Universal Frequency Counters
PM 6673...76

Operators' Manual

9499 460 10901
860901 Third edition

PHILIPS

**Industrial &
Electro-acoustic Systems**

PHILIPS

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

⚠

The counter is marked with this symbol when it is necessary for the user to refer to the manual.

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Printed in Sweden

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1. Technical specification

Introduction

The PM 6673...76 series of universal frequency counters offers automatic time and frequency measurements under microcomputer control.

For application in measuring systems, provision is made by an interface option for full IEC-625/IEEE-488 bus programmability. Other data interface options, like BCD and analog output, are also available.

An internal rechargeable battery unit is available to enable the counter to be used in field applications.

Measuring Modes

Frequency

Range

Sine: 10 Hz...120 MHz (PM 6673)
10 Hz...550 MHz (PM 6674)
10 Hz...600 MHz (PM 6675)
10 Hz... 1.5 GHz (PM 6676)

Pulse: Minimum frequency down to 0.1 Hz.

Mode: RECIPROCAL and CONVENTIONAL. For the highest possible resolution for both LF and HF measurements, the counter employs the RECIPROCAL mode for LF signals. Above 10 MHz it automatically uses the CONVENTIONAL mode.

For special applications, one can select either RECIPROCAL or CONVENTIONAL.

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^{-8} Hz...10^{2} Hz (PM 6673 and PM 6675), 10^{-8} Hz...10^{3} Hz (PM 6674 and PM 6676), depending on measuring time and input frequency. At least 7 digits displayed per second of measuring time.

Resolution: LSD*

Inaccuracy (rel.error):

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

Period average

Range: 100 ns...100 s.

LSD displayed: 10^{-16}...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):

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

Ratio

Range:

$\frac{\text{FREQ A}}{\text{FREQ D}} = \frac{10\,\text{Hz}...120\,\text{MHz}}{1\,\text{kHz}...10\,\text{MHz}}$ (PM 6673)

$\frac{\text{FREQ A or B}}{\text{FREQ D}} = \frac{10\,\text{Hz}...550\,\text{MHz}}{1\,\text{kHz}...10\,\text{MHz}}$ (PM 6674)

$\frac{\text{FREQ A or B}}{\text{FREQ D}} = \frac{10\,\text{Hz}...600\,\text{MHz}}{1\,\text{kHz}...10\,\text{MHz}}$ (PM 6675)

$\frac{\text{FREQ A or B}}{\text{FREQ D}} = \frac{10\,\text{Hz}...1.5\,\text{GHz}}{1\,\text{kHz}...10\,\text{MHz}}$ (PM 6676)

LSD displayed:
10^{-8}...10^{-1} (A/D all models and B/D; PM 6675)
10^{-8}...10^{0} (B/D; PM 6674)
10^{-8}...10^{0} (B/D; PM 6676); depending on measuring time and ratio.

Resolution: LSD*

Inaccuracy (rel.error):

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

Count

Totalize range: 1...10^{17}, with indication of k-pulses, M-pulses and G-pulses beyond the 10^{9} display range.

Frequency range:
Sine: 10 Hz...10 MHz
Pulses: 0 Hz...10 MHz

Sequential start-stop periods are accumulated or individually totalized after reset.

** see definitions*

Choice of crystal oscillators

PM 667./0. version including timebase option	/01 standard version	/02 version PM 9678	/03 version PM 9679	/04 version PM 9690	/05 version PM 9691
Stability against	Standard	TCXO	Oven	Oven	Oven
Ageing: /24 h /month /year	n.a. $< 5 \times 10^{-7}$ $< 5 \times 10^{-6}$	n.a. $< 1 \times 10^{-7}$ $< 5 \times 10^{-7}$	n.a. $< 1 \times 10^{-7}$ $< 5 \times 10^{-7}$	$< 1.5 \times 10^{-9}$** $< 3 \times 10^{-8}$ $< 1.5 \times 10^{-7}$	$< 5 \times 10^{-10}$** $< 1 \times 10^{-8}$ $< 7.5 \times 10^{-8}$
Temperature: 0...50°C ref. to + 23°C	$< 1 \times 10^{-5}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-7}$	$< 3 \times 10^{-8}$	$< 5 \times 10^{-9}$
Change in measuring - and supply mode; line/int. battery/ext. DC 12 V... 28 V	$< 3 \times 10^{-7}$	$< 5 \times 10^{-8}$	$< 1 \times 10^{-8}$	$< 3 \times 10^{-9}$	$< 3 \times 10^{-9}$
Line voltage; ± 10 %	$< 1 \times 10^{-8}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 5 \times 10^{-10}$	$< 5 \times 10^{-10}$
Warm-up time to reach; 10^{-7} of final value	n.a.	n.a.	< 10 min	< 15 min	< 15 min

** see definitions*

*** After 48 hours of continuous operation.*

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 frequency 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.

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 "DISPL HOLD" control is used to start and stop totalizing.

Reset

Manual via pushbutton or electrical via input E.

Input and Output Specifications

LF-input (channel A)

Frequency range: 10 Hz...120 MHz.

Sensitivity:
Sine: 10 mV_{rms} (20 Hz...120 MHz), 6 dB down at 10 Hz.
Pulse: 30 mV_{p-p} (0 Hz...120 MHz), minimum pulse duration 4 ns.

Attenuation: Continuously variable in two ranges between ×1...×500. Noise immunity band (hysteresis band) can be continuously adjusted over the range: 20 mV_{p-p}...10 V_{p-p} nominal.

Noise filter: Switchable 50 kHz Low Pass filter. Noise suppression ≥ 20 dB at 500 kHz.

Impedance: 1 MOhm//≤ 25 pF

Trigger level: Switchable with waveform selectors for optimum triggering on signals of various duty factors.

⎍: for duty factor of < 0.25
∿ : for duty factor of 0.25...0.75
⎍: for duty factor of > 0.75

Coupling: AC.

Maximum voltage without damage:
DC: 300 V.
AC: 260 V_{rms} at ≤ 440 Hz declining to 12 V_{rms} at ≥ 1 MHz (in 10 mV_{rms} range), 260 V_{rms} (in 200 mV_{rms} range).

RF-input (channel B)

Frequency range:
PM 6674: 50 MHz.. 550 MHz; 6 × prescaled.
PM 6675: 50 MHz...600 MHz; direct gating.
PM 6676: 100 MHz...1.5 GHz; 16 × prescaled.

