall figures, taking into account all instrument error-contributors, such as quantization error, trigger errors, reference crystal oscillator ageing, temperature drift and one year calibration interval. Reference is made to the Users Manual, for exact calculations of the measurement's uncertainties (random, systematic and total values), taking into account specific manual settings, ambient temperature and input signal characteristics such as slew-rate and noise.

Frequency measurements on Sinewave signals
Table 1 shows the uncertainty for measurements on undistorted 1Vrms sinewave input signals, with instrument settings obtained through AUTOSET and making use of the internal time-base reference at room temperature.
Conditions that lead to a better accuracy (reduced uncertainty) are: steeper trigger transitions (for instance through higher input amplitude and higher input frequency), use of STATISTICS to average the result of a number of readings, the use of a more accurate external time-base reference and a shorter calibration interval than 12 months. In LF Frequency measurements, the internal trigger uncertainty is the dominant error contributor, whereas for HF Frequency measurements the internal time-base uncertainty dominates.

Frequency and timing measurements on Pulse input signals
Table 2 shows the uncertainty for measurements on undistorted 1Vp-p pulse signals with 10 ns rise/fall times (except for rise/fall-time measurements, where noted differently), with instrument settings obtained through AUTOSET and making use of the internal time-base at room temperature.
Conditions that lead to a better accuracy (reduced uncertainty) are: steeper trigger transitions (for instance through shorter rise/fall time and higher input amplitude), use of STATISTICS to average the result of a number of readings, the use of a more accurate external time-base reference and a shorter calibration interval than 12 months. For short duration Time measurements, the 1 ns resolution is the dominant error-contributor, whereas for long duration Time measurements, the internal time-base uncertainty dominates.

Model	**164**	**164T**	**164H**
Mode and input signal	**Absolute uncertainty**	**Absolute uncertainty**	**Absolute uncertainty**
Frequency & Period average: (Period = 1÷Frequency)			
≤100 Hz	1 mHz	1 mHz	1 mHz
1 kHz	5 mHz	1 mHz	1 mHz
10 kHz	50 mHz	10 mHz	1 mHz
100 kHz...2.7 GHz	$5x10^{-6}$ x Freq.	$1x10^{-6}$ x Freq.	$1x10^{-7}$ x Freq.
Phase:			
≤100 kHz	0.1°	0.1°	0.1°
1 MHz	0.5°	0.5°	0.5°
10 MHz	5°	5°	5°
Frequency Ratio f_1 / f_2:			
f_2: 100 Hz	0.1	0.1	0.1
10 kHz	0.001	0.001	0.001
1 MHz	0.00001	0.00001	0.00001
100 MHz	0.0000001	0.0000001	0.0000001

*Table 1: Uncertainty on **Sinewave** signals.*

Model	**164**	**164T**	**164H**
Mode and input signal	**Absolute uncertainty**	**Absolute uncertainty**	**Absolute uncertainty**
Frequency & Period average: (Period = 1÷Frequency)			
20 Hz to 2.7 GHz	$5x10^{-6}$ x Freq.	$1x10^{-6}$ x Freq.	$1x10^{-7}$ x Freq.
Period Single:			
≤1 µs	1 ns	1 ns	1 ns
1 ms	5 ns	1.5 ns	1 ns
1 s	5 µs	1 µs	100 ns
Time Interval, Pulse width:			
≤1 µs	1.5 ns	1.5 ns	1.5 ns
1 ms	5 ns	2 ns	1.5 ns
1 s	5 µs	1 µs	100 ns
Rise / Fall time, @ 100kHz:			
≤10 ns	2 ns	2 ns	2 ns
100 ns	5 ns	5 ns	5 ns
1 µs	50 ns	50 ns	50 ns
Duty Cycle:			
≤100 Hz	0.0001 %	0.0001 %	0.0001 %
10 kHz	0.0015 %	0.0015 %	0.0015 %
1 MHz	0.15 %	0.15 %	0.15 %

