PM 6666
Programmable Timer / Counter

Technical Data

• Unrivaled price/performance
• 160 MHz / 1.3 GHz option
• Reciprocal counting, 7 digits per second
• High stability MTCXO: 2x10^-7 over 0°C to 50°C with push-button calibration
• Error-free triggering, high noise immunity input circuitry
• PM 6666: Full GPIB/IEEE 488 programmability, Auto trigger, Voltage measurements
• PM 6669 Ease of operation, auto triggering, auto range and auto display
• Rugged, no compromise quality, MTBF 50,000h & 70,000h
• Excellent suppression of RF interference through all-metal cabinet
• Optional battery for field use
The PM6666 and PM6669 are economical, easy-to-use counters that meet the demands for high-precision measurements, reliability and durability. The units use reciprocal frequency counting, which yields high resolution measuring results under all conditions, even on low frequency measurements. The high performance counter front-ends, providing variable sensitivity and noise immunity increase measuring accuracy. Accuracy can be further improved with the optional high stability MTCXO TimeBase, that offers a stability of $2 \times 10^{-7}$ (0°C to 50°C), comparable to that of an oven stabilized oscillator. The counters have high input protection, allowing it to withstand inputs of 12V rms on the optional 50Ω RF input and 350V (dc+ac peak) on the 1 MΩ LF input.

### PM 6669 Frequency Counter
The multi-function PM 6669 offers next to frequency measurements also period, count totalization, ratios, pulswidth and frequency difference measurements, functions normally found only in more expensive timer / counters. This counter can be used on the test bench or for field service. It has a full 9-digit display, to allow complete presentation of measuring results. When less accurate measurements are made, blanking of irrelevant display digits makes it easy to read results.

### PM 6666 Programmable Timer/Counter
The PM 6666 is a low cost timer/counter with high accuracy frequency, time and voltage measurements that also offers 100% programmability including trigger level and sensitivity settings. A bus learn mode is provided to speed and simplify programming. The PM 6666 is also a bench-top use; with 9 front panel selectable measuring functions including voltage max. /min. measurements.

### Error-Free Triggering
Triggering is error-free on the PM 6666 for all waveforms. Trigger level setting can be automatic on all input signals over 100 Hz. Resolution is 20/200 mV, over a very wide range (-50V to +50V) that allows measurements to be accurate even on high voltage events. The trigger level can be displayed immediately with one keystroke; and inputs can be instantly checked for triggering with the Tri-state LED trigger indicators. To give the various noise immunity settings, input sensitivity has six steps, from 20 mV to 1V rms.

### Vpp measurements up to 50 MHz
The PM 6666 has Volt peak measurements up to 50 MHz. When displaying Vmax. / min. measurements, positive and negative signal peaks of the input signal are shown simultaneously with a resolution of 20 or 200 mV.

### High Resolution
The PM 6666 can measure low frequency signals to high resolution with synchronized multiple period measurements and computing the reciprocal values. Resolution is at least 7 digits on a 1s measuring time, because the traditional ± 1 input cycle error is eliminated. Time interval measurements are high resolution measurements.

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![Selection Table](image.png)
as well as high accuracy, due to the time interval averaging technique. The 100 ns resolution is improved by a factor \( vN \) (\( N = \) number of time intervals averaged) when compared with single time interval measurements.

**MTCXO Time Base**  
(Mathematically Temperature Compensated Crystal Oscillator)  
Counter stability and precision is ultimately determined by the time-base oscillator. This can be further improved with the optional high stability MTCXO time-base that offers a stability, comparable to that of an oven stabilized oscillator, but at much lower cost. The temperature dependency curve for each individual crystal oscillator is factory-measured, and the frequency deviations \( \Delta f \) across the temperature range are stored in a non-volatile memory. During operation, the \( \Delta f \) value for the operating temperature is referenced in memory and used to compensate the measuring result before it is displayed. This automatic temperature compensation also results in highly accurate measurements instantly, without long warm-up times. The unique MTCXO principle gives a residual temperature stability of \( 2 \times 10^{-7} \) over the temperature range 0 °C to 50°C.

