2. TECHNICAL SPECIFICATION

Measuring modes

Frequency

Range: 0.1 Hz...120 MHz (PM 6670, 6671). 0.1 Hz...1 GHz (PM 6672).

Mode: Input-signal synchronized, high resolution computing measuring method (reciprocal).

Signal mode: CW, SINGLE BURST, MULTIPLE BURST FREQUENCY AVERAGE. In the FREQUENCY AVERAGE mode (rear panel selectable), the counter measures the average of a multiple of frequency samples. Samples are taken with external gate control (≧500 ns) and totalized during the selected measuring time (10 ms...96 s) to allow multiple burst frequency measurements or to sample frequency sweep profiles.

LSD displayed: 10^{-7} Hz...10^{3} Hz (PM 6670, 6671). 10^{-7} Hz...10^{4} Hz (PM 6672), depending on measuring time and input frequency. At least 7 digits displayed per second of measuring time.

Resolution: LSD*.

Inaccuracy (rel. error):

$$\pm\frac{\text{resolution}}{\text{FREQ}} \pm \frac{\text{trigger* error}}{\text{measuring time}} \pm \text{rel. time base error.}$$

Period average

Range: 100 ns...100 s

LSD displayed: 10^{-15}...10^{-6} s, depending on measuring time and period duration. At least 7 digits displayed per second of measuring time.

Resolution: LSD*.

Inaccuracy (rel. error):

$$\pm\frac{\text{resolution}}{\text{PERIOD}} \pm \frac{\text{trigger* error}}{\text{measuring time}} \pm \text{rel. time base error.}$$

Time interval A to B ; single

Range: 100 ns...10^{8} s.

LSD displayed: 10^{-7} s...10^{0} s.

Resolution: LSD*.

Inaccuracy (rel. error):

$$\frac{\pm\,\text{resolution} \pm \text{trigger* error}}{\text{TIME INT}} \pm \text{rel. time base error.}$$

Pulse width A

Pulse width measurements are similar to single time interval measurements. Both start and stop triggering take place in channel A, with common trigger level setting and automatic trailing edge trigger slope inversion with respect to selected leading edge trigger slope.

All other specifications are identical to single time interval. High resolution, pulse-width measurements on narrow pulses can be made in the time interval average mode with manual selection of common source and stop slope polarity.

Time interval A to B ; average

Range: 0 ns...100 s.

LSD displayed: 10^{-15}s...10^{-6}s, depending on measuring time and time interval.

Resolution:

$\frac{10^{-7}\text{s}}{\sqrt{N}}$ or, 1 LSD unit, whichever is greather.

Inaccuracy (rel. error):

$$\pm\frac{4\text{ ns} \pm \text{resolution}}{\text{TIME INT}} \pm \frac{\text{trigger* error}}{\sqrt{N} \times \text{TIME INT}}$$

± rel. time base error.

Number of intervals averaged (N): Measuring time x interval repetition rate.

Minimum dead time from stop to start: 300 ns.

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

Count A

Totalize range: 1...10^{17}, with indication of M-pulses and G-pulses beyond the 10^{8} display range.

Pulse pair resolution: 80 ns.

Mode:

Manual: Start-stop by DISPL. HOLD push button. Sequential start-stop periods are accumulated or individually totalized after reset.

External: Totalizing interval controlled via input B, selectable: count A gated during pulse duration on B or count A gated between start and stop pulse on B.

Inaccuracy: Pulse repetition rate A x trigger* error B.

Phase A—B

Phase is the result of a simultaneous time interval average and period average measurement. The maximum phase range is therefore limited, due to the 300 ns dead time between stop and start of the next time interval, and consequently frequency dependent. For phase measurements between 180° and 360° on high frequency signals, it is recommended to measure the complementary phase 0°...180° by changing the input leads (phase B to A).

Phase range: 0.1°...360° x |1-(300 ns x FREQ)|;

Example 0.1°...359.995° at 50 Hz
0.1°...357.3° at 25 kHz
0.1°...180° at 1.666 MHz

Frequency range: 0.03 Hz...1.6 MHz

LSD displayed: 10^{-6}...10^{-2} degrees, depending on measuring time and phase difference.