*Table 2: Uncertainty on **Pulse** input signals.*

Internal Time Base Stability

	Type	**Standard**	**TCXO**	**Oven**
	Model	**164**	**164T**	**164H**
Aging Rate per:	24h			< $1.5 x 10^{-9}$ (1st year)
	Month	< $5 x 10^{-7}$	< $1 x 10^{-7}$	< $3 x 10^{-8}$
	Year	< $5 x 10^{-6}$	< $1 x 10^{-6}$	< $1 x 10^{-7}$ (after 1st year)
Temperature Stability:	0 to 50°C	< $5 x 10^{-6}$	< $1 x 10^{-6}$	< $2 x 10^{-7}$
	10 to 40°C			< $1 x 10^{-7}$
(after 15 min. and referenced to 23°C)	18 to 28°C	< $2 x 10^{-6}$		< $5 x 10^{-8}$
Factory adjustment uncertainty at 23° C		< $5 x 10^{-6}$	< $1 x 10^{-6}$	< $1 x 10^{-7}$

Timer/Counter Measurement Uncertainty

Uncertainty Survey
(maximal inaccuracies after 30 minutes warm-up time)

Measuring Function	Random Uncertainties, rms or STD DEV	Systematic Uncertainties	LSD Displayed
Time Interval **Pulse Width** **Rise/ Fall Time (in s)**	$\sqrt{1ns^2 + (\text{Start Trigger Error}^2 + \text{Stop Trigger Error}^2}$	±Trigger Level Timing Error ± 1ns ±(Time Base Error x Measurement Value)	500 ps
Frequency (in Hz) **Period (in s)**	$\frac{\sqrt{1ns^2 + 2 \times (\text{Start Trigger Error}^2)}}{\text{Measuring Time}} \times \text{Frequency or period}$	±(Time Base Error x Measurement Value) $\pm \frac{1ns}{\text{Measuring Time}} \times \text{Frequency or period}$	$\frac{\text{500 ps x Freq. or Per.500 ps x Freq. or Per.}}{\text{Measuring Time}}$ (Rounded to nearest decade)
Ratio f_1 / f_2	$\frac{\sqrt{\text{Prescaler Factor}^2 + 2 \times (f_1 \times \text{Start Trigger Error } f_2)^2}}{f_2 \times \text{Measuring Time}}$		$\frac{\text{Prescaler Factor}}{\text{Measuring Time} \times f_2}$ (Rounded to nearest decade)
Phase **(in °)**	$\sqrt{(1\ ns^2 + \text{Start Trigger Error}^2 + \text{Stop Trigger Error}^2)} \times$ x Frequency x 360°	±(Trigger Level Timing Error x Freq. x 360°) ±1ns x Frequency x 360°)	0.01°
Duty Cycle **(in %)**	$\sqrt{(1\ ns^2 + \text{Start Trigger Error}^2 + \text{Stop Trigger Error}^2)} \times$ x Frequency x 100%	±(Trigger Level Timing Error x Freq. x 100%) ±1ns x Frequency x 100%)	0.0001%

Start/Stop Trigger Error due to Random Effects

Trigger error, caused by external and internal noise, results in too early or too late start- and stop- triggering. The rms trigger error at each trigger point is:

Start / Stop Trigger Error =

$$\frac{\sqrt{(\text{Vnoise - input})^2 + (\text{Vnoise - signal})^2}}{\text{Signal slew rate } (V/s) \text{ at trigger point}}$$

Vnoise–input: 1 mVrms noise of the input amplifier
Vnoise–signal: rms noise of the input signal over a 160 MHz bandwidth

Calculation of Measurement Uncertainty (2 σ)

The total uncertainty of a measurement is calculated as twice the combined standard uncertainty (two standard deviations or 2σ using the following formula:

Total Combined Standard Uncertainty =

$$2 \chi \sqrt{s^2 + \frac{S_{ai^2}}{3}}$$

where:
s = uncertainty due to random effects, as specified for each measuring function.
ai = uncertainty due to systematic effects, calculated for each contributing error, as specified for each measuring function.