**Specifications PM6666**

**Measuring Modes**

| Mode | Reciprocal freq. counting. | LSD displayed: 2.5 x 10^{-7} FREQ / Measuring time |
| Period A | Range: 8 ns to 2 x 10^9 s | Mode: Single period measurement (SINGLE) or period average measurement (0.2, 1 or 10 s measuring-times). |
| LSD displayed: | SINGLE period measurement: | - (TIME < 100 s): 100 ns |
| | - (TIME > 100 s): 5 x PERIOD / 10^9 s | Period average measurement: |
| | - 2.5 x 10^{-7} x PERIOD / meas. time |
| Ratio A/B | (Ratio B/A, C/A or C/B via GPIB only) | Range: |
| | 0 and 1 x 10^{-7} to 2 x 10^9 (A/B) | LSD displayed (Ratio A/B): 25 / meas. time x FREQ B (0.2, 1 or 10 s Measuring times) |
| | 0 and 1 x 10^{-4} to 2 x 10^9 (B/A) | LSD displayed (Ratio B/A): 2.5 / meas. time x FREQ A (0.2, 1 or 10 s Measuring times) |
| | 0 to 1 x 10^8 (A/B SINGLE and B/A SINGLE), 8 to 6 x 10^{10} (C/B) | LSD displayed (A/B SINGLE, B/A SINGLE): | - (RATIO < 10^9): 1 |
| | | - (RATIO > 10^9): 5 x RATIO / 10^9 |
| | 640 / meas. time x FREQ A or B | LSD displayed (Ratio C/A or C/B): |
| Time interval A-B | (Time interval B-A via GPIB only) | Range: 100 ns to 2 x 10^{10} s (SINGLE) |
| Mode: | Single time interval (SINGLE) for time interval average measurements (at 0.2, 1 or 10 s measuring-times). |
| LSD displayed: | SINGLE Time interval measurement: |
| | (TIME < 100 s): 100 ns |
| | (TIME > 100 s): 5 x TIME / 10^9 s |
| | Time interval average measurement: |
| | - 2.5 x 10^{-7} s / N |
| Number of Intervals | \( N \) |
| | averaged: |
| | Measuring time / pulse repetition rate. |
| | Min dead time from start to |
| | start: 250 ns |
| Timing difference A-B | channels: |
| | 4 ns max. |

*Note: Input signals must be repetitive and asynchronous with respect to the time base.*

**Totalize A**  
(Totalize B via GPIB only)  
Range: 0 to 1 x 10^{15} with indication of k or M (kilo-pulses or Mega-pulses) the result is truncated if out of display range.  
Frequency range: 0 Hz to 16 MHz  
Pulse pair resolution: 80 ns  
LSD displayed: 1 unit count (counts < 10^9)  
5 x counts / 10^9 (counts > 10^9)  
Gated by B (A) mode: Event counting on input A (B) during the duration of a pulse on input B (A).  
Start/stop by B (A) mode: Event counting on input A (B) between two consecutive pulses on input B (A).  
Manual mode: Event counting is controlled by the START/STOP button. Sequential start-stop counts are accumulated.  
RESET closes the gate and resets the Timer/Counter to zero.

**Volt Max/Min A**  
(Volt Max/Min B via GPIB only)  
Range: -51 V to +51 V  
Frequency range: DC and 100 Hz to 50 MHz
**Input A**
DC and 100 Hz to 5 MHz (Input B)

**Resolution:**
Input signals within ± 5 V: 20 mV
Input signals outside ± 5 V: 200 mV

**Inaccuracy DC and 100 Hz to 16 MHz (A) or to 1 MHz (B):**
Input signals within ± 5 V: 30 mV ±1 % of reading ±3 % of Vpp
Input signals outside ± 5 V: 300 mV ±3 % of reading ±3 % of Vpp

**Inaccuracy 16 MHz to 50 MHz (A) or 1 MHz to 5 MHz (B):**
Input signals within ± 5 V: 30 mV ±10 % of reading ±10 % of Vpp
Input signals outside ± 5 V: 300 mV ±10 % of reading ±10 % of Vpp

**Definitions PM6666**

**LSD displayed**
LSD = Unit value of the least significant digit displayed. All calculated LSD's (see section Measuring functions) should be rounded to the nearest decade (e.g. 0.3 Hz is rounded to 0.1 Hz and 5 Hz to 10 Hz) and cannot exceed the 9th digit.

