FLUKE®

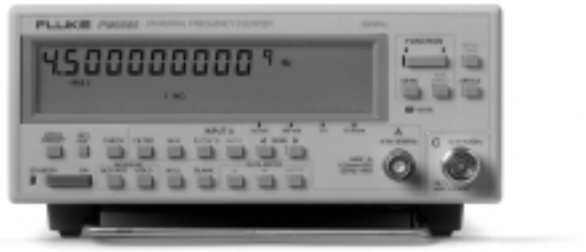
PM 6685
PM 6685R

Technical Data

Universal Frequency Counter
Rubidium Frequency
Counter Calibrator

Cal lab performance you can take anywhere

Cal lab performance in the field The PM 6685 frequency counter from Fluke brings cal lab accuracy to field measurements. With 10 digits per second, plus overflow (displays 11th and 12th digits), it delivers high-accuracy measurements instantly. The PM 6685 is easy to use, compact and – most important of all – it has today's smartest input triggering for frequency measurements. The battery option for the PM 6685 maintains oven stability for 20 hours, giving you instant oven performance even after long transportation.



PM 6685

- 300 MHz basic input range; options for 1.3 GHz or 2.7 GHz
- Ultra High Stability Oven: up to 5 x 10^{-9} within 10 min
- Battery supply in combination with Ultra High Stability Oven for On-Site calibration
- Displays 10 digits in a second
- Smart AUTO trigger eliminates guesswork, provides error-free measurements
- Analog Bar Graph displays signal strength and input sensitivity to assist instrument setup and RF tuning applications
- Nulling function lets you use any value as input reference
- Digit blanking function to eliminate distracting or insignificant digits in your readings
- Connect-and-go convenience for testbench and field use Optional IEEE-488 (SCPI) interface

GSM Network operators

Depending on the cellular radio system network operators and the internal procedures and budgets, the calibration requirement can be fulfilled with the following solutions from Fluke.

- PM6685 with the Ultra-High-Stability oven oscillator in the small housing with or without battery supply to check base stations, offering a low initial cost-effective solution (6 month calibration interval for a margin of 3x better than GSM specification)
- PM6685R **Rubidium** Frequency Counter/Calibrator, to check base stations, providing low cost of

ownership, (10 year calibration interval, for a margin of 50x better than GSM specification)

Ultra High Stability Timebase

The new Ultra-High-Stability oven oscillator PM9692 fills the gap between the currently available best crystal oscillators and the Rubidium oscillator. The short warm-up time of 10 min to reach 5 x 10^{-9} of final value makes it the ideal solution for many on-site calibration applications.
The PM9692 oscillator in the smaller housing of the PM6685, provides adequate accuracy to handle the fast-growing need for calibrations of digital cellular telephony systems and other calibration applications, very cost effectively.

PM6685R – Today's most accurate frequency counter

The PM 6685R from Fluke is the most accurate portable frequency counter on the market. It offers all the functionality of the PM 6685, plus the stability and accuracy of a built-in Rubidium atomic reference.
High stability, high accuracy and short warm-up times make this instrument ideal for high-accuracy calibration procedures outside the cal lab environment, such as in base station transmitters of large telecommunication networks like GSM.
The short warm-up time means that the PM 6685R is ready for use within minutes after field transport or a change of location inside a building.

Additional features PM 6685R

- High accuracy and short warm-up times:
  5 min. to lock
  4 x 10^{-10} within 10 min.
  Aging 1 x 10^{-9} in 10 year
- Calibrates any application specific frequency
- 10 MHz buffered Rubidium reference output
- 2 year warranty on Rubidium element

Technical Specifications PM 6685

Measuring Functions

Refer to table 1 for measurement uncertainty information.