Operating input voltage range:
10 mV_{rms}...12 V_{rms}
PM 6675: sensitivity is 5 mV_{rms} (100 MHz...500 MHz).
PM 6676: sensitivity above 1 GHz decreases to 30 mV_{rms} (worst-case) or 15 mV_{rms} (typical) at 1.5 GHz.

Impedance: 50 Ohm nominal; VSWR < 2.

Coupling: AC.

AM tolerance: 98%; minimum signal must exceed 30 mV_{p-p}.

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

Ext. reference and Ratio input (channel D)

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.

Ext. arming/Freq-avg/ Reset (channel E)

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 mode.

FREQUENCY A AVERAGE: When making reciprocal frequency or period measurements, the measurement is interrupted when input E is high. The measurement is continued again when input E is low.

To allow frequency average measurements up to 100 MHz, the automatic switching to the CONVENTIONAL mode above 10 MHz is omitted.

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 push-button. (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.

Timebase oscillator output

Crystal frequency: 10 MHz.

Output level: LS-TTL compatible.

Output impedance: Approx. 400 Ohm.

Coupling: DC.

Overload protection: Short-circuit proof.

General

Display

Read out: 9 digits, 11 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 BY: 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.

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.

Power requirements

These counters can be powered from: the line voltage, and optional battery pack or external battery voltage.

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

Internal battery unit: PM 9693.

External DC Source:
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.

Environmental conditions

Temperature:
Rated range of use: − 5°C...+50°C.
Functional operation: −10°C...+55°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 < 10 MHz or Period Average:

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

For Frequency > 10 MHz:

$$LSD = \frac{2.5 \times \text{prescaling factor}^{(p)}}{\text{measuring time}}$$

For Ratio:

$$LSD = \frac{2.5 \times \text{prescaling factor}^{(p)} \times \text{RATIO}}{\text{measuring time} \times \text{FREQ A or B}}$$

All calculated LSD's shall be rounded to nearest decade (e.g. 5ns will be 10ns and 0.4 Hz will be 0.1Hz) and cannot exceed the 9th digit.

(p) = 1 Channel A, all models.
(p) = 6 Channel B, PM 6674.
(p) = 1 Channel B, PM 6675.
(p) = 16 Channel B, PM 6676.

Resolution

Smallest increment between two measuring results, being most often 1 LSD unit. Due to arithmetic truncation the resolution can be 2 LSD units, but can then be reduced to 1 LSD unit, by doubling the measuring time.

The resolution is 2 LSD units: if

$$LSD < \frac{1}{\text{measuring time}} \quad (\text{Freq.} > 10\,\text{MHz})$$

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

(Freq. ≤ 10 MHz, Period or Ratio).

In all other cases the resolution is 1 LSD unit.

Rel. Trigger error

For any waveform:

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

For sinewave:

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

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

Accessories

Supplied with the instrument:

- Line power cord
- Fuse, 1.6 A fast-blow
- Front cover
- Manual

To be ordered separately:

PM 9678: TCXO, 1×10^{-7}/month. included in version/02.

PM 9679: Proportionally oven controlled oscillator 1×10^{-7}/month. Included in version/03.

PM 9690: Proportionally oven controlled oscillator $1{,}5 \times 10^{-9}$/24 h. Included in version/04.

PM 9691: Proportionally oven controlled oscillator 5×10^{-10}/24 h. Included in version/05.

PM 9693: Battery unit.

PM 9694: BCD output and display offset unit.

PM 9695: Analog recorder output (DAC).

PM 9696: IEC625/IEEE488 BUS interface.

PM 2296/50: IEEE-to-IEC adapter.

PM 2295/05: IEEE cable, 0,5 m.

PM 2295/10: IEEE cable, 1 m.

PM 2295/20: IEEE cable, 2 m.

PM 9697: External reference frequency multiplier.

PM 8923: 120MHz, 1Mohm probe set, 1:1 and 1:10.

PM 8943: 650MHz, 50ohm/1Mohm FET probe set, 1:1-10-100.

PM 9639: 1,5GHz, 500ohm probe set 1:10.

PM 9581: 50 ohm feed-through termination, 1W.

PM 9585: 50 ohm feed-through termination, 3W.

PM 9074: Coaxial cable, 50 ohm, BNC to BNC, 1m.

PM 9588: Set of 15 coaxial cables, 50 ohm, BNC to BNC.
5 cables (20.7 cm), 4 cables (40.5 cm), 3 cables (60.3 cm), 3 cables (198.6 cm).

PM 9669/01: 19" rack mount adapter to fit one instrument.

PM 9669/02: 19" rack mount adapter to fit two instruments.

PM 9672: Carrying case.

NOTE: The timebase oscillators, PM 9678, -79, -90 and -91, can also be ordered separately for later upgrading of the counters. 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 simultaneously with the /01 oscillator. In /02.../05 versions the oscillator must be removed before a PM 9697 can be plugged in.

2. Installation instructions

General information

This counter has been designed and tested in accordance with IEC Publication 348, Safety requirements for electronic measuring apparatus for Class 1 instruments, and has been supplied in a safe condition. The present manual contains information and warnings that shall be followed by the user to ensure safe operation and to retain the counter in a safe condition.

Before connecting the counter to the line (mains), visually check the cabinet, controls, connectors, etc, to ascertain whether any damage has occurred in transit. If any defects are apparent, do not connect the counter to the line.
All components on the primary side of the line transformer are CSA approved and should only be replaced with original parts.

Claims: In the event of obvious damage, missing parts or if the safety of the counter is suspected, a claim should be made to the carrier immediately. A PHILIPS Sales or Service organisation should also be notified in order to facilitate the repair of the counter.

Grounding

The counter is connected to ground via a three-core line cable, which must be plugged into a socket outlet with a protective ground contact. No other method of safety grounding is permitted for this counter.

When the counter is brought from a cold to a warm environment, condensation may cause a hazardous condition. Therefore, ensure that the grounding requirements are strictly met.

Warning: Any interruption of the protective ground, inside or outside the counter is dangerous. Line extension cables must always have a protective ground conductor.

Opening of the cabinet

The counter shall be disconnected from all voltage sources before any adjustment, replacement, maintenance or repair is effected with the covers removed.

If adjustment or maintenance of the counter with the covers removed is inevitable, it shall be carried out only by a skilled person, who is aware of the hazard involved.