Resolution: $\frac{10^{-7}\text{s} \times \text{FREQ} \times 360°}{\sqrt{N}}$

Inaccuracy (rel. error):

$$\pm\frac{4\text{ ns} \times 360° \times \text{FREQ}}{\text{PHASE}} \pm \frac{\text{resolution}}{\text{PHASE}} \pm \frac{\text{trigger* error} \times \text{FREQ} \times 360°}{\sqrt{N} \times \text{PHASE}}$$

Number of input cycles averaged (N): Measuring time x FREQ A.

Minimum input signal: 100 mV_{rms}.

Phase jitter tolerance: The tolerated phase jitter peak-value ≤ phase difference, i. e. phase jitter around 0° should not cause consecutive measurement results of slightly above 0° and slightly below 360°, since the toltal measurement result is the statistical average of all individual results.

Ratio

Range:

$$\frac{\text{FREQ A}}{\text{FREQ B}} = \frac{0...10\text{ MHz}}{0...10\text{ MHz}} \text{ (all models)}$$

LSD displayed: 10^{-7}...10^{0}

Resolution: LSD*.

Inaccuracy (rel. error):

$$\pm\frac{\text{resolution}}{\text{RATIO}} \pm \text{rel. trigger* error B.}$$

Note: Frequency ratio measurements

$$\frac{\text{FREQ A (or C)}^{**}}{\text{FREQ D}} = \frac{0.01\text{ Hz}...120\text{ MHz (or 1 GHz)}^{**}}{50\text{ kHz}...10\text{ MHz}}$$

can also be made in the frequency mode, by making use of the external reference input D. However, this arrangement does not give correct decimal points.

** C only on PM 6672.

RPM

The RPM (revolutions per minute) mode is similar to the frequency mode. The measured frequency is multiplied x 60, before being displayed.

Range: 0.6 RPM...10^{8} RPM (with one pulse per revolution).

LSD displayed: 10^{-7} RPM...10^{0} RPM, depending on measuring time and RPM.

Resolution: LSD*.

Inaccuracy (rel. error):

$$\pm\frac{\text{resolution}}{\text{RPM}} \pm \frac{\text{trigger* error}}{\text{measuring time}} \pm \text{rel. time base error.}$$

* see definitions.

Auxiliary functions

Measuring time

The measuring time is "continuously" variable (33 steps/decade): 10 ms...96 s, with clear setpoints at 10 ms, 100 ms, 1 s, 10 s and 96 s. Selected measuring time is displayed, without any delay, when depressing the measuring time control.

The actual measuring time equals the selected measuring time plus the time needed to synchronize the measurement with an integer number of cycles of the input signal (Reciprocal measurements are synchronized with multiples of 10 input cycles).

In the FREQUENCY AVERAGE mode, the measuring time can be externally controlled to make burst frequency average measurements.

Hold-off PM 6671 only

With trigger hold-off activated, the counter ignores re-triggering (channel A) or stop triggering (channel B) during the set hold-off time. The hold-off time can be digitally measured by pressing CHECK. Applicable in all time modes.

Range: 200 µs...200 ms, in period, time interval and pulse width mode, the set hold-off time is visible with CHECK depressed.

On/off indication: LED indicates when hold-off is activated.

Monitor: The selected hold-off duration can be made visible via the gate monitor output.

On Stand By

In "ST BY" position, power is available to maintain an ovenized crystal oscillator heated and to recharge the optional battery pack.

Check

10 MHz internal reference connected to logic circuitry. Self-test of most measuring functions can be selected. By using this mode, the COUNT function provides a stop-watch facility.

Display hold

Depressing "DISP HOLD" button sets display time to infinite and freezes the last measurement result. A new measurement can be initiated using reset.

In the COUNT mode, the "DISP HOLD" control is used to start and stop manual totalizing.

Reset

Manual via pushbutton or electrical via input E.

Input and output specifications

Inputs A and B

Frequency range:

DC coupled: 0...120 MHz

AC coupled: 50 Hz...120 MHz

Rise time: Approx. 4 ns.

