Measuring Functions

Refer to page 13-8 for uncertainty information.

Inputs A and B can be swapped *internally* in all modes except Rise and Fall Time (for example to measure Frequency B).

Frequency A, B and C

Range:

Input A: 10^{-10} Hz to 225 MHz

Input B: 10^{-10} Hz to 160 MHz

Input C: 70 MHz to 1.3 GHz (PM 9621)
100 MHz to 2.7 GHz (PM 9624)
150 MHz to 4.5 GHz (PM 9625)

Resolution: 10 digits in 1s measuring time

Frequency Burst A: Burst Frequency and PRF of burst signals can be measured without external control signals

Period A

Range: 6 ns to 10^{10}s

Resolution: 10 digits in 1s measuring time

Ratio A/B, C/B

Range: 10^{-9} to 10^{15}

Frequency Range:

Input A,B: 10^{-10} Hz to 160 MHz

Input C: 70 MHz to 1.3 GHz (PM 9621)
100 MHz to 2.7 GHz (PM 9624)
150 MHz to 4.5 GHz (PM 9625)

Time Interval A to B

Range: 0 ns to 10^{10}s
Typical: –2 ns to 10^{10}s (B to A, 3 ns to 10^{10}s)

Repetition Rate: Max 160 MHz

Mode: Single or average

Pulse Width A

Range: 3 ns to 10^{10}s

Repetition Rate: Max 160 MHz

Mode: Single or average

Rise and Fall Time A

Range: 3 ns to 10^{10}s

Repetition Rate: Max 160 MHz

Minimum Amplitude: 500 mVp-p

Mode: Single or average

Phase A Relative B

Range: –180° to 360°

Frequency Range: 0.01 Hz to 160 MHz

Voltage Range:

x1: 100 mV rms to 3.5 V rms

x10: 1 V rms to 35 V rms

Mode: Single or average

Duty Factor A

Range: 0 to 1

Frequency Range: 0.01 Hz to 160 MHz

Mode: Single or average

Totalize A, B

Range: 0 to 10^{17}
0 to 10^{10} in A minus B modes

Frequency Range: 0 to 160 MHz

A Gated by B: Event counting on Input A during the presence of a pulse on Input B

A Gated by B Accumulated: Cumulative event counting on Input A during the presences of pulses on Input B, within set measuring time

A Start/Stop by B: Event counting on Input A between two consecutive pulses on Input B

Manual A: Event counting on Input A with manual start and stop

Manual A-B: Input A minus Input B event counting with manual start and stop

Manual/Timed A: Event counting on Input A with manual start. Stop after set measuring time

Manual/Timed A-B: Input A minus Input B event counting with manual start. Stop after set measuring time

AC/DC Voltage A, B

Range: -51 V to +51 V

Frequency Range: DC, 100 Hz to 120 MHz

Mode: V max, V min, V p-p

Uncertainty for DC, > 10 ns Pulses and Sine waves:

< 50 MHz (x1): ± (30 mV + 2% of reading + 5% of V p-p)

< 50 MHz (x10): ± (300 mV + 3% of reading + 5% of V p-p)

> 50 MHz (x1): ± (30 mV + 3% of reading + 10% of V p-p)

> 50 MHz (x10): ± (300 mV + 5% of reading + 10% of V p-p

Gated Volt: External masking of unwanted signal components such as overshoot

Input Specifications

Input A and Input B

Frequency Range Input A:

DC Coupled: DC to 225 MHz

AC Coupled: 10 Hz to 225 MHz

Frequency Range Input B:

DC Coupled: DC to 160 MHz

AC Coupled: 10 Hz to 160 MHz

Rise Time: Approx 1.5 ns

Minimum Pulse Width: 5 ns at 60 mV p-p, 3 ns at 90 mV p-p

Sensitivity: 20 mV rms, < 100 MHz
30 mV rms, 100 MHz to 200 MHz
40 mV rms, > 200 MHz