Bear in mind that capacitors inside the counter may still retain their charge, even if the counter is disconnected from all voltage sources.

Warning: Opening of the cabinet or removing of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals that can be dangerous to life.

Line voltage setting

Before connecting the counter to the line, ensure that it is set to the local line voltage.

On delivery, the counter is set to either 115V or 220V, as indicated on the line voltage selector on the rear panel. If the voltage setting is incorrect, set the line voltage selector in accordance with the local voltage, before connecting the counter to the line.

External battery operation

For field applications, the counter can be operated from an external 11.8...28V_{DC} supply, connected to the EXT BATT socket.

Connecting the counter to both the line and an external battery at the same time, gives a power back-up facility that maintains heating of the oven oscillator and recharges the optional internal battery pack PM9693 when fitted. For proper recharging, the external battery has to deliver at least 20 V_{DC}

Fuses

The counter is protected by a thermal fuse, located in the line transformer, and a secondary fuse (1.6A fast-blow) on PCB U1. Remove the line plug before fitting a fuse. Ensure that only fuses of the specified type are used.

If the counter is set for operation on 115 V line voltage, but is connected to 220 V supply, the thermal fuse will blow immediately to protect the counter.

Type	Service code number
Thermal fuse	4822 252 20007
1.6A fast-blow fuse 5x20mm	4822 253 20022

Operating position

The counter can be operated in any desired position. A fold-down tilting handle can be rotated and locked in several fixed positions by first depressing the knob at the side of the handle.

Front cover

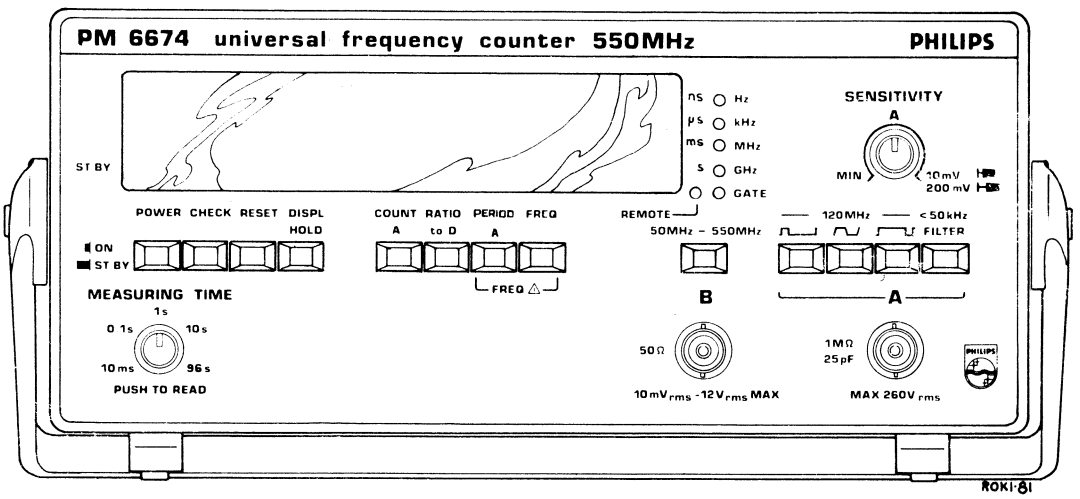
The front panel controls and connectors can be protected by a plastic snap on the front cover, service code number 5322 447 84642

Cleaning the counter covers

The top and bottom covers, lacquered with Nextel suède coating, need special treatment if the surface gets soiled. The 3M Company has developed a "Doolebug Pad" (Catalogue No.8440) which when soaked in water, ethanol or common household cleaning agent, will penetrate holes and pores to restore its former lustre.

Note: Abrasive cleaning pads will result in surface scratches. Although the Nextel suède coating is ethanol resistant, it is susceptible to methylated spirit, which could damage the surface due to one of the denaturing substances present.

3. Operating instructions



Front Panel Controls

POWER

Supplies power to the counter in the ON position (depressed).
In the ST BY position (released) the counter is switched off, but power is still available for the oven oscillator and the rechargeable battery.

WARNING: This is a secondary power switch. Even in the ST BY position the counter contains live conductors and parts. The line cord (mains lead) must be removed to disconnect power from the counter.

MEASURING TIME, PUSH TO READ

Measuring time can be selected betwen 10 ms and 96 s, for optimum resolution and measuring speed.

Incorporates a "PUSH TO READ" switch for immediate display of measuring time.

CHECK

When depressed, connects the internal 10 MHz standard signal to the logic circuits.

In conjunction with the function selector pushbuttons, CHECK enables a self-test of most measuring functions.

RESET

When depressed, resets the counter and blanks the display. On release, RESET initiates a new measurement.

DISPL HOLD

When DISPLAY HOLD is depressed, the display time is set to infinity, ∞. A new measurement can be started with the RESET pushbutton.

COUNT A

Sets the counter to totalize events (pulses or periods) on Input A during the time interval between releasing and depressing the DISPL HOLD pushbutton.

The result can be accumulated with another count sequence or reset with the RESET button.

RATIO to D

Sets the counter to measure the ratio between signals applied to inputs A and D, or B and D. Connect the lower frequency signal to input D (on rear panel).

PERIOD A

Sets the counter to perform period average measurements on the signal applied to input A. The number of signal periods that are measured in a period average measurement depends on the MEASURING TIME setting and the period duration of the input A signal.

FREQ

Sets the counter to perform frequency measurements on the input A signal, operating in the auto frequency mode.

The counter selects automatically between reciprocal and conventional measuring method to ensure the best possible resolution.

For input B signals, the counter always performs a conventional frequency measurement.

NOTE: In the frequency average mode, selected on rear panel, measurement is performed in the reciprocal mode up to 100 MHz.

FREQ ⚠

PERIOD A and FREQ depressed simultaneously give a conventional frequency measurement of the input A signal over the whole frequency range of 10 Hz to 120 MHz.

