PM 6681 / PM 6681R

Technical Data

Timer / Counter / Analyzers
Rubidium Frequency Reference / Counter / Calibrator

PM 6681: the highest performance timer/counter/analyzer available
The PM 6681 from Fluke sets the new standard for measurement and analysis of time intervals, frequency, phase and jitter. For development, calibration or challenging production test applications, the PM 6681 is the leader.

Check these key PM 6681 performance parameters, and compare the new state-of-the-art for yourself:

- 50 ps single-shot time interval resolution (1 ps averaged)
- 1.25 mV vertical resolution
- 300 MHz range, options to 8 GHz
- 8k readings/s to internal memory
- 250 readings/s over GPIB
- Continuous single-period measurements at up to 40k readings/s
- Unique hold-off and arming delay facilities to measure any part of any complex signal
- TimeView™ PC software for time and frequency analysis

So for the ultimate performance, choose the advanced PM 6681.

PM 6681R: ideal for calibration applications
The Rubidium reference of the PM 6681R makes this instrument the most accurate Frequency Reference/Counter/Calibrator for the calibration of frequency, time or phase.

- High accuracy and short warm-up times:
  5 min. to lock
  $4x10^{-10}$ within >10 min.
  Aging $1x10^{-9}$ in 10 year
- Calibrates Frequency, Time or Phase
- Calibrates any application specific frequency
- 5x 10MHz & 1x 5MHz buffered reference outputs

Measuring Functions

Refer to table 1 for uncertainty information. Inputs A and B can be swapped internally in all modes except Rise and Fall Time.

Frequency A, B, C

Range:	
Input A:	10^{-10} Hz to 300 MHz
Input B:	10^{-10} Hz to 100 MHz
Input C:	2.7 GHz or 8 GHz with options
Resolution:	11 digits in 1s measuring time

Frequency Burst A, B, C

Frequency and PRF of burst signals can be measured without external control signal and with selectable start arming delay.

Range:	
Input A:	Up to 300 MHz
Input B:	Up to 100 MHz
Input C:	Up to 8 GHz with options
Start Delay Range	200 ns to 1s, 100 ns resolution

Period A

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

Ratio A/B, C/B

Range:	10^{-9} to 10^{15}
Frequency Range:	
Input A, B:	10^{-10} Hz to 160 MHz
Input C:	2.7 GHz or 8 GHz with options

Time Interval A to B

Range:	0 ns to 10^{10} s
Resolution	
single shot:	50 ps (1 ps average)
Frequency Range:	Up to 160 MHz

Pulse Width A

Range:	3 ns to 10^{10} s
Frequency Range:	Up to 160 MHz

Rise and Fall Time A

Range:	3 ns to 10^{10} s
Frequency Range:	Up to 160 MHz
Input Amplitude:	>250 mV p-p

Phase A Relative B

Range:	-180° to +360°
Resolution:	0.01
Frequency Range:	0.03 Hz to 160 MHz

Duty Factor A

Range:	0 to 1
Frequency Range:	0.11 Hz to 160 MHz

Totalize A, B

Range:	0 to 10^{17}, 0 to 10^{10} in A-B modes
Frequency Range:	0 to 160 MHz
A Gated by B:	Event counting on Input A during the presence of a pulse on Input B. Single or cumulative event counting during set measuring time
A Start/Stop by B:	Event counting on Input A between two consecutive pulses on Input B
Manual A-B:	Input A minus Input B event counting with manual start and stop
Manual/Timed A-B:	Input A minus Input B event counting with manual start. Stop after set measuring time. Time counted from first trigger event on A.