**Resolution**
Resolution = smallest increment between two measuring results on the display, due to the 1 count error.

**Freq. A, C, Period A and Ratio A/B:**
Resolution can be 1 LSD unit or 2 LSD units if:
- LSD x Measuring time / FREQ or PERIOD < 10^-7 the resolution is 2 LSD units (30 % probability).
- Otherwise resolution is 1 LSD unit (70 % probability).

**Ratio A/B:**
Resolution can be 1 LSD unit or 2 LSD units if:
- LSD x Measuring time / RATIO < 10 / FREQ A the resolution is 2 LSD units (30 % probability).
- Otherwise resolution is 1 LSD unit (70 % probability).

**Pulse:**
60 mV pp, 0 Hz to 30 MHz
110 pp, 30 MHz to 120 MHz

**Sensitivity AC coupled**
20 mV rms, 0 Hz to 30 MHz
40 mV rms, 30 MHz to 120 MHz

**Sensitivity DC coupled**

**Triggering**
**Trigger level range**
DC coupled: +51 V to –51 V, adjustable via up/down control.
AC Coupled: 0 V fixed or AUTO level.

**Trigger level resolution:**
signals within ± 5 V: 20 mV
signals outside ± 5 V: 200 mV

**Trigger level setting accuracy:**
± 10 mV 1 % of setting

**AUTO trigger level:** Trigger level on input A (and B when required) is automatically set to 50 % of input signal amplitude. Frequency range: 100 Hz to 160 MHz (120 MHz to 160 MHz with limited temperature range; typ. +23 °C ± 5 °C)

**Trigger indicators:** Tri state LED-indicators;
On: Signal above set trigger level.
Off: Signal below set trigger level.
Blinking: Triggering occurs.

**Trigger slopes:** Positive or negative.

**Auxiliary functions PM6666**

**Power on/off:**
Switches counter power on/off. At power up a self test is performed.
and the counter is set to default settings.

**Default settings**
Function: FREQ A
Measuring time: 0.2 s
Coupling Input A: AC
Coupling input B: DC
AUTO trigger level: On
Trigger Slope A & B: Positive

**Reset:**
The RESET-button has three functions:
- **RESET:** Starts a new measurement. The settings are not changed.
- **LOCAL:** Makes the counter go to LOCAL operation, when in remote operation (unless Local Lock-Out is programmed).
- **START/STOP:** Opens/closes the gate in TOTALIZE A or B manual mode.

**Measuring time**
A measuring-time of 0.2 s, 1 s, 10 s or SINGLE can be selected. (When SINGLE is selected together with PERIOD, RATIO or TIME, the result is a single cycle measurement, but SINGLE together with FREQUENCY results in a fixed 3 ms measuring-time.

**Measuring rate:**
Approx. 5 measurements/s. Approx. 2 measurements/s when AUTO trigger level is switched on.

**Display time:**
Normally the display time equals the set measuring-time. When SINGLE is selected, a display time of 0.1 seconds is used.

**Display hold:**
The result of the current measurement will be frozen on the display. A new measurement starts when RESET button is pressed.

**SPECIFICATIONS PM6669**

**Measuring Modes**

**Frequency A or B (optional)**

**Frequency Range:**
Freq. A: 0.1 Hz...160 MHz
Freq. B: 70 MHz...1.3 GHz (option PM 9608B)
**Mode:** Reciprocal frequency counting.
**LSD displayed:** 2.5 x 10⁻² x FREQ / Measuring-time

**Frequency A/Ao**
A Frequency-A measurement is performed. The measured frequency is divided by the constant Ao before display. The resolution of the displayed ratio is determined by the FREQ A measurement. At power-on Ao is set to 1 (default).

**Frequency A-Ao**
A Frequency-A measurement is performed. The value of constant Ao is subtracted from the measured frequency before display. The resolution of the displayed difference is determined by the FREQ A measurement. At power-on Ao is set to 0 (default).