50 MHz – 550 MHz (PM 6674)

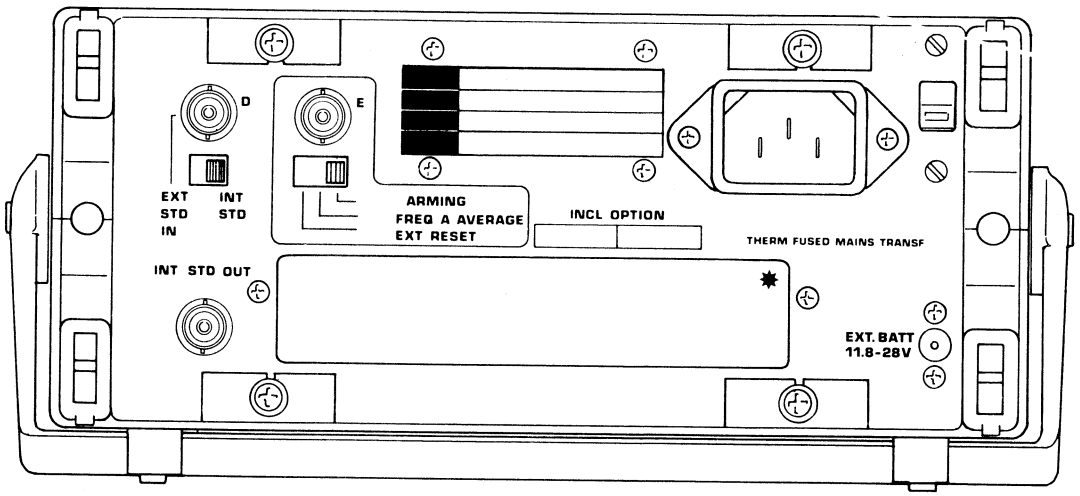
50 MHz – 600 MHz (PM 6675)

100 MHz – 1,5 GHz (PM 6676)

Pushbutton depressed, selects channel B input.
Not fitted on PM 6673.

GATE

LED indication that a measurement is in progress.



Rear Panel Controls

SENSITIVITY

A continuously-variable sensitivity control incorporating a push-pull switch for the two ranges:

20 mV_{pp} to 1 V_{pp} (push)
200 mV_{pp} to 10 V_{pp} (pull)

INPUT A

Low-frequency, LF, input socket A for frequency, period, count and ratio measurement.

INPUT B

High-frequency, HF, input socket B for frequency and ratio measurements.

WAVEFORM SELECTOR PUSHBUTTONS

For optimum sensitivity and reliable triggering, depress the appropriate pushbutton:

⎍ for signals with a duty factor less than 0.25.

∿ for signals with a duty factor of 0.25–0.75.

⎍ for signals with a duty factor greater than 0.75.

<50 kHz FILTER

A low-pass filter to improve triggering when measuring noisy signals.

UNIT INDICATOR

A multi-purpose 4-LED Unit Indicator.

For FREQ read: Hz, kHz, MHz, GHz.

For PERIOD A and MEASURING TIME read: ns, µs, ms, s.

For COUNT A read: µs/kHz = 10^3 pulses
ms/MHz = 10^6 pulses
s/GHz = 10^9 pulses

REMOTE

LED indication that the counter is in the remote-controlled mode via the optional Bus interface PM 9696.

LINE INPUT

Line (mains) input.

LINE VOLTAGE SELECTOR

Line voltage selector, switchable between 115 V and 220 V AC.

EXT BATT

Input from an external DC source of 11.8...28 V.

SLOT✸

Opening for mounting of options, e.g. Battery unit PM 9693, BCD output/display offset unit PM 9694, Digital to analog converter PM 9695, IEEE Bus interface PM 9696.

INT STD OUT

An output for the internal 10 MHz standard signal.

EXT STD IN/INT STD

Two-position switch selection of standard signal from the internal 10 MHz oscillator or from an external 10 MHz source.

INPUT D

Input socket for an external standard signal, and the lower frequency in a "RATIO to D" measurement.

INPUT E

Input socket for "arming", "frequency A average" or "external reset" signal.

ARMING, FREQ A AVERAGE or EXT RESET

Three-position slide switch for selecting the functions of Input E.

Theory of Measurements

Optimum setting of trigger controls

Correct triggering is based on knowing how best to exploit the hysteresis band (trigger window) characteristics of the input circuit, see Fig.3.1.

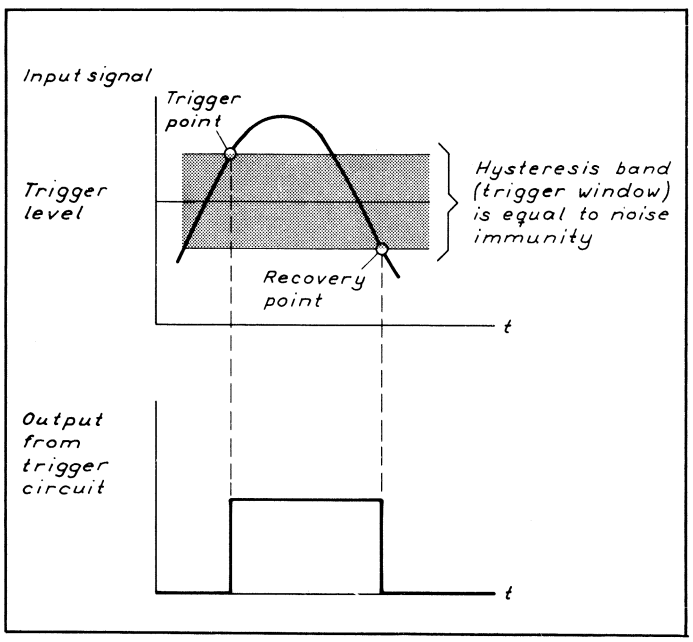


Fig.3.1. Visualization of the trigger function.

The width of the hysteresis band at the input, is the same as the effective input sensitivity in V_{pp}.
The ideal hysteresis band is 50–60% of the signal's peak-to-peak value. Too narrow a hysteresis band, i.e. too high sensitivity, means that the counter is too sensitive to noise see Fig.3.2.

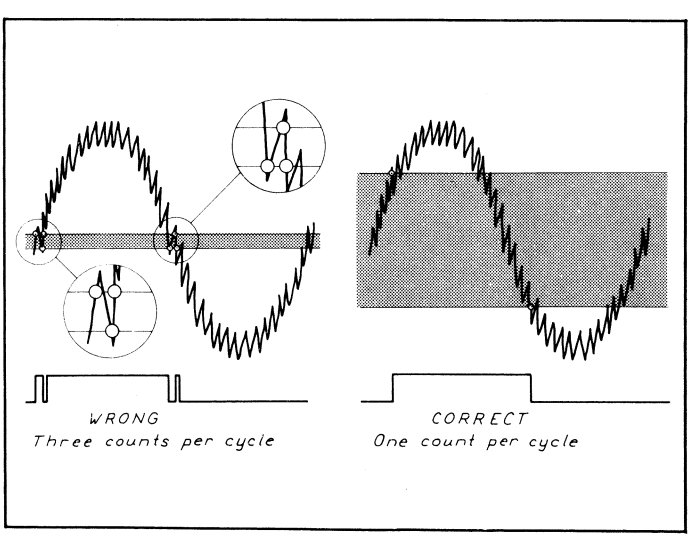


Fig.3.2. Do not use higher sensitivity than needed for correct triggering.