AC/DC Voltage A, B

Range:	-50V to +50V
Frequency Range:	DC, 1 Hz to 100 MHz
Mode:	V_{max}, V_{min}, V_{p-p}
Resolution:	1.25 mV
Gated Volt:	External masking of unwanted signal components such as overshoot

Input and Output Specifications

Inputs A and B

Frequency Range:	
DC-Coupled:	DC to 300 MHz
AC-Coupled:	10 Hz to 300 MHz
Coupling:	AC or DC
Impedance:	1 MΩ/15 pF or 50Ω (VSWR 2:1) 1 MΩ/65 pF or 50Ω with PM 9611/80 rear panel inputs
Trigger Slope:	Positive or negative
Channel Inputs:	Separate, common A or swapped
Max. channel timing difference:	500 ps
Sensitivity:	20 mV rms, <100 MHz 25 mV rms, 100 MHz to 200 MHz 40 mV rms, 200 MHz to 250 MHz 60 mV rms, >250 MHz
Pulse Width:	>5 ns at 60 mV p-p, >3 ns at 90 mV p-p
Attenuation:	x1 or x10
Hysteresis Window (x1):	20 mV p-p
Variable Hysteresis A (x1):	30 mV p-p to 10V p-p up to 120 MHz
Dynamic Range (x1):	60 mV p-p to 10V p-p (up to 100 MHz) within ±5V window 75 mV p-p to 10V p-p (100 to 200 MHz) within ±5V window
Trigger Level:	Read-Out on display
Range:	(x1): -5V to +5V (x10): -50V to +50V
Resolution (x1):	1.25 mV
Uncertainty (x1):	±(4 mV + 0.8% of trigger level)
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)
Frequency:	>1 Hz
Low Pass Filter A:	100 kHz fixed. >40 dB attenuation at 1 MHz
Digital Low Pass Filter:	1 Hz to 10 MHz using trigger Hold-Off
Trigger Indicator:	Tri-state LED-indicator
Max Voltage Without	
Damage: 1 MΩ:	350V (DC + AC pk) at DC to 440 Hz, falling to 12V rms (x1) and 120V rms (x10) at 1 MHz
50Ω:	12V rms

Input C (Option PM 9624)

Frequency Range:	100 MHz to 2.7 GHz
Prescale Factor:	32
Operating Input Voltage Range:	
100 to 300 MHz:	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
Amplitude Modulation:	
DC to 0.1 MHz:	Up to 94% depth
0.1 to 6 MHz:	Up to 85% depth
Minimum signal must exceed minimum operating input voltage	
Impedance:	50 Ω nominal, AC coupled, VSWR <2.5:1
Max Voltage Without Damage:	12V rms, pin-diode protected
Connector:	Type N Female

Input C (Option PM9638)

Frequency range	300 MHz to 8 GHz
Prescaler factor	256
Operating input voltage	
300 … 500 MHz	–21 dBm (20 mVrms)
0.5 … 3.0 GHz	–27 dBm (10 mVrms)
3.0 … 4.5 GHz	–21 dBm (20 mVrms)
4.5 … 6.0 GHz	–15 dBm (40 mVrms)
6.0 … 8.0 GHz	–9 dBm (80 mVrms)
Max. input level	+30 dBm (7 Vrms)
Input Impedance	50 Ω nominal, VSWR < 2:1
Connector	N-type (female)

Rear Panel Inputs and Outputs

Reference Input:	1, 2, 5, or 10 MHz >200 mV rms signal
Reference Output:	1x 10 MHz >0.5V rms sinewave into 50Ω load
PM 6681R:	5x 10 MHz & 1x 5 MHz. >0.5V rms sinewave into 50Ω load
Arming Input:	Most measuring functions can be performed.
Frequency Range	DC to 100 MHz
Slew Rate:	>2 V/s
Trigger Level:	TT L level, 1.4V nominal
Trigger Slope:	Positive or negative
Gate Output:	Gate open/gate closed signal output
Trigger Level Outputs:	Outputs for channel A and B trigger levels
Probe Compensation Outputs:	Outputs for channel A and B to adjust for best pulse response when using probes for counter input
Analog output:	0 to 4.98V proportional to 3 selected 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 x 10^9 samples

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) or as value from preceding measurement (X_{n-1})