Sensitivity:

DC coupled: 10 mV_{rms} sine wave or 30 mV_{pp} (0...75 MHz).
20 mV_{rms} sine wave or 60 mV_{pp} (75...120 MHz).

AC coupled: 10 mV_{rms}...100 mV_{rms} sine wave (50 Hz...75 MHz).
20 mV_{rms}...100 mV_{rms} sine wave (75...120 MHz).

Attenuation: x 1/x 10 fixed.
For frequency related measurements, the fixed attenuator can be used in combination with the continuously variable attenuator x1...x10 (AC coupled position).

Noise immunity/hysteresis band:

DC coupled: approx. 20 mV_{pp}/200 mV_{pp}.

AC coupled: approx. 20 mV_{pp}...2 V_{pp}.

Dynamic input voltage range:

DC coupled: 30 mV_{pp}...5 V_{pp}/
300 mV_{pp}...50 V_{pp}.

AC coupled: 10 mV_{rms}...2 V_{rms}/
100 mV_{rms}...20 V_{rms}.

Trigger level:

DC coupled: −2.5 V...+2.5 V/
−25 V...+25 V.

AC coupled: fixed 0 V; level control acts as continuously variable attenuator, which is more suitable for frequency related measurements.

Trigger level output, not available on PM 6670: Set trigger voltages −2.5 V...+2.5 V, available on 1 mm jacks at the front for monitoring of set trigger level.

Trigger indicators, not available on PM 6670: Tri-state LED trigger lights to indicate trigger status:

On: trigger level is too low.

Blinking: triggering occurs, input signal crosses hysteresis band.

Off: trigger level is too high.

Coupling: DC/AC.

Impedance: Approx. 1 MOhm//35 pF, independent of sep/com switch position.

Channel input: Separate A and B or common A.

Noise filter: Switchable 50 kHz Low pass filter in channel A. Noise suppression approx. 40 dB at 1 MHz.

Maximum voltage without damage:

DC: 300 V.

AC: 260 V_{rms} at ≤440 Hz declining to 12 V_{rms} at ≥1 MHz (in ATT x 1 position). 260 V_{rms} (in ATT x 10 position).

Input C, PM 6672 only

Frequency range: 70 MHz...1 GHz.

Operating input voltage range:

15 mV_{rms}...12 V_{rms} (70 MHz...800 MHz).
25 mV_{rms}...12 V_{rms} (800 MHz...1 GHz).

Impedance: 50 Ohm nominal; VSWR <2.

Coupling: AC.

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

Maximum voltage without damage: 12 V_{rms}; overload protection with PIN diodes.

Ext. reference and Ratio input (channel D), not available on PM 6670

Frequency range: 1 kHz...10 MHz.

Sensitivity: 500 mV_{rms}.

Impedance: Approx. 2 kOhm.

Coupling: Ac.

Max. voltage without damage: 25 V_{rms}.

Note: As external reference frequency, only 10 MHz will give correct decimal point and unit indication. With the optional frequency multiplier PM 9697 references of 1 and 5 MHz can also be accepted.

Internal standard output (channel D), not available on PM 6670

Crystal frequency: 10 MHz.

Output level: LS-TTL compatible.

Output impedance: Approx. 400 Ohm.

Coupling: DC.

Overload protection: Short-circuit proof.

Ext. arming/Freq-avg/Reset (channel E), not available on PM 6670

A 3-position rear panel switch gives choice of external control over:

ARMING: In this position, the counter is prevented from starting a new measurement when input E is high. A high-to-low going pulse arms the counter to start a new measurement.

Note: Arming not applicable in COUNT A, manual mode.

FREQUENCY AVERAGE: Frequency measurements (max. 100 MHz) and period measurements are interrupted when input E is high. The measurement is continued again when input E is low. Each individual frequency sample must contain at least 20 pulses (FREQ mode) or 2 pulses (PERIOD mode).

The effective measurement time (defining resolution and accuracy) is the sum of external gate times that occurs during the selected measurement time.

EXT. RESET—START: Electrical reset, equivalent to the front panel RESET pushbutton. (See HOLD and RESET). Counter is reset when input E goes high. A new measurement can be made after input E has returned low.

Input levels:

High: ≥2 V.