The hysteresis band is centred around the trigger level. For AC-coupled inputs, the trigger level is 0V, which is the same as the average DC-component of the AC-coupled signal. With symmetrical input signals, the hysteresis band is centred at 50% of the signal's peak-to-peak value. However, the average DC-component of non-symmetrical signals is not centred at 50% of the signal's peak-to-peak value, which could lead to problems, as shown in Fig.3.3.

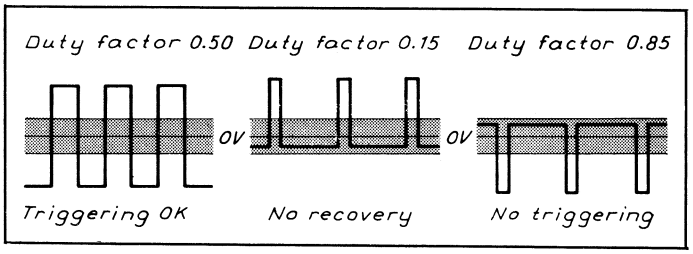


Fig.3.3 Non-symmetrical signals could lead to problems.

The solution in PM6673...76 is to offset the hysteresis band, by depressing one of the three push-buttons marked ⎍⎍, ⎍⎍ and ⎍⎍ as illustrated in Fig.3.4.

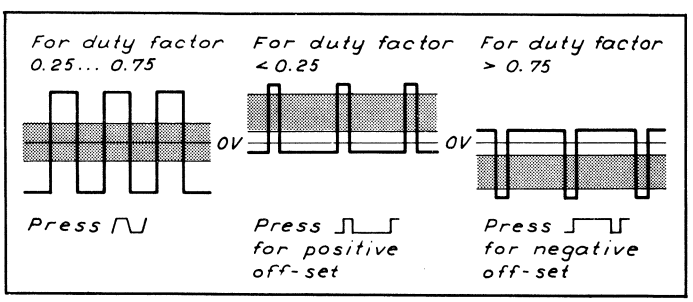


Fig.3.4. Optimum trigger level setting by three waveform select push-buttons.

Even with non-symmetrical signals, it is possible to obtain triggering by increasing the input sensitivity, instead of offsetting the trigger level. However, this is NOT RECOMMENDED, since this gives a poor noise immunity. The relationship between required input voltage and duty factor is illustrated in Fig.3.5.

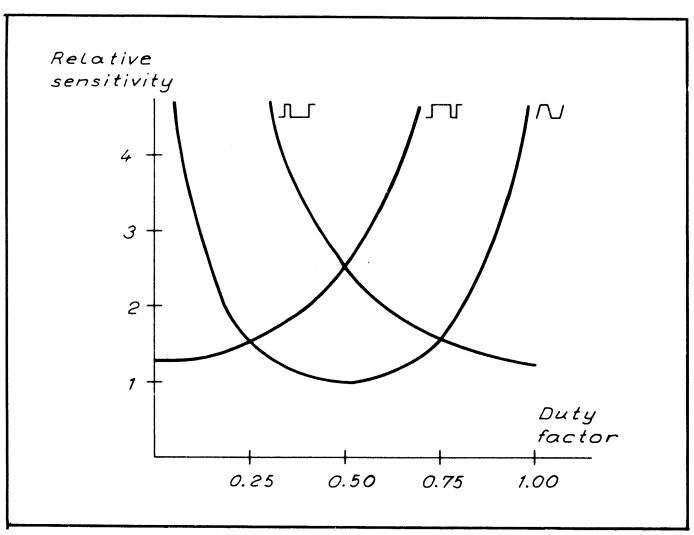


Fig.3.5. The relationship between required input voltage and duty factor

When the input signal's duty factor or waveshape is unknown, it is still possible to find the optimum trigger setting by a trial-and-error method:

1. Start with max input sensitivity (10mV).
2. Check which waveform select push-button causes triggering. Depending on input amplitude and duty factor this might occur with one, two or all three waveform select push-buttons, see Fig.3.5.
3. Turn the SENSITIVITY knob slightly anti-clockwise to decrease the sensitivity. If necessary, pull the knob to lower the sensitivity range.
4. Check which of the waveform select push-buttons still gives triggering.
5. Repeat step 3 and 4 until only one waveform select push-button gives triggering.
6. Decrease the sensitivity still further until no triggering at all occurs.
7. Increase the sensitivity again until a stable reading is obtained.

The low-pass filter

Press the push-button marked < 50kHz FILTER to activate the low-pass filter for improved triggering on noisy LF-signals. The filter characteristic is shown in Fig.3.6. It is also possible to use this filter for signals with frequencies above 50kHz, but at reduced sensitivity.

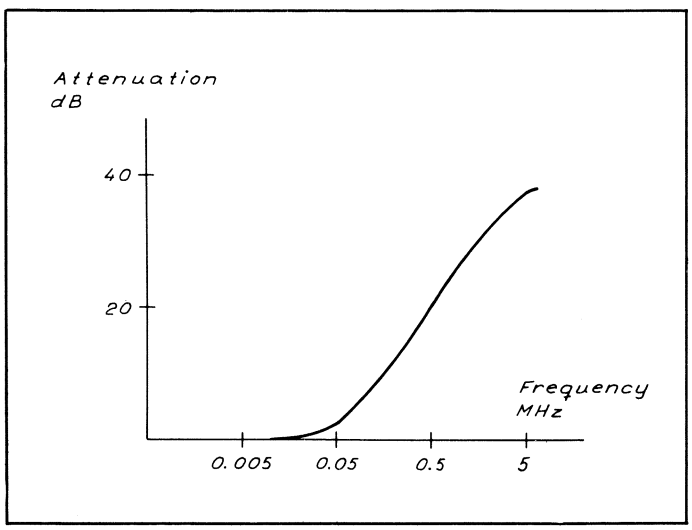


Fig.3.6. The low-pass filter reduces noise and interference

Measuring time

The measuring time can be varied in 33 steps per decade between 10ms and 96s. The counter continues to totalize input cycles until the set measuring time has elapsed. The number of cycles (N) is therefore:

$$N = \frac{\text{measuring time}}{\text{period duration}} \qquad N \geq 10$$

Frequency and period measurements

The microcomputer-based frequency counters PM6673...76 perform a measurement as given in the frequency definition:

$$\text{Frequency} = \frac{\text{Number of cycles}}{\text{Time}}$$

The counter:

Counts the number of input cycles during the measuring time.