Hysteresis Window: Approx 30 mV p-p

Variable Hysteresis Channel A:
60 mV p-p to 10 V p-p up to 120 MHz

Dynamic Range:

1X: 60 mV p-p to 10 V p-p within ± 5 V window

10X: 0.6 V p-p to 100 V p-p within ± 50 V window

Maximum Voltage Without Damage:

1 MΩ: 350 V (DC+AC_{pk}) at DC to 440 Hz, falling to 12 V rms (1X) and 120 V rms (10X) at 1 MHz

50Ω: 12 V rms

Attenuation: 1X or 10X

Coupling: AC or DC

Impedance: 1MΩ//30pF or 50Ω (VSWR ≤2:1) (1 MΩ//80pF or 50Ω if PM9611/80 rear panel inputs are used)

Channel Inputs: Separate, common via A or swapped

Trigger Slope: Positive or negative

Trigger Level Range:

1X: - 5.10 V to + 5.10 V

10X: - 51.0 V to + 51.0 V

Trigger Level Readout: On display

Trigger Indicator: Tri-state LED indicator

Trigger Level Resolution:

1X: 20 mV

10X: 200 mV

Trigger Level Setting Uncertainty (x1):

Separate Inputs: ± (20 mV + 1% of setting)

Common Input: ± (20 mV ± 3% of setting)

AUTO Trigger Level:

Minimum Amplitude: 150 mV p-p

Minimum Frequency: 100 Hz

Trigger level is automatically set to 50% point of input signal (10% and 90% for Rise and Fall Time measurements, 75% and 25% for variable hysteresis A)

Analog Low pass Filter Channel A: 100 kHz fixed, > 40 dB attenuation at 1 MHz

Digital Low pass Filter Channel A and B: 1Hz to 5 MHz using trigger Hold Off to disable stop triggering

Input C (Option PM 9621)

Frequency Range: 70 MHz to 1.3 GHz

Prescaler Factor: 256

Coupling: AC

Operating Input Voltage Range:
10 mV rms to 12V rms, 70 MHz to 900 MHz
15 mV rms to 12 V rms, 900 MHz to 1.1 GHz
40 mV rms to 12 V rms, 1.1 GHz to 1.3 GHz

Amplitude Modulation:

AM Freq. DC to 100 kHz: Up to 94% depth

AM Freq. 100 kHz to 6 MHz: Up to 85% depth

Minimum signal must exceed minimum operating input voltage.

Impedance: 50Ω nominal, VSWR < 2:1

Maximum Voltage Without Damage:
12 V rms, pin-diode protected

Connector: BNC

Input C (Option PM 9624)

Frequency Range: 100 MHz to 2.7 GHz

Prescaler Factor: 16

Coupling: AC

Operating Input Voltage Range:
20 mV rms to 12 V rms, 100 MHz to 300 MHz
10 mV rms to 12 V rms, 300 MHz to 2.5 GHz
20 mV rms to 12 V rms, 2.5 GHz to 2.7 GHz

Amplitude Modulation:

AM Freq. DC to 100 kHz: Up to 94% depth

AM Freq. 100 kHz to 6 MHz: Up to 85% depth

Minimum signal must exceed minimum operating input voltage

Impedance, 50Ω nominal:
VSWR < 2:1, 100 MHz to 1.8 GHz
VSWR < 2.5:1, 1.8 GHz to 2.7 GHz

Maximum Voltage Without Damage:
12 V rms, pin-diode protected

Connector: Type N Female

Input C (Option PM 9625)

Preliminary data, October 14, 1991

Frequency Range: 150 MHz to 4.5 GHz

Prescaler Factor: 32

Coupling: AC

Operating Input Voltage Range:

20 mV rms to 1V rms (–21 to +13 dBm) , 150 MHz to 300 MHz

10 mV rms to 1V rms (–27 to +13 dBm), 300 MHz to 2.7 GHz

15 mV rms to 1V rms (–23.5 to +13 dBm), 2.7 GHz to 3.5 GHz

25 mV rms to 1V rms (–19 to +13 dBm), 3.5 GHz to 4.5 GHz

Amplitude Modulation:

AM Freq. DC to 100 kHz: Up to 94% depth

AM Freq. 100 kHz to 6 MHz: Up to 85% depth

Minimum signal level must exceed minimum operating input voltage

Impedance, 50Ω nominal:
VSWR 2:1, 150 MHz to 3.5 GHz
VSWR 2.5:1, 3.5 GHz to 4 GHz
VSWR 3:1, 4 GHz to 4.5 GHz

Maximum Input Without Damage: 12V rms (+34 dBm), pin-diode protected

Connector: Type N Female

External Reference Input D

The use of external reference is indicated on the display

Frequency: 10 MHz standard. 1 MHz and 5 MHz with Optional Reference Frequency Multiplier (PM 9697)

Voltage Range: 500 mV rms to 10 V rms

Coupling: AC

Impedance: Approx 500Ω

Arming Input E

Most measuring functions can also be performed via Input E

Frequency Range: DC to 50 MHz

Minimum Pulse Width: 10 ns

Minimum Slew Rate: 2 V/μs

Trigger Level: TTL level, 1.4 V nominal

Trigger Slope: positive or negative

Maximum Input Voltage: 25 V

Coupling: DC

Impedance: Approx 2 kΩ

Output Specifications

Reference Output G

Frequency: 10 MHz, sine wave

Output Level: > 0.5 V rms into 50Ω load, > 0.7 V rms into high impedance load

Coupling: AC

Gate Open Output H

Output Level:

Gate Closed: < 0.4 V

Gate Open: > 1.4 V into 50Ω load,

> 2.8 V into high impedance load

Internal delay: Approx 20 ns

Trigger Level Outputs I, J

Buffered outputs for channel A and B trigger levels

Output Level:

(x1): 0.1 * Trigger Level Setting

(x10): 0.01 * Trigger Level Setting

Uncertainty: ± (3 mV + 8% of output level)

Output Impedance: Approx 3 kΩ

Probe Compensation Outputs K, L

Buffered outputs for channel A and B signals. To be used for adjustment of probes to best pulse response for the combination of probe and counter input

Output Level: (Input level)/(Attenuator setting)

Test Signal: 2 kHz to 3 kHz square wave

Output Impedance: Approx 1.5 kΩ

Auxiliary Functions

Trigger Hold Off

After start of measurement, Trigger Hold Off disables erroneous stop triggering during a preset time. The Hold Off can also be defined as a preset number of trigger events on channel B. Trigger Hold Off can be used in all measuring functions, with the exception of Duty Factor and AC/DC Voltage.

Time Delay Range: 200 ns to 1.6s

Resolution: 100 ns

Channel B Event Delay Range: 2^1 to $2^{24}-1$, negative slope

External Arming

Arming is used to inhibit start - and/or stop triggering with the aid of an external signal. Stop arming is not applicable to the time interval average functions (Time, Rise/Fall, Pulse Width), Phase and Duty Factor.

For time interval average functions the start arming is applied only to the first measure-

ment in the average sequence. The arming function is not applicable to the Frequency Burst and Volt functions.

Input: E or B. Trigger level on B channel can be set to position the arming trigger event

Arming Delay: Arming can be delayed with respect to the external arming trigger event until:

- Preset arming time has elapsed or
- Preset number of trigger events on B has occurred

Time Delay Range: 200 ns to 1.6s

Resolution: 100 ns

Channel B Event Delay Range: 2^1 to $2^{24}-1$, negative slope

Statistics

Statistics may be applied to all measuring functions, with the exception of Manual Totalize and AC/DC Voltage. Statistics may also be applied on the result from Mathematics.

Max and Min: Displays maximum and minimum values of selected sample size

Mean and Std Dev.: Displays calculated arithmetic mean and standard deviation of selected sample size

Sample Size: Default N = 100 or selectable between 1 and 65535 samples

Mathematics

Mathematics may be applied to all Measuring Functions. When Volt max/min is used with Math, the Volt peak to peak value is used.