Low: ≤0.5 V.

Input impedance: Approx. 2 kOhm.

Max. input voltage without damage: ±25 V.

Minimum pulse duration:

Arming and frequency avg: 500 ns.

External reset: 200 µs.

Gate monitor output (rear), not available on PM 6670

The gate-status monitor output permits observation on an oscilloscope of the measured time interval and the trigger hold-off time (PM 6671 only).

Output level:

Main gate open: approx. 0.4 V.

Hold-off active: approx. 1.2 V.

Main gate closed: approx. 2.5 V.

Output impedance: Approx. 1.5 kOhm.

Delay: Internal delay between actual triggering and gate monitor output is approx. 150 ns.

Overload protection: Short circuit proof.

General

Display

Read out: 8 digits, 7,6 mm high-efficiency LED's. Microprocessor control of display format, decimal point and unit indication: Hz, kHz, MHz, GHz, ns, µs, ms and s.

Display time: Continuously variable 80 ms...96 s plus DISP HOLD.

Gate lamp: Indicates that main-gate is opened and measurement takes place.

ST BT: Stand-by indication with LED when instrument is not switched ON.

REMOTE:** Indicates when control over counter is taken by the installed BUS interface option (IEC 625 — IEEE 488).

Low-battery:** Indication by blinking display some 15 min. before recharging is needed.

Power requirements

In addition to the normal line voltage supply, the PM 6671 and PM 6672 can also be powered from an optional battery pack or external DC voltage.

Line: 115/230 V ± 15%; 45...440 Hz; <25 VA.

Internal battery unit:** PM 9693.

External DC Cource:**

Voltage: 11.8 V...28 V; 4.5...8 W depending on version and options installed.

Connector: Battery jack fitting DIN 45323.

Line interference: Below VDE 0871 (B) and MIL STD 461.

Safety: According to IEC 348 and CSA 556 B.

** not available on PM 6670.

Dimensions and weight

Width: 210 mm (8.25 in).

Height: 89 mm (3.8 in).

Depth: 280 mm (11.0 in).

Weight:

Net: approx. 2.5 kg.

Shipping: approx. 3.6 kg.

Environmental conditions

Temperature:

Rated range of use: — 5°C...+50°C.

Storage and transport: —40°C...+70°C.

Humidity:

Operating: 10...90% RH, no condensation.

Storage: 5...95% RH.

Altitude/Barometric pressure

Operating: 5000 m (15000 ft) — 53.3 kN/m².

Storage: 15000 m (50000 ft) — 15.2 kN/m².

Vibration test: According to IEC 68 Fc.

Bump test: According to IEC 68 Eb.

Handling test: According to IEC 68 Ec.

Transport test: According to NLN-L88.

Definitions

LSD displayed

Unit value of Least Significant Digit, displayed.

For FREQUENCY, PERIOD AVERAGE, RPM and PHASE:

$$LSD = \frac{2.5}{\text{measuring time}} \times \frac{\text{FREQ or PERIOD or RPM or } 360°}{10^7\ \text{Hz}}$$

For RATIO: LSD =

$$= \frac{2.5 \times \text{prescaling factor (P)} \times \text{RATIO}}{\text{measuring time} \times \text{FREQ A or C}}$$

(P) = 1 Channel A, all models

(P) = 256 Channel C, PM 6672.

For SINGLE TIME INTERVAL and PULSE WIDTH:

LSD = 100 ns (for times <10 s).

$$LSD = \frac{5 \times \text{TIME}}{10^8}\ \text{(for times} \geq 10\ \text{s)}.$$

For TIME INTERVAL AVG: LSD =

$$= \frac{2.5 \times 10^{-7}\ \text{s}}{\text{meas. time} \times \text{time int. rep. rate in Hz}}$$

All calculated LSD's shall be rounded to nearest decade (e.g. 5 ns will be 10 ns and 0.4 Hz will be 0.1 Hz) and cannot exceed the 8th digit.