Other Functions

Measuring Time:	Single cycle, 80, 160, 320, 640, 1280 ns and 20 µs to 20s (or to 400s for some functions)
Display Hold:	Freezes measuring result, until a new measurement is initiated via Restart
Settings:	20 instrument setups can be saved and recalled from internal non-volatile memory. 10 can be user protected.
Auxiliary Menu:	Gives access to additional functions
Display:	10+2 digit LCD with high-luminance backlight

GPIB Interface

Programmable Functions:	All front panel accessible functions
Compatibility:	IEEE 488.2-1987, SCPI 1991.0
Interface Functions:	SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, E2
Time Stamping:	125 ns resolution
Measurement Rate*	
Via GPIB	250 readings/s
To Internal Memory:	8k readings/s
Internal Memory Size*	Up to 6100 readings
Data Output:	ASCII, IEEE double precision floating point

TimeView™ Time & Frequency Analysis Software

TimeView runs on an IBM PC/AT or compatible with VGA monitor.

Data Capture Modes and Measurement Rate*

Free Running Measurement:	8k readings/s
Repetitive Sampling:	Up to 10 MHz
Continuous Single-Period:	Up to 40k readings/s (200 ns resolution)
Waveform Capture:	Yes
Data Analysis Features:	Measurement data vs time FFT Graph Root Allan Variance Smoothing function Zoom function Cursor measurements Distribution Histogram Setup and Measurement Data Archive and printing

* Depending on measurement function and internal data format

Systematic Uncertainties

Trigger Level Timing Error

Time Interval, Rise/Fall Time, Pulse Width, Duty Factor (x1):

Trigger Level Timing Error =

= TLU x (1/Sx + 1/Sy) ± 0.5 x Hyst. x (1/Sx + 1/Sy)

Where:

Sx = Slew rate at start trigger point in V/s
Sy = Slew rate at stop trigger point in V/s
TLU = Trigger Level Uncertainty in Volt
Hyst. = Hysteresis Window in Volt
Hyst. = 0 for Time Interval and Rise/Fall Time

Phase, sinewave signals and trigger levels 0V (x1):

Trigger Level Timing Error =

= [0.2/V pk of A + 0.2/V pk of B]

Where:

V pk (A) = Input A peak voltage in Volt
V pk (B) = Input B peak voltage in Volt

Measurement Uncertainties

Measuring Function	Random Uncertainty rms	Systematic Uncertainty
Time Interval **Pulse Width** **Rise/Fall Time**	$\frac{\sqrt{(QE)^2 + (\text{Start Trigger Error})^2 + (\text{Stop Trigger Error})^2}}{\sqrt{N}}$ or min.: 1 ps	± Trigger Level Timing Error ± 500 ps Systematic Error ± Time Base Error x Time Interval
Frequency **Period**	$\frac{\sqrt{(QE)^2 + 2 \times (\text{Start Trigger Error})^2}}{\text{Measuring Time}}$ x Frequency or Period	± Time Base Error x Freq. or Period $\pm \frac{\text{QE x Freq. or Period}}{\text{Measuring Time}}$
Ratio f_1/f_2	$\frac{\sqrt{(\text{Prescaler Factor})^2 + 2x (f_1 \text{ x Start Trigger Error of } f_2)^2}}{f_2 \text{ x Measuring Time}}$	
Phase	$\frac{\sqrt{(QE)^2 + (\text{Start Trigger Error})^2 + (\text{Stop Trigger Error})^2}}{\sqrt{N}}$ x Freq. x 360° or min.: 1 ps x Freq. x 360°	± Trigger Level Timing Error° ± 500 ps Sys. Error x Freq. x 360°
Duty Factor	$\frac{\sqrt{(QE)^2 + (\text{Start Trigger Error})^2 + (\text{Stop Trigger Error})^2}}{\sqrt{N}}$ x Frequency or min.: 1 ps	± Trigger Level Timing Error x Freq. ± 500 ps Sys. Error x Freq.