Measures the effective gate time.

Calculates the number of cycles per second.

Input A

When measuring the frequency of a signal connected to Input A, the counters PM6673...76 automatically select the synchronization mode, which gives the best resolution and accuracy.

For frequencies < 10MHz, the measurement is synchronized with the input signal. This is called the *Input Synchronized* or *Reciprocal* method.

For frequencies ≥ 10MHz, the measurement is synchronized with the 10MHz clock signal. This is called the *Clock Synchronized* or *Conventional* method.

If the Input A selector on the rear panel is set to FREQ A AVERAGE the counter always uses the reciprocal method. However, it is possible to select the conventional method by pressing PERIOD and FREQ simultaneously.

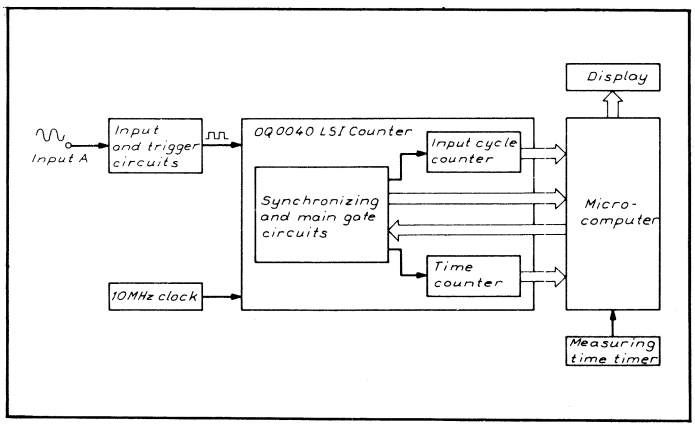
Input B

PM6674...76 have RF inputs, called Input B. Via this input the counter always performs a conventional frequency measurement. Note that maximum $12V_{rms}$ is allowed at Input B and that the input sensitivity is adjusted automatically.

PM6675 offers direct gating and $5mV_{rms}$ sensitivity via Input B. The other models apply prescaling and have 10mV sensitivity.

Input synchronized mode

In the input synchronized mode, the actual measuring time also called gate time, is selected as multiples of 10 completed input cycles. Both the opening and closure of the main gate is synchronized with the input signal, so that only completed input cycles are counted. This means that the traditional ± 1 input cycle error is avoided. During the gate time the counter also totalizes the number of 100 ns x-tal clock pulses. Each of these computing frequency counters contain two counting registers. One for input cycles and one for time reference clock pulses, as shown in Fig. 3.7.



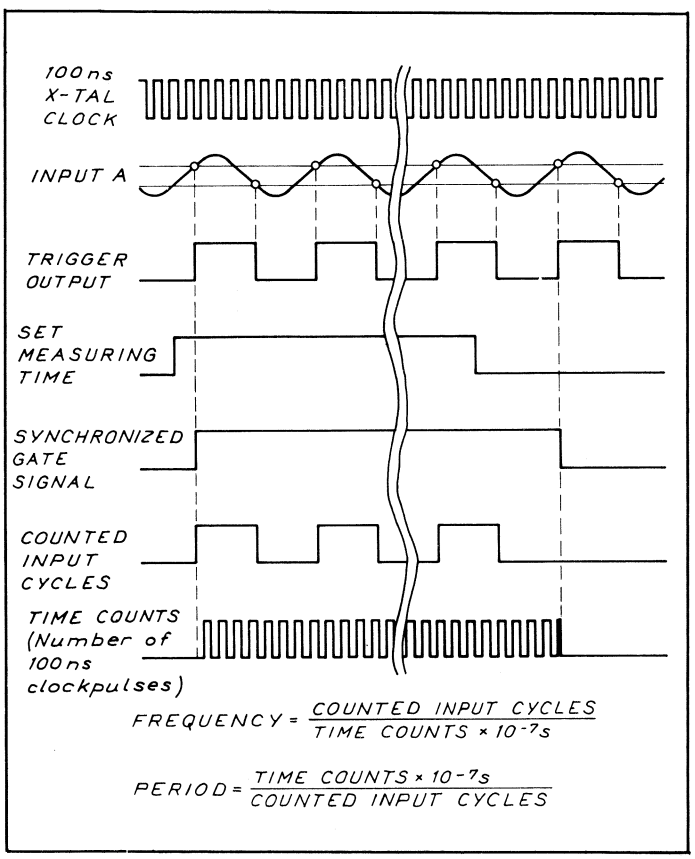


Fig.3.7. Input synchronized mode.

When the measurement is finished, the microcomputer calculates the measuring result with a 10-digit resolution. However, the number of digits displayed, is limited only to the significant digits, depending on the measuring resolution. This measuring resolution is defined by the input frequency and the measuring time.

The number of digits is selected in such a way that the measuring resolution is equal to 0.2...2 units of the least-significant digit (LSD), where:

$$LSD = \frac{2.5 \times \text{Frequency}}{\text{Measuring time} \times 10^7 \text{Hz}} \quad \text{or} \quad \frac{2.5 \times \text{Period}}{\text{Measuring time} \times 10^7 \text{Hz}}$$

rounded to the nearest decade.

Below 10 MHz, the reciprocal method gives a higher resolution. Above 10 MHz, the conventional method is better. The PM 6673...76 series of counters use the reciprocal method up to approx. 10 MHz and automatically switch to the conventional method for higher frequencies, see Fig. 3.8.