Trigger Level Timing Error due to Systematic Effects

Trigger level timing error is the sum of two error sources:

1. The trigger level setting error due to deviation of the actual trigger point from the set (indicated) trigger level and
2. The width of the input hysteresis band (only in Pulse Width & Duty Cycle measurements)

The magnitude of both errors depend on the input signals slew rate:

Trigger Level Setting Error =

$$\frac{\text{2 x trig. resol.+1\% of start trigger level}}{\text{Slew rate } (V/s) \text{ at start trigger point}} + \frac{\text{2 x trig. resol.+1\% of stoptrigger level}}{\text{Slew rate } (V/s) \text{ at stop trigger point}}$$

Input Hysteresis Error =

$$\frac{0.001}{\text{Slew rate } (V/s) \text{ at start trigger point}} - \frac{0.001}{\text{Slew rate } (V/s) \text{ at stop trigger point}}$$

Internal Time Base Stability

	Type	Standard	TCXO	Oven
	Model	**163, 164**	**164T**	**164H**
Aging Rate per:	24h			$< 1.5 \times 10^{-9}$ (1st year)
	Month	$< 5 \times 10^{-7}$	$<1 \times 10^{-7}$	$< 3 \times 10^{-8}$
	Year	$< 5 \times 10^{-6}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-7}$ *(after 1st year)*
Temperature Stability: *(after 15 min. and referenced to 23°C)*	0 to 50°C	$< 5 \times 10^{-6}$	$< 1 \times 10^{-6}$	$< 2 \times 10^{-7}$
	10 to 40°C			$< 1 \times 10^{-7}$
	18 to 28°C	$< 2 \times 10^{-6}$		$< 5 \times 10^{-8}$
Factory adjustment uncertainty ***(at 23°C)***		$< 5 \times 10^{-6}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-7}$

Ordering Information

FLUKE®

Selection guide

Models		164	164T	164H
Function/Frequency range: 160 MHz Frequency Counter 50 MHz Waveform, Timing and Vp-p modes 100 MHz Totalize of Counts V dc and 10 MHz true RMS Volt modes		•	•	•
2.7 GHz Frequency- and Period modes			•	•
Timebase stability / Accuracy	per month	5×10^{-7}	1×10^{-7}	5×10^{-8}
	per year	5×10^{-6}	1×10^{-6}	5×10^{-7}
Optional PC-support: RS232 adapter Optional FlukeView® for Windows®		○	○	○

Fluke 164	50 MHz / 160 MHz MultiFunction Counter with Standard Time Base
Fluke 164T	50 MHz / 2.7 GHz MultiFunction Counter with TCXO Time Base
Fluke 164H	50 MHz / 2.7 GHz MultiFunction Counter with High Stability Oven Time Base

Included Accessories

Operators Manual
Calibration certificate

PM 9086	Ni-Cd Battery Pack
PM 9083	Protective Holster
PM 9651/00X	AC/DC Power Adapter/ Battery Charger

For other country versions than country of ordering, please contact your Fluke representative.

Optional Accessories

Probes; safety designed for isolated measurements on inputs A & B:

PM 8918/101	Probe 1:1, 1 MΩ, 12 MHz BW, (1.5 m, 5 ft)
PM 8918/002	Probe Set (2 pcs) 10:1,10 MΩ, 100 MHz BW, (1.5 m, 5 ft)
PM 8918/202	Probe Set (2 pcs) 10:1, 10 MΩ, 75 MHz BW, (2.5 m, 8 ft)
80i-110s	Clamp-on AC/DC current probe, DC to 100 kHz, 100 mV/A (max. 10A) or 10 mV/A (max. 100 A)

Probes; optimized for HF-measurements:

PM 9020/001	Probe 10:1, 10 MΩ, 200 MHz BW, (1.5 m, 5 ft). Recommended for pulse response testing on input A & B.
PM 9639/011	Probe 10:1, 500Ω, 1GHz (-3dB) 2.3 GHz (-6dB), (1.5 m, 5 ft). Recommended for frequency measurements on input C.

50Ω BNC-BNC cables; safety designed for isolated measurements on inputs A & B:

PM 9091/001	cable set (3 x 1.5 m)
PM 9092/001	cable set (3 x 0.5 m)

50Ω BNC-BNC regular cables:

PM 9588/01	50Ω BNC-BNC cable set (5 x 0.2 m, 4 x 0.4 m, 3 x 0.6 m, 3 x 2 m).

Other Accessories:

C 95	Soft carrying case
C 97B	Protective hard carrying case
PM 9080/001	Optically isolated RS-232 adapter/cable
PM 9585/01	50Ω Feedthrough Termination, 1W
SW 160/011	FlukeView®; MultiFunction Counter software for Windows®
PM 9086/011	Spare Ni-Cd Battery Pack

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10157-ENG
Rev. 02