Resolution

For multiple event measurements:

FREQUENCY, PERIOD AVERAGE, RPM and RATIO, the resolution is the smallest increment between two measuring results, being most often 1 LSD unit. Due to arithmetic truncation, the resolution can be 2 LSD units if:

$$\frac{\text{LSD} \times \text{measuring time}}{\text{FREQ or PERIOD or RPM or RATIO}} < 10^{-7}\ \text{s}$$

but can then be reduced to 1 LSD unit, by doubling the measuring time.

For single event measurements:

PULSE WIDTH and SINGLE TIME INTERVAL, the measuring resolution is 100 ns (one clock pulse). The counter can accumulate up to 10^{15} clock pulses, of which only the 8 most significant digits are shown.

For statistical measurements:

TIME INTERVAL AVERAGE and PHASE, the measuring resolution is the smallest increment between two measuring results, with confidence level of 95%.

Trigger error

Trigger error is the absolute measurement error due to noise on the input signal causing a too early or too late triggering.

For any waveform (FREQ, PERIOD, RATIO, RPM and PULSE WIDTH):

$$\frac{\text{peak-to-peak noise voltage}}{\text{signal slope (V/s)}}$$

For sinewave (FREQ, PERIOD, RATIO, RPM):

$$\frac{1}{\text{FREQ} \times \pi \times \text{S/N ratio}}$$

Example: For S/N ratio of 100 (40 dB) and 1 second measuring time, the trigger error is: $\frac{3 \times 10^{-3}}{\text{FREQ}}$

For separate source TIME INTERVAL:

$$\frac{\text{peak noise voltage (input A)}}{\text{signal slope A (V/s)}} \pm \frac{\text{peak noise voltage (input B)}}{\text{signal slope B (V/s)}}$$

For PHASE:

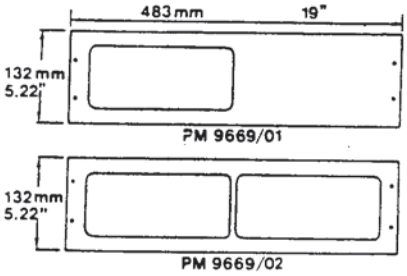
$$\frac{1}{\text{FREQ} \times 2\pi} \times \left[\frac{1}{\text{S/N ratio (input A)}} \pm \frac{1}{\text{S/N ratio (input B)}}\right]$$

Note: S/N ratios calculated with peak-to-peak signal and noise values.

Optional accessories

Rack mounting

The PM 6670-series counters can be fitted into a standard 19 inch rack, using adaptor PM 9669/01 or PM 9669/02 for one or two instruments respectively.



Carrying case PM 9672

To protect the instrument during transport and storage, an ever-ready case PM 9672 is optionally available.

Battery unit PM 9693

The PM 9693 is a rechargeable battery unit for mounting inside the PM 6670-series counters. The unit contains two standard 6V, sealed batteries of lead-acid type.

Battery capacity (typical at 20°C): 30 Wh; sufficient for 4 hours operation for the /01 and /02 models. For the high stability /03, /04 and /05 models, the capacity is sufficient for 3 hours operation or 20 hours stand-by.

Battery voltage: 12V nominal.

Recharging time: 5 h to approx. 75% or 10 h to >90% of full capacity.

Recharging power: From counter <12 W.

Battery low indication: By blinking display, 10...15 min. before recharging is needed.

Temperature:

Operating: 0...+40°C.

Storage: —40...+50°C.

Other environmental conditions as for PM 6670-series of counters.

Weight: 1.4 kg (3.1 lb).

BCD-output and Display offset unit PM 9694

The PM 9694 converts and buffers the counters serial BCD output data into parallel form. The unit offers also the possibility of adding or subtracting a programmable value to the measured value before being displayed and output. This latter feature allows adding or subtracting a reference frequency to the measured frequency e.g. measurement of tuned receiver frequency, by measuring the local oscillator (**IF offset**).

Installation: Inside the counter, BCD-output and offset inputs available on rear panel.

Output signals: 8 × 4 parallel data lines for 7 most significant digits plus decimal point; 8-4-2-1 BCD, TTL positive true logic plus 6 lines for exponent.

Ready: A low going pulse is given when measurement and data conversion have been finished; TTL level; pulse duration: approx. 40 µs.