**RPM A**
A Frequency-A measurement is done. The measured frequency is multiplied with 60, and shown on the display as revolutions per minute (RPM).
Range: 6 RPM...720 x 10⁶ RPM

**Period A**
Range: 8 ns...2 x 10¹⁰s
**Mode:** Single period measurement (SINGLE) or period average measurement (at 0.2, 1 or 10 s measuring-times).
**LSD displayed:**
- SINGLE period measurement:
  (TIME < 100 s): 100 ns
  (TIME > 100 s): 5 x WIDTH / 10⁹s
- Period Average measurement:
  2.5 x 10⁻⁷ x PERIOD / Measuring time

**Totalize A**
Event counting is controlled by the START/STOP button. Sequential start-stop counts are accumulated. RESET closes the gate and resets the Frequency Counter to zero.
**Range:** 0...1 x 10¹⁰ with indication of k or M (kilo-pulses or Mega-pulses). The result is truncated if out of display range.

**Definitions PM6669**

**LSD displayed**
LSD = Unit value of the least significant digit displayed. All calculated LSD’s [see section Measuring functions] should be rounded to the nearest decade (e.g. 0.3 Hz is rounded to 0.1 Hz and 5 Hz to 10 Hz) and cannot exceed the 9th digit.

**Resolution**
Resolution = smallest increment between two measuring results on the display, due to the 1 count error.

**Freq. A, B, Period**
Resolution can be 1 LSD unit or 2 LSD units if:
- LSD x Measuring time / FREQ or PERIOD < 10⁻⁷
  the resolution is 2 LSD units (30% probability).
- Otherwise resolution is 1 LSD unit (70% probability).

**SINGLE Period A and Width A**
Resolution equals 1 LSD unit.

**Inaccuracy**
Inaccuracy, i.e. the relative error, depends on the following factors:
± Resolution / FREQ, PERIOD or
Input-A

Frequency range:
10 Hz...160 MHz (120 MHz to 160 MHz with limited temperature range; typ. +23 °C ± 5 °C)

Sensitivity,
Sine: 10 mVrms, 10 Hz to 120 MHz
30 mV rms typically, 120 to 160 MHz at room temperature
Pulse: 30 mV rms, 0.1 Hz...120 MHz

Coupling: AC
Impedance: 1 MΩ // 30 pF

Trigger levels:
3 different levels for triggering on signals with various duty factors, and AUTO.
- Symmetrical input signals, should be selected for input signals with a duty factor of 0.25...0.75.
- Positive pulses, for input signals with duty factor <0.25.
- Negative pulses, for input signals with duty factor >0.75.

AUTO trigger level:
The counter will make test settings and automatically select the best trig level setting. AUTO requires repetitive signals with a repetition rate > 100 Hz. AUTO is not active in TOTALIZE-A measurements.

Trigger slopes (via GPIB only):
Positive or negative.

Auxiliary functions PM6669

Power on/off:
Switches counter power on/off. At power up a self-test is made and the counter is set to default settings.

Default settings
Function: FREQ A
Measuring time: 0.2 s
Trigger level Offset: AUTO

Reset:
The RESET-button has three functions:
RESET Starts a new measurement. The settings are not changed.
LOCAL Makes the counter go to LOCAL operation, when in remote operation (unless Local Lock-Out is programmed).
START/STOP, Opens/closes the gate in TOTALIZE A.

Measuring-time
A Measuring-time of 0.2 s, 1 s, 10 s or SINGLE can be selected. (When SINGLE is selected together with PERIOD or WIDTH, the result is a single cycle measurement, but SINGLE together with FREQUENCY or RPM results in a fixed 3 ms Measuring-time.)

Measuring rate:
Approx. 5 measurements/s.

Display time:
Normally the display time equals the set Measuring-time. When SINGLE is selected, a display time of 0.1 seconds is used.

Displ. Hold/Store Ao:
The DISPL HOLD/STORE AO button has two functions DISPL HOLD: The current measurement result is frozen on the display. A new measurement starts when RESET button is pressed.
STORE AO: This function is active in FREQ A measurements only. When the button is pressed for > 1 s, the result on the display is stored as the constant AO, which is used for the calculation of Frequency difference (A-A0) and ratio (A/A0).

Blank digits
This function blanks any number of least significant digits on the display, in order to hide unstable digits on the display.