Frequency A, C	
Range	
Input A:	10 Hz to 300 MHz
Input C:	70 MHz to 1.3 GHz (PM 9621) 100 MHz to 2.7 GHz (PM 9624)
Resolution:	10 digits/s measurement time
Burst Frequency A	
Frequency Range:	100 Hz to 160 MHz
PRF Range:	1 Hz to 100 kHz
Pulse Width Range:	1 µs to 50 ms, min. 3 periods of this signal
Period A	
Range:	6 ns to 100 ms
Resolution:	10 digits/s measurement time
Ratio A/E, C/A	
Range:	10^{-7} to 10^{10}
Frequency Range:	
Input A:	10 Hz to 160 MHz
Input E:	10 Hz to 50 MHz
Input C:	70 MHz to 1.3 GHz (PM 9621) 100 MHz to 2.7 GHz (PM 9624)
Pulse Width A	
Range:	3 ns to 10 ms
Frequency Range:	50 Hz to 160 MHz
Voltage Range:	100 mV p-p to 70V p-p
Duty Factor A	
Range:	0 to 1
Frequency Range:	50 Hz to 160 MHz
Voltage Range:	100 mV p-p to 70V p-p
Totalize A	
Event counting on input A with manual start and stop	
Range:	0 to 10^{17} 0 to 160 MHz

Input and Output Specifications

Input A	
Frequency Range:	10 Hz to 300 MHz
Coupling:	AC
Impedance:	1 MΩ//25 pF or 50Ω, VSWR < 2:1
Sensitivity:	
Sinewave:	10 mV rms, 10 Hz to 50 MHz 15 mV rms, 50 MHz to 100 MHz 20 mV rms, 100 MHz to 150 MHz 30 mV rms, 150 MHz to 200 MHz 50 mV rms, 200 MHz to 300 MHz
Pulse:	50 mV p-p, 3 ns minimum pulse width
Dynamic Range:	30 mV p-p to 70V p-p
Manual Trigger:	
Sensitivity Range:	10 mV rms to 10V rms, variable in 3 dB steps, indicated on a bar graph
Trigger Level:	Selectable for optimum triggering on waveforms with duty factors <0.25, 0.25 to 0.75 and >0.75
Trigger Slope:	Positive or negative
Auto Trigger:	Automatic setting of input signal conditioning circuits for optimum triggering on different amplitudes and waveforms
Frequency:	Minimum 50 Hz
Sensitivity Range:	10 mV rms to 25V rms
Signal Monitor:	A bar graph displays actual input signal level in 3 dB steps, 10mV rms to 10V rms
Low Pass Filter:	100 kHz nominal 3 dB point. Minimum 40 dB attenuation at 1 MHz.
Damage Level:	1 MΩ: 350V (dc + ac peak) at dc to 440 Hz, falling to 12V rms at 1 MHz and above 50Ω: 12V rms

Input C (Option PM 9621)

Frequency Range:	70 MHz to 1.3 GHz
Prescaler Factor:	256
Operating Input Voltage Range:	
70 to 900 MHz:	10 mV rms to 12V rms
900 to 1100 MHz:	15 mV rms to 12V rms
1100 to 1300 MHz:	40 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:	50Ω nominal, ac coupled, VSWR <2:1
Max Voltage without Damage:	12V rms, pin–diode protected
Connector:	BNC

Input C (Option PM 9624)

Frequency Range:	100 MHz to 2.7 GHz
Prescaler Factor:	16
Operating Input Voltage Range:	
100 MHz to 300MHz	20 mV rms to 12V rms
0.3 GHz to 2.5 GHz	10 mV rms to 12V rms
2.5 GHz to 2.7 GHz	20 mV rms to 12V rms
Amplitude Modulation:	As PM 9621
Impedance:	50 nominal, ac coupled, VSWR <2,5:1
Max Voltage without Damage:	12V rms, pin–diode protected
Connector:	Type N Female

External Reference Input D

The use of external reference is indicated on the display

Input Frequency:	10 MHz standard. 1 MHz and 5 MHz with optional Reference Frequency Multiplier (PM 9697).
Voltage Range:	500 mV rms to 10V rms
Impedance:	Approx 1 k (ac coupled)

Input E

Used in Ratio A/E and external arming/gating modes

Frequency Range:	DC to 50 MHz
Pulse Width:	10 ns minimum
Slew Rate:	2V/µs minimum
Trigger Level:	TTL level, 1.4V nominal
Trigger Slope:	Positive or negative
Impedance:	Approx 2 kΩ (dc coupled)
Damage Level:	±25V peak

Reference Output G

Frequency:	10 MHz, sine wave
Output Level:	>0.5V rms into 50Ω load, >0.7V rms into high impedance load
Coupling:	AC

Auxiliary Functions

External Arming/External Gate

External signal on input E can be used to inhibit start and/or stop triggering.

Stop arming is not applicable to Pulse Width and Duty Factor measuring modes.

Start Arming Delay:	OFF or 200 ns to 1.6s in 100 ns steps

Nulling/Frequency Offset

Nulling enable measurements to be displayed relative to a previously measured value or any frequency offset value entered via front panel keys

Other Functions

Measuring Time:	Single cycle, 0.8, 1.6, 3.2, 6.4, 12.8 µs and 50 µs to 20s, (up to 400s, depending on measuring function and input signal frequency)
Local/Preset:	Go to local function in remote mode, or preset counter to default setting in local mode
Restart:	Starts a new measurement
Display Hold:	Freezes measuring result. Start and stop of the totalization in TOT A MAN.
Check:	Applies 10 MHz to the measuring logic
Display:	LCD with high–luminance backlight
Number of Digits:	10 digits plus exponent
Blanking:	Least significant digits can be blanked
Bar graph:	Displays input signal level or sensitivity setting in 3 dB steps from 10mV rms to 10V rms
Auxiliary Menu:	The following functions are available from the AUX MENU and via the GPIB interface
Save/Recall:	19 complete instrument settings. 10 settings can be user protected
GPIB–Address:	Read and temporarily change via front panel keys. (Set new address on rear panel switch.)
Burst Frequency:	A or C input, set synchronization delay time
PRF:	A or C input, set synchronization delay time
Trigger Slope:	Positive or negative slope
Arming Start:	Positive or negative slope, set start arming delay time
Arming Stop:	Positive or negative slope
Null:	Read and change stored offset frequency
Display Overflow:	Display of the 11th and 12th digits
Test:	Select selftests
Program Version:	Display instrument and GPIB program versions
Time Out:	OFF or 100 ms to 25.5s in 100 ms steps
Analog Output:	Select digits and scaling factor
Display Backlight:	On/Off

Measuring function	Random Uncertainty rms	Systematic Uncertainty	LSD Displayed
Frequency Period	$\pm \frac{\sqrt{(250ps)^2 + (\text{Trigger Error})^2}}{\text{Measuring Time}} \times \text{Freq. or Period}$	± Time Base Error x Freq. or Period	$\frac{250ps \times \text{Freq. or Period}}{\text{Measuring Time}}$ $\pm \frac{QE \times \text{Freq. or Period}}{\text{Measuring Time}}$
Ratio f_1/f_2	$\pm \frac{\sqrt{(\text{Prescaler Factor})^2 + (f_1 \times \text{Trigger Error of } f_2)^2}}{f_2 \times \text{Measuring Time}}$		$\frac{\text{Prescaler Factor}}{f_2 \times \text{Measuring Time}}$
Pulse Width (Auto Trigger)	$\pm \sqrt{(250\ ps)^2 + (\text{Trigger Error})^2}$	± Time Base Error x Pulse Width ± 0.5 x Transition Time ± 1.5 ns	100 ps
Duty Factor	$\pm \sqrt{(250\ ps)^2 + (\text{Trigger Error})^2 \times \text{Frequency}}$	± (0.5 x Transition Time ± 1.5 ns) x Frequency	1×10^{-6}