Formula: (K*X+L)/M or (K/X+L)/M, where X is current reading and K, L, and M are selectable constants

K, L and M Constants: Set via keyboard, as frozen reference value from display (X_0) or as value from preceding measurement (X_{n-1})

Other Functions

Measuring-Time: Single cycle, 0.8, 1.6, 3.2, 6.4, 12.8 µs and 50 µs to 400s. The effective measuring time can be extended through multiple average measurements, using the Statistics function. The short measuring times 0.8 to 12.8 ns are only applicable to time and frequency measurements.

Restart: Starts a new measurement, or data capture in Statistics mode

Local/Preset: Go to local function in remote mode, or preset counter to default setting in local mode

Displ Hold: Freezes measuring result until a new measurement is initiated via Restart

Check: Applies 10 MHz Time Base Frequency to the measuring logic

Settings: 20 complete instrument settings can be saved and recalled from internal non-volatile memory. 10 memory positions (10-19) can be user protected

Menu: Display of all choices of Measuring Functions, Mathematics and Statistics. Displays also the states of inactive selections

Input Channel Selection A <=> B: Channels A and B are internally swapped

Display

Type: LCD with high-luminance backlight

Number of Digits: 10 digits plus exponent

Overflow: 2 more digits made visible via the use of mathematics

Blanking: Insignificant digits can be blanked

Auxiliary Menu: An AUX MENU gives access to additional functions from the front panel (for example self tests). These functions can also be accessed via the GPIB interface

Measurement Uncertainties

Time Interval, Pulse Width and Rise and Fall Time

Total Uncertainty

Total Random Uncertainty rms

$$\pm \frac{\sqrt{(500\ ps)^2+(Trigger\ Error)^2}}{\sqrt{N}} \text{ (or min 100 ps)}$$

Total Systematic Uncertainty

$\pm$*Trigger Level Timing Error*
$\pm$1.5 *ns Systematic Error*
$\pm$*Time Base Error* * *Time Interval*

LSD Displayed

$$\frac{500\ ps}{\sqrt{N}}$$

Frequency and Period

Total Uncertainty

Total Random Uncertainty rms

$$\pm \frac{\sqrt{(500\ ps)^2 + (Trigger\ Error)^2}}{Measuring\ time} * Freq.\ or\ Per$$

Total Systematic Uncertainty

$\pm$ *Time Base Error* * *Freq. or Per.*

LSD Displayed

$$\frac{500\ ps * Frequency\ or\ Period}{Measuring\ Time}$$

Ratio f_1 / f_2

Total Uncertainty

Total Random Uncertainty rms

$$\pm \frac{\sqrt{(Prescaler\ Factor)^2 + (f_1 * Trigger\ Error\ of\ f_2)^2}}{f_2 * Measuring\ Time}$$

LSD Displayed

$$\frac{Prescaler\ Factor}{Measuring\ Time * f_2}$$

Phase

Total Uncertainty

Total Random Uncertainty rms

$$\pm \frac{\sqrt{(500\ ps)^2+(TriggerError)^2}}{\sqrt{N}} * Freq. * 360°$$

(or min 100 *ps* * *Frequency* * 360°)

Total Systematic uncertainty

$\pm$ (*Trigger Level Timing Error* +
1.5 *ns Systematic Error*) * *Frequency* * 360°

LSD Displayed

0.01°

Duty Factor

Total Uncertainty

Total Random Uncertainty rms

$$\pm \frac{\sqrt{(500\ ps)^2 + (Trigger\ Error)^2}}{\sqrt{N}} * Frequency$$

(*or* min 100 *ps* * *Frequency*)

Total Systematic Uncertainty

± (*Trigger Level Timing Error* + 1.5 *ns Systematic Error*) * *Frequency*

LSD Displayed

$1 * 10^{-6}$

Voltage

See AC/DC Voltage on page 13-3.

Random Uncertainty

Random uncertainty is due to quantization error, internal and external noise. These effects are specified with their rms values