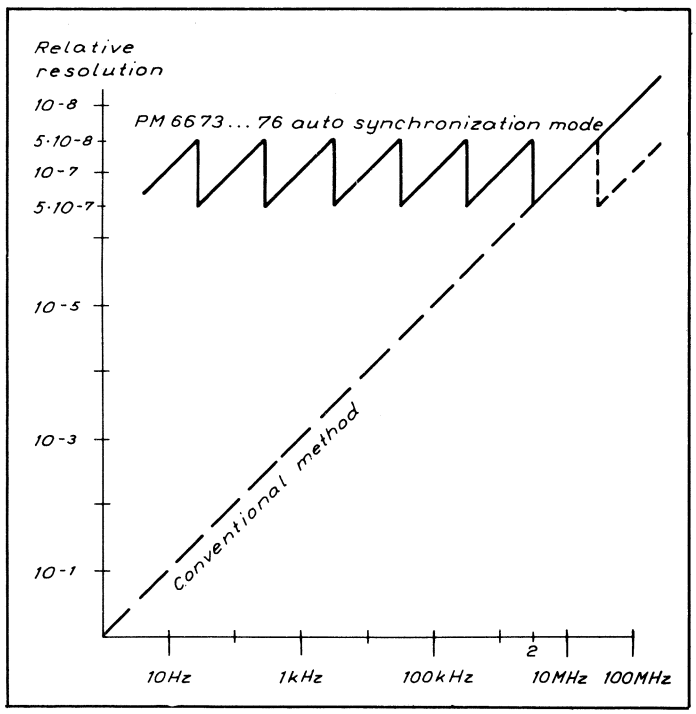


Fig.3.8. Relative resolution as a function of input frequency with 1s measuring time (Input A).

Clock synchronized mode ⚠

In conventional counters, the gate time is synchronized with the clock signal. The first and last trigger output pulse, can therefore be truncated, causing a ±1 cycle error, see fig.3.9. The importance of this error is depending on input frequency and selected gate time. For input frequencies above 10MHz, the clock synchronized mode gives a better resolution than the input synchronized mode.

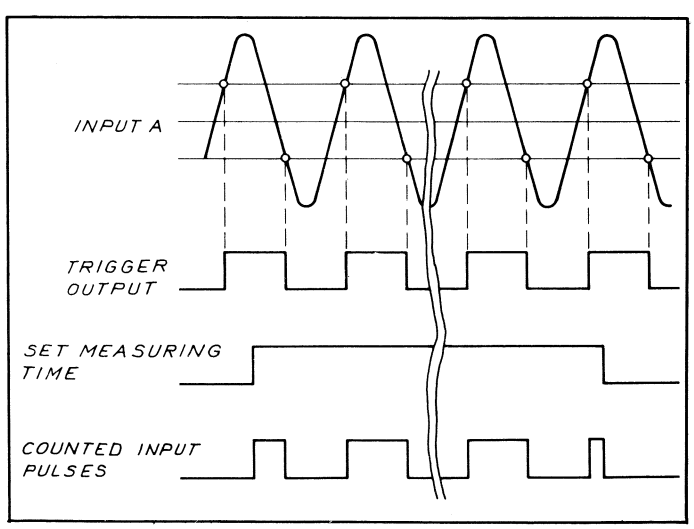


Fig.3.9. Clock synchronized mode.

$$\text{Rel.resolution} = \frac{\pm \text{ period duration of one input cycle}}{\text{measuring time}}$$

$$\text{LSD} = \frac{2.5 \times \text{prescaling factor (P)}}{\text{measuring time}}$$

P	Channel	Model
1	A	PM6673...76
6	B	PM6674
1	B	PM6675
16	B	PM6676

Table 3.1.

Period A average

In the PERIOD mode, the counter measures the average period duration. The counting technique is exactly the same as in the frequency mode, but the microcomputer calculates clock pulses divided by counted input cycles instead. The number of input cycles averaged, is the number of periods that fills the set measuring time.

Ratio measurements

The counter measures the frequency ratio between signals connected to Input A and D or between Input B and D.

A ratio measurement is useful, for instance, when calibrating a large number of oscillators with an awkward frequency. For example, say that the frequency should be 4.3625872MHz. This is difficult to read on the display for repetitive measurements. By connecting such a reference signal to Input D and measuring the ratio instead the oscillator is correctly calibrated when the display shows 1.0000000, which is much easier to read.

Note that the frequency range of Input D is 1 kHz...10 MHz.

Count measurements

In the count mode, the counter totalizes events on Input A. An event is defined as a positive-going slope. Start and stop functions are achieved by releasing and pressing the DISPL HOLD push-button. The result is accumulated with previous count sequences, if RESET is not pushed between measurements.

Single burst frequency measurements

The input synchronized counter, is in general suitable for burst frequency measurements. The frequency measurement does not start until the burst has arrived, because the opening of the main gate is controlled by the input signal. However, there are some restrictions:

- The set measuring time must be shorter than the burst duration.
- The burst must contain at least 20 cycles.
- If the burst frequency is higher than 10 MHz, it is necessary to set slide switch E on the rear panel to FREQ A AVERAGE.
- The minimum measuring time is 10ms.

Multiple burst frequency average

The PM6670-series is equipped with an external gate function, permitting the counter to make burst measurements down to 500ns and measure burst frequencies up to 100MHz.

By setting the 3-position switch on the rear panel in position FREQ A AVERAGE, the counter is forced to function in the input synchronized mode over the entire frequency range.

An external gate control signal can be connected to Input E for controlling the multiple burst frequency average measurement. The measurement is interrupted when Input E is higher than 2V. The external gate time can be down to 500ns. The actual measuring time, is the sum of all individual gate openings made during the set measuring time.

Note that the burst must contain at least 20 cycles during the time Input E is low and 10 cycles after that Input E has returned high, as shown in Fig.3.10.

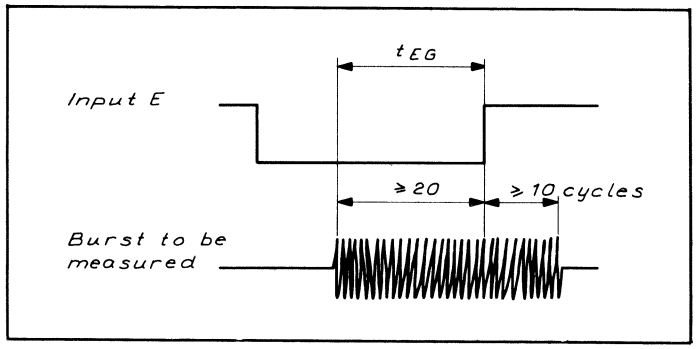


Fig.3.10. Burst requirements for multiple burst frequency average.