Table 1. Measurement Uncertainties and LSD Displayed

Random Uncertainty

Random uncertainty is due to quantization error, short-term Time Base stability, internal noise and input signal noise. The random uncertainty can be reduced by increasing the measurement time. Trigger Error: Internal noise and input signal noise, expressed as an rms Trigger Error.

$$\text{Trigger Error} = \frac{1.4 \times \sqrt{(e_{amp})^2 + (e_n)^2}}{\text{Signal slew rate (V/s) at trigger point}}$$

Where:
e_{amp} = rms input amplifier noise (250 µV rms typical)
e_n = rms noise of the input signal over a 300 MHz bandwidth

Systematic Uncertainty

See crystal oscillator specifications for aging and possible frequency deviation due to the oscillator's temperature dependency

LSD Displayed

Unit value of Least Significant Digit (LSD) displayed. After calculation, the LSD value is rounded to the nearest decade before display (for example >0.5 Hz will be 1 Hz and <0.5 Hz will be 0.1 Hz). LSD blanking is available to reduce displayed resolution. Measuring times >1s can give significance in > 10 digits. The 11th and 12th digits can be displayed using the display overflow function.

Options

Battery Unit (Option PM 9623)

The PM 9623 is a rechargeable battery unit for mounting inside the counter.

Battery Type:	Sealed lead-acid cells
Battery Capacity:	At 25C
Standby Mode:	Typically 20 hours with Oven Time Base
Operating Mode:	Typically 3 hours without options, 2.5 hours with Oven Time Base, and 2 hours with Oven Time Base and Input C
Recharge Time:	Typically 8 hours in standby mode
Battery Protection:	Overcharge and deep discharge protection
External DC:	12V to 24V via socket on rear panel (16V to 24V to charge internal battery)
Line Failure Protection:	Counter automatically switches to internal battery or external dc when the line voltage falls below 90V ac
Temperature	
Operating:	0°C to +40°C
Storage:	–40°C to +50°C
Weight:	1.5 kg (3.3 lb)

GPIB (Option PM 9626/02)

Programmable Functions:	All front panel and AUX MENU functions
Compatibility:	IEEE 488.2-1987, SCPI 1991.0
Interface Functions:	SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, E2
Maximum Measurement Rate to Internal Memory:	200 to 1600 readings/s, depending on measurement function and internal data format
Internal Memory Size:	764 to 2600 readings, depending on measurement function and internal data format
Maximum Bus Transfer Rate from internal memory:	150 to 1000 readings/s, depending on internal data format and output data format
Data Output Format:	ASCII, IEEE double precision floating point
Time Out:	Off or 100 ms to 25.5s in 100 ms steps
Analog Output:	0 to 4.98V in 20 mV steps, derived from three consecutive digits selected from the measurement result
Output Impedance:	200Ω

Timebase Options

Option model:		PM668-/-1-	PM668-/-5-	PM668-/-6-	PM668-/-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,	$<1x10^{-5}$	$<5x10^{-9}$	$<2.5x10^{-19}$	$<3x10^{-10}$
	20°C–26°C (typ. values)	$<3x10^{-6}$	$<6x10^{-10}$	$<4x10^{-10}$	$<5x10^{-11}$
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		$<7x10^{-6}$	$<1x10^{-7}$	$<2.5x10^{-8}$	$<6x10^{-10}$
2 years after calibration		$<1.2x10^{-5}$	$<2x10^{-7}$	$<5x10^{-8}$	$<8x10^{-10}$

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

Temperature	
Operating:	0C to +50C
Storage:	–40°C to +70°C
Humidity:	95% RH, 0°C to 30°C
Altitude Operating:	Up to 4600m (15000 ft)
Non-operating:	Up to 12000m (40000 ft)
Vibration:	3G at 55 Hz per MIL-T-28800D, Class 3, Style D
Shock:	Half-sine 40G per MIL-T-28800D, Class 3, Style D. Bench handling. Shipping container.
Reliability:	MTBF 30 000 hours
Safety:	IEC 1010 Class 1, CSA 22.2 No. 231, EN61010, CE
EMC:	EN 55011, VDE 0871 Level B, FCC Part 15J Class A, CE EN 50082/2

Power Requirements

AC:	90 to 265V rms, 45 to 440 Hz, max 30W
DC (PM 9623):	Internal battery or external 12 to 24V dc, max 2A

Mechanical Data

Width	210 mm (8.25 in)
Height	86 mm (3.4 in)
Depth	395 mm (15.6 in)
Weight:	Net 3.2 kg (7 lb); shipping 5.5 kg (12 lb)

Additional Specification for PM6685R
(where these differ from the standard model PM6685)
Short-term (Root Allan Variance of reference Oscilator)
See Timebase Options table

Warm-up time (at 25°C)
Unlocked status indicated by LED

Time to lock	approx. 5 min.
Retrace:	< 2.5 x 10^{-11}

Power requirements (at 25°C)

Voltage	90 ... 264 Vrms, 47 ... 440Hz
Power rating	<100W for <4 min., 47W continuous operating

Dimensions and weight

Width	315 mm (12.4 in)
Weight	Net 5.5 kg (12 lb)
Shipping weight	8.8 kg (19 lb)

FLUKE®

Ordering Information

Basic Model

PM 6685/011	Universal Frequency Counter 300 MHz incl. Standard Time Base

Rubidium Reference Basic Model

PM 6685R/071	Rubidium Frequency Counter/Calibrator
Included with Instrument	*One year product warranty, line cord, operator manual, and Certificate of Calibration practices*

Input Frequency Options

PM 6685_/4_	1.3 GHz Input C (PM 9621)
PM 6685_/6_	2.7 GHz Input C (PM 9624)

Time Base Options

PM 6685/_1_	Standard Time Base
PM 6685/_5_	Very High Stability Oven Time Base (PM 9691)
PM 6685/_ 6 _	Ultra-High-Stability Oven Time Base (PM 9692)
PM 6685R/_7_	Rubidium Time Base 1)

1) Product physical dimensions are larger with rubidium time base. The rubidium time base is not customer installable.

Battery Unit and GPIB Interface Options

PM 6685/_ _1 or PM 6685R/_ _1	No Battery Unit or GPIB Interface
PM 6685/_ _3	Battery Unit (PM 9623)
PM 6685/_ _6 or PM 6685R/_ _6	GPIB Interface (PM 9626/02) and Time & Frequency Analysis SW: TimeView

Example, Ordering Configuration

To order the 300 MHz PM 6685 version with Standard Time base, 1,3 GHz input C and GPIB Interface, select the complete Model Number PM 6685/416

Options and Accessories

PM 9621	1.3 GHz Input C
PM 9624	2.7 GHz Input C
PM 9691/01	Very High Stability Oven Time Base
PM 9692/01	Ultra-High-Stability Oven Time Base
PM 9623 **	Battery Unit
PM 9626/02 *	GPIB-Interface
PM 9622/00	Rack Mount Kit for PM 6685R
PM 9622/02	Rack Mount Kit for PM6685
PM 9627	Carrying Case
PM 9627H	Heavy Duty Alumium Carrying Case
PM9020/002	200 MHz 10:1 probe 1MΩ/30pF
PM9639	2.3 GHz 500Ω probe 10:1 (BNC)

* PM9626 GPIB-Interface includes Analog Output and TimeView Analysis software

** PM 9623 can not be fitted in PM 6685R

When ordered together with the basic counter, options are factory installed.

SW Drivers	on request
MET/CAL	procedures are available
HPVEE	driver is available
Manuals	
PM6685	Operator *
PM6685	Program *
PM6685	Service
	* No charge with purchase of unit
Factory Warranty	One year product warranty Two year warranty on Rubidium Element