General Specification PM6666 & PM6669

RF Input 1.3 GHz
(Option PM 9608B)
PM6666 Input C
PM6669 Input B
Freq. range: 70 MHz to 1.3 GHz

Coupling: AC

Operating input voltage range:
10 mV rms to 12 V rms, 70 MHz to 900 MHz
15 mV rms to 12 V rms, 0.9 to 1.1 GHz
40 mV rms to 12 V rms, 1.1 to 1.3 GHz

AM tolerance: 98 %, minimum signal must exceed minimum operating input voltage requirement

Impedance: 50Ω nominal, VSWR <2:1

Maximum voltage without damage:
12 V rms, overload protection with PIN diodes.

External reference input D
The input automatically detects when a suitable external reference signal is connected. The use of an external reference signal is indicated on the display.

Input frequency: 10 MHz ± 0.1 MHz

Coupling: AC
Sensitivity: 500 mV rms
Input impedance: approx. 300 Ω at 10 MHz
Max input voltage: 15 V rms

Power requirements
Line voltage: 115 or 230 V rms ±15 %; 46 to 440 Hz, (<24 VA incl. all options).
Safety:
According to CE publication 73/23 EN10101, CAT II, Pollution Degree 2;
CSA 22.2 No.231.

Line interference:
According to CE regulation 89/336: Emission according to EN 50081-1,
EN 55011. Immunity according to EN 50082-1, inclusive IEC 801-2,-3,-4

Battery unit:
See PM 9605 option.

Dimensions and weight:
Dimensions: Width: 186 mm  
Height: 88 mm Depth: 270 mm

Weight:
PM 6666: Net: 2.4 kg, Shipping: 3.2 kg
PM 6669: Net: 2.1 kg, Shipping: 3.0 kg

Cabinet:
The counter is housed in a metal cabinet, to minimize electromagnetic interference and achieve good mechanical stability.

Environmental conditions:
Temperature:
Operating: 0 °C to +50 °C
Storing: -40 °C to +70 °C

Altitude:
Operating: 5000 m (53.3 kN/m2)
Storing: 15000 m (15.2 kN/m2)

Humidity:
Operating: 10 % to 90 % RH, no condensation
Storing: 5 % to 95 % RH

Display:
Read out: 9 digit LCD display with unit indication.

Unit indication: MHz, kHz, Hz, mHz, ks, s, ms, s, ns, M, k, m and n.

GATE indicator: Indicates that the counter is busy measuring.

REMOTE indicator: indicates when control over the counter is taken over by an installed GPIB interface PM 9604.

Cursor: Indicates selected measuring function, selected Measuring-time, input triggering, display hold and whether an external reference frequency is in use.

TimeBase Crystal Oscillators:

Standard Crystal Oscillator
(order no PM 666/-1-)

Uncertainty due to:
Calibration adjustment tolerance, at +23°C ± 3°C < 1 x 10^4

Aging
- per 24 hr. N/A.
- per month: < 5 x 10^-2 (5 Hz)
- per year: < 5 x 10^-4 (50 Hz)

Temperature variation:
- 0 to 50°C: < 1 x 10^-6 (100 Hz)
- 20°C – 26°C: < 3 x 10^-6 (typical value)

Power voltage variation 10 %: < 1 x 10^-4 (0.1 Hz),

Power-on stability:
- Deviation versus final value after 24hr on time, N/A.
- after a warm-up time of: 30 min

Typical total uncertainty, for operating temperature 20°C to 26°C, at 2s (95 %) confidence interval:
- 1 year after calibration < 6 x 10^-7
- 2 years after calibration < 1 x 10^-6

The MTCXO can be ordered separately for later upgrading of the counter (option PM 9607).

MTCXO working principle:
[Mathematically Temperature Compensated Crystal Oscillator]
The temperature of the crystal is measured. The built in microprocessor calculates the frequency deviation for that particular temperature from a stored table. The measuring result is mathematically corrected for the time-base frequency temperature error, before being displayed. The correction is switched off when SINGLE is selected to increase the number of measurements/second. This may introduce an additional time base error of < 1 x 10^-6.

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 from frequency drift due to aging and ambient temperature variations versus the reference temperature. The operating
temperature range and the calibration interval are part of this specification.

**GPIB Interface**

**Option PM 9604**
- **Mounting:** Inside counter cabinet.
- **Interface functions:** SH1, AH1, T5, L4, SRI, RL1, DC1, DT1, E2
- **Address setting:** Switch selectable at rear panel between 0 and 30. Factory Preset at 10.

**Programmable device Functions for:**
- **PM 6666** Full GPIB programmability, Auto trigger, Voltage Measurements.
- **PM 6669** All front panel settings except Power On/Standby, Sensitivity and Filter On/Off; plus trigger Slope (Pos/Neg)

**Max Data Output Rate**
- **Normal Mode:** Approx. 5 readings/s
- **High-Speed Dump:** Approx. 100 readings/s.

**Output Time for measuring Data**
- **Normal Mode:** Approx. 10 ms (21 bytes)
- **High-Speed Mode:** Approx. 4 ms (15 bytes)
- **Response time for Addressing:** Approx. 5 µs
- **Response Time for Trigger Command (GET):** Approx. 10 ms
- **Typical Read Time for Programming Data:** Approx. 1 ms/byte

**Battery unit PM 9605**
The PM 9605 is a rechargeable battery unit for mounting inside the counter. The unit contains a standard 6 V sealed lead-acid battery and an automatic battery charger.

**Battery capacity (20 °C):**
- Approx. 15 Wh

**Operating time when battery powered for:**
- **PM 6666** 2 hours of cont. operation.
- **PM 6669** 3 hours of cont. operation.

**Recharging time:** 7 hours to approx. 75% of full capacity.

**Battery protection:** Overcharge protection and auto-shut-off total discharge protection.

**Temperature:**
- Operating: 0 ...+ 40 °C
- Storage: -40 ... + 50 °C
- Weight: 0.8 kg

**Carrying Case PM9609**
The PM9609 is a leather-like carrying case, for protection of the counter during transportation.

**Ordering Information**
- **Basic Models**
  - PM 6666/011 Timer/Counter
  - PM 6669/011 Frequency Counter
- **Included with Instrument**

**Optional Configurations**
When ordering, select basic “PM” Model desired from above, plus construct a 3-digit/suffix by selecting 1-digit in each suffix column to identify Input Frequency, Reference Oscillator, and Interface.

**RF Input Frequency Option**
- /0- - Standard 160 MHz
- /4- - 1.3 GHz (PM 9608/201)

**Reference Oscillator Option**
- /1 - Standard
- /3 - MTCXO (PM 9607/00)

**Interface Option**
- /-1 Standard line voltage, non GPIB/IEEE-488
- /-3 Battery (PM 9605/00)
- /-6 GPIB/IEEE-488 (PM 9604/00)

**Options & Accessories**
- **PM 9581/011** 50Ω Termination, 3W
- **PM 9585/011** 50Ω Termination, 1W
- **PM 9604/001** * GPIB Interface
- **PM 9605/001** * Battery Unit
- **PM 9606/021** Rack kit for PM 666x and 8840A/42A
- **PM 9606/011** Rack Kit for PM 666x
- **PM 9607/001** MTCXO Time Base
- **PM 9608/201** 1.3 GHz RF-Input
- **PM 9609/001** Carrying Case

All options can be field installed by the user.
* Note: Options PM 9604 and PM 9605 cannot be installed together in a PM 666x Counter.

**Manuals**
- **PM 6666 Operator**
- **PM 6669 Operator**
- **PM 6669 Service**

**Factory Warranty**
- One-year product warranty.

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Fluke Corporation
P.O. Box 9090, Everett, WA 98206

Fluke Europe B.V.
P.O. Box 1186, 5602 BD Eindhoven, The Netherlands

For more information call:
In the U.S.A.: (800) 443-5853
or Fax: (425) 356-5116
In Europe/M-East:
+31 (0)40 2 678 200
or Fax: +31 (0)40 2 678 222
In Canada: (905) 890-7600
or Fax: (905) 890-6866
From other countries:
+1(425) 356-5500
or Fax: +1 (425) 356-5116
Web access: http://www.fluke.com

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