It is also possible to measure a single burst by means of Input E control. The burst duration may be down to 500 ns. The difference in propagation delay in the two counting channels (input cycles and time counts) is approx 15ns. When very short external gate times are used, this delay will cause a measurable error. The 15ns will be repeated for each external gate pulse.

It is possible to compensate for this error, if a stable frequency in the same frequency range is first measured in the normal mode without external gate signal. Call this measured value F1. Then connect the external gate signal. This new reading is called F2. To compensate for the error obtained in the frequency average mode, multiply the reading with the factor K = F1/F2.

The total relative error for a multiple frequency average measurement is:

$$\text{Rel.error} = \pm \frac{15\text{ns}}{t_{EG}} \pm \frac{100\text{ns} \pm \text{trigger error}_{EG} \pm \text{trigger error}_{A}}{t_{EG}\sqrt{N}} \pm$$

$$\pm \text{ rel. time-base error}$$

where t_{EG} = external gate duration

N = number of burst samples.

Arming

This mode can be selected when the counter is used in a remote controlled measuring system and the internal measuring set-up time, from a given start point, has to be as short as possible. Arming is also useful for measuring pulsed RF signals.

When Input E is high, the counter is prevented from starting a new measurement. However, the counter makes all preparations for a measurement. When Input E returns low, the measurement will start with a minimum of delay. The delay is approx 20ns plus synchronization time.

Note that arming cannot be used in the COUNT mode.

Practical Measurements

Preliminary settings

- Before connecting the counter to the line, check that the counter is set to the local line voltage.
- The slide switches on the rear panel should be set to INT STD and EXT RESET.
- The push-buttons CHECK, RESET and DISPL HOLD should be in released position.
- Press POWER ON.
- Set MEASURING TIME to approx 0.1s.
- Set SENSITIVITY fully clockwise and pushed.

Frequency measurements

- Make the preliminary settings.
- Press FREQ for automatic selection of synchronization mode or press FREQ and PERIOD A simultaneously for a conventional (clock-synchronized) frequency measurement over the entire frequency range 10Hz...120MHz.
  If a reciprocal frequency measurement is desired, set slide switch E on the rear panel to FREQ A AVERAGE.
- Connect the signal to be measured to Input A if the frequency is between 10Hz...120MHz
- Press the waveform select push-button most suitable for the signal's duty factor. Se section Measurements Theory for a detailed explanation.
- Decrease the sensitivity until the displayed frequency is stable.
- Set MEASURING TIME to give optimum resolution and measurement speed.
- If the frequency of the signal to be measured is higher than 120 MHz, Input B must be used (PM 6674...76).

Instrument	Input B frequency range
PM6674	50.....550MHz
PM6675	50.....600MHz
PM6676	100...1500MHz

- Press push-button B to select Input B.

The sensitivity is automatically adjusted for Input B, thus facilitating perfect triggering under all conditions. Maximum allowed voltage at Input B is $12V_{rms}$

Period measurements

- Make the preliminary settings.
- Press PERIOD A.
- Connect the signal to be measured to Input A.
- Press the waveform select push-button most suitable for the signal's duty factor.
- Decrease the sensitivity until the displayed value is stable.
- Set MEASURING TIME to give optimum resolution and measurement speed.

Count measurements

- Make the preliminary settings.
- Press COUNT A.
- Connect the signal to be measured to Input A.
- Press the waveform select push-button most suitable for the signal's duty factor.
- Set SENSITIVITY fully anti-clockwise and pulled, i.e. minimum sensitivity. Increase the sensitivity until the counter starts to count. Increase the sensitivity slightly more.
- Stop the measurement by pushing DISPL HOLD. Start a new measurement by realeasing DISPL HOLD. The result is accumulated with previous count sequences, if RESET is not pushed between measurements.
- At 10^9 counted events, the display is full. The Unit Indicator is now used as an exponent. If the us/kHz indicator glows read 10^3 pulses, for ms/MHz read 10^6 pulses and for s/GHz read 10^9 pulses.

Ratio measurements

- Make the preliminary settings.
- Press RATIO to D.
- Connect the signal with the lower frequency to Input D on the rear panel. The frequency range is 1kHz...10MHz and the sensitivity is $500mV_{rms}$
- Connect the other signal to Input A, if the frequency is between 10Hz...120MHz.
- Press the waveform select push-button most suitable for the signal's duty factor.
- Decrease the sensitivity until the displayed ratio is stable.
- Set MEASURING TIME to give optimum resolution and measurement speed.
- If the frequency is higher than 120MHz, Input B must be used (PM6674...76).
- Press push-button B to select Input B.

Check mode

- Make the preliminary settings.
- Press CHECK. The internal 10MHz standard signal is now connected to the logic circuits.
- CHECK enables a self-test of the measuring functions FREQ, PERIOD A and COUNT A. Select one of these functions.
- The resolution is given by the set measuring time.

If Input B is selected (PM6674...76) the display will show:

PM6674	60MHz
PM6675	100MHz
PM6676	160MHz

The resolution is dependent on the set measuring time. For PM 6675 the two least significant digits are dependent on set measuring time.

Measuring time

Selected measuring time can be displayed by pushing the MEASURING TIME rotary knob. However, this will terminate the measurement, if the measuring time is longer than one second.

Overflow condition

An attempt to divide by zero (in Ratio to D mode) or effective measuring periods longer than 99s will result in an overflow condition.
The display will show 9.9.9.9.9.9.9.9.

Arming, External reset and Frequency A average

These functions can be selected on the rear panel. See section Measurements Theory for more information.

Arming:
In this position, the counter is prevented from starting a new measurement when Input E is high. However, the counter prepares for a measurement. When Input E returns low, the measurement will start with a minimum of delay. Note that arming cannot be used in the COUNT mode.

Ext reset:
In this position, the counter is reset when Input E goes high. A new measurement can be made when Input E has returned low.

Freq A average:
The counter is forced to function in the input synchronized (reciprocal) mode over the entire frequency range.
An external gate control signal can be connected to Input E for controlling the multiple burst frequency average measurement. The measurement is interrupted when Input E is high.

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Zambia: Philips Electrical Zambia Ltd.,
Mwenbeshi Road, P.O.B. 31878, Lusaka;
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Zimbabwe: Philips Electrical (Pvt) Ltd.,
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For information on change of address:
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