Table 1: Measurement Uncertainties

Random Uncertainties

(QE) Quantization Error

10°C to 40°C:	50 ps rms
0 to 10°C and 40 to 50°C:	75 ps rms

(N) Number of samples

Frequency <12 kHz:	Measuring Time x Frequency/2
Frequency >12 kHz:	Measuring Time x 6000

Start/Stop Trigger Errors:

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

Vnoise-input: 100µV rms typical

Display Resolution

LSD Displayed
Unit value of the least significant digit displayed. All calculated LSDs should be rounded to the nearest decade (e.g. 0.3 Hz is rounded to 0.1 Hz, 5 Hz is rounded to 10 Hz.) and cannot exceed the 12th digit.

Frequency and Period
LSD Displayed $\frac{\text{50 ps x Frequency or Period}}{\text{measuring time}}$

Time Interval, RT, FT, PW
LSD Displayed $\frac{\text{50 ps}}{\sqrt{N}}$

Duty Factor
LSD Displayed 1×10^{-6}

Phase
LSD Displayed 0.01°

Ratio f1/f2
LSD Displayed $\frac{\text{Prescaler Factor}}{f_2 \text{ x measuring time}}$

Time Base Options

Option model:		PM6681/-1-	PM6681/-5-	PM6681/-6-	PM6681/-7-
Retro-fittable option:		non retrofit.	PM9691/011	PM9692/011	non retro-fit.
Time base type:		Standard	OCXO	OCXO	Rubidium
Uncertainty due to:					
Calibration adjustment tolerance, at + 23°C ± 3°C		$<1x10^{-6}$	$<2x10^{-8}$	$<5x10^{-9}$	$<5x10^{-11}$
Ageing:	per 24 hr.	n.a.	$<5x10^{-10}$ ❶	$<3x10^{-10}$ ❶	n.a.
	per month	$<5x10^{-7}$	$<1x10^{-8}$	$<3x10^{-9}$	$<5x10^{-11}$ ❷
	per year	$<5x10^{-6}$	$<7.5x10^{-8}$	$<2x10^{-8}$	$<2x10^{-10}$ ❸
Temperature variation:	0°C–50°C,	$<1x10^{-5}$	$<5x10^{-9}$	$<2.5x10^{-9}$	$<3x10^{-10}$
	20°C–26°C (typ. values)	$<3x10^{-6}$	$<6x10^{-10}$	$<4x10^{-10}$	$<2x10^{-11}$
Power voltage variation:	± 10%	$<1x10^{-8}$	$<5x10^{-10}$	$<5x10^{-10}$	$<1x10^{-11}$
Short term stability:	τ = 1 s		$<5x10^{-12}$	$<5x10^{-12}$	$<5x10^{-11}$
(Root Allan Variance)	τ = 10 s	not specified	$<5x10^{-12}$	$<5x10^{-12}$	$<1.5x10^{-11}$
(typical values)	τ = 100 s		n.a.	n.a.	$<5x10^{-12}$
Power-on stability:					
Deviation versus final value after 24hr on time,		n.a.	$<1x10^{-8}$	$<5x10^{-9}$	$<4x10^{-10}$
after a warm-up time of:		30 min	10 min	10 min	10 min
Total uncertainty, for operating temperature 0°C to 50°C, at 2σ (95%) confidence interval:					
1 year after calibration		$<1.2x10^{-5}$	$<1x10^{-7}$	$<2.5x10^{-8}$	$<7x10^{-10}$
2 years after calibration		$<1.5x10^{-5}$	$<2x10^{-7}$	$<5x10^{-8}$	$<9x10^{-10}$
Typical total uncertainty, for operating temperature 20°C to 26°C, at 2σ (95%) confidence interval:					
1 year after calibration		$<7x10^{-6}$	$<1x10^{-7}$	$<2.5x10^{-8}$	$<2.5x10^{-10}$
2 years after calibration		$<1.2x10^{-5}$	$<2x10^{-7}$	$<5x10^{-8}$	$<5x10^{-10}$

n.a. Not discernible, neglectable versus 1°C temperature variation.
❶ After 48 hours of continuous operation, PM9692 typical value 1×10^{-10} / 24h
❷ After 1 month of continuous operation
❸ Typical value. Aging during 10 year $<1x10^{-9}$