Input command signals:

Ext. start: A low level on EXT START disables counting, when returned high, a new measurement will be initiated.

Inhibit: Data transfer is inhibited when signal is low.

Offset: Two different values can be programmed by soldering diodes on circuit board.

External selection by logic levels to select: offset on-off and offset value 1 or 2.

Connectors:

BCD-output: Amphenol or Cinch Series 57 Micro-ribbon.

Offset selection inputs: 2 mm banana sockets.

Analog recorder output PM 9695

The digital-to-analog converter PM 9695 provides a high resolution analog output e.g. for recording frequency stabilities of oscillators, filters and crystals on a Y-t chart recorder. In frequency control systems, having analog feed-back, the DAC serves as an extremely accurate frequency-voltage converter. The PM 9695 permits conversion of any three consecutive digits out of the total of nine, as such it functions as a magnifying glass to focus on just that part of the read-out which is most important. In the **normal mode** 000 is converted in a zero analog output and 999 into a full scale defelction.

In the **offset mode**, however, 500 gives a zero output and 000 a mid-scale deflection. Thus, for a display changing between 9.9999999 and 10.0000000 MHz, it is possible to record the frequency on the center of the strip chart, rather than shooting between zero and full scale.

Installation: Inside the counter, output connector and NORMAL/OFFSET-mode switch available on rear panel.

Decade conversion: Any 3 consecutive digits can be selected. The value of the least significant of the 3 digits can be selected with a 12 position switch.

Normal mode: Analog output is directly proportional to digital input. 000 produces 0.000 V. 999 produces 0.999 V.

Offset mode: Adds 500 to digital input to obtain half scale offset. 500 produces 0.000 V. 499 produces 0.999 V.

Output:

Zero output: 0 V.
Full scale deflection: 0.999 V.
Connector: BNC.

Accuracy: ±2 mV.

Nonlinearity: ±0.5 mV.

Temperature coefficient: ±(0.1 mV + 0.03% of reading)/°C.

Output impedance: 100 Ohm ±1%.

Weight: Approx. 160 g (0.35 lb).

IEC 625-IEEE 488 BUS interface PM 9696

When provided with this interface option, the PM 6671 and PM 6672 timer/counters are fully BUS compatible. Talker and listener functions in these counters allow bi-directional bus communication, including programmability of all major functions.

Installation: Inside the counter, connector and address switch available on rear panel.

Interface function repertoire: Frequency A, Period A, Single Time Interval A—B, Time Interval Average A—B, Pulse Width A, Count A (manual), Count A gated by B, Count A start/stop by B, Ratio A/B, Phase A—B, RPM, Hold-Off on/off, frequency input channel selection A or C, Frequency average/arming on/off, Display hold, Measuring time, Trigger (start measurement), Device clear, Program data out, Service request disable/enable.

BUS commands: SH1, AH1, T5, L3, SR1, RL1, DC1 and DT1.

Connector: IEEE recommended type. Amphenol or Cinch Series 57 Micro-ribbon. Compatibility with IEC recommended type is obtained via the optional screw-on IEEE-to-IEC connector transition PM 9483/50.

Ext. reference frequency multiplier PM 9697

To accept external reference frequencies other than 10 MHz, the frequency multiplier PM 9697 can be ordered.

With this option installed, the PM 6670-series counters can accept external reference frequencies of 1 MHz, 5 MHz or 10 MHz. All other input specifications as for external reference input.

PM 9581: 50 Ohm feed-through termination; 3 W.

PM 9585: 50 Ohm feed-through termination; 1 W.

PM 8923: 120 MHz*; 1 MOhm probe-set; 1:1 and 1:10.

PM 9639: 1.5 GHz*; 500 Ohm probe-set; 1:10.

PM 8943: 650 MHz; 50 Ohm/1 MOhm FET probe-set.

* Indicated frequency with limited loss of sensitivity suitable for frequency measurements. For amplitude measurements, a limited frequency range is specified in the T&M catalogue.

ATTENTION

The counters can NOT simultaneously be equipped with more than one of the following options: PM 9693, PM 9694, PM 9695 and PM 9696.

The multiplier PM 9697 can only be installed in the /01 counter versions.