Explanation
Calibration Adjustment Tolerance is the maximal tolerated deviation from the true 10MHz frequency after a calibration. When the reference frequency does not exceed the tolerance limits at the moment of calibration, an adjustment is not needed.
Total uncertainty is the total possible deviation from the true 10MHz value under influence of frequency drift due to ageing and ambient temperature variations versus the reference temperature. The operating temperature range and the calibration interval are part of this specification.

General Specifications

Environmental Data

Operating Temp	0°C to +50°C
Storage Temp :	–40°C to +70°C
Vibration:	3G at 55 Hz per MIL-T-28800D
Shock:	Half-sine 40G per MIL-T-28800D. Bench handling. Shipping container.
Reliability:	MTBF 30 000 h (calculated)
Safety:	IEC 1010 Class 1, CSA 22.2 No. 231, EN 61010-1
EMC:	EN 55011 ISM Group 1, Class B; EN 50082-2; FCC Part 15J Class A

Power Requirements

90V rms to 265V rms, 45 Hz to 440 Hz, 35W
100 W during warm-up (5 min.), 47 W during normal operation (PM 6681R)

Dimensions and Weight

Width:	315 mm (12.4 in),
Height:	86 mm (3.4 in),
Depth:	395 mm (15.6 in)
Weight,	Net 4 kg (8.5 lb),
	Shipping 7 kg (15 lb)
Weight PM 6681R:	Net 4.8 kg (10.5 lb),
	Shipping 7.8 kg (16.8 lb)

Ordering

Basic Models

PM 6681/016	300 MHz, 50 ps Timer/Counter including Standard Time Base, External Reference Frequency Multiplier (1, 2 or 5 MHz input), GPIB-interface and 'TimeView' Time & Frequency Analysis Software for DOS

Rubidium Reference Basic Model

PM 6681R/076	300 MHz Frequency Reference/ Counter/Calibrator including GPIB-interface and 'TimeView' Time & Frequency Analysis Software for DOS

Included with Instrument

One year product warranty, line cord and Certificate of Calibration Practices, Operators' Manuals on CD-ROM, Getting Started booklet

Input Frequency Options (PM 6681, PM 6681R)

PM 6681/6 _ _	2.7 GHz Input C (PM 9624)
PM 6681/7 _ _	8 GHz Input C (PM 9638)

Time Base Options (PM 6681)

PM 6681/_ 5 _	Very High Stability Oven Time Base (PM 9691)
PM 6681/_ 6 _	Ultra High Stability Oven Time Base (PM 9692)

Example Ordering Configuration

To order the PM 6681 300 MHz, 50 ps version with the 2.7 GHz input C and Standard Time Base, select the complete Model Number: PM 6681/616

Options and Accessories

PM 9611/80	Rear Panel Inputs (front inputs disconnected)
PM 9624	2.7 GHz Input C
PM 9638	8 GHz Input C
PM 9691	Very High Stability Oven Time Base
PM 9692	Ultra High Stability Oven Time Base
PM 9622/00	Rack-Mount Kit
PM 9627	Carrying Case
PM 9627H	Heavy Duty Alumium Carrying Case
PM 9639	2.3 GHz 500Ω probe 10:1 (BNC)
TimeView-81W	Time and Frequency Analysis Software for Windows®

When ordered together with the basic counter, options are factory installed.
Options ordered separately can be customer retrofitted, except PM 9611/80 Rear Panel Inputs.
SW Drivers on request
MET/CAL procedures are available
HPVEE driver is available
LabView driver is available from National Instruments

Manuals on CD-ROM

Operator *
Programming*
Getting Started in English, French and German
*No charge with purchase of unit

Factory Warranty

One year product warranty
Two year warranty on Rubidium Reference Sytem, Lifetime Limited Warranty on the Rubidium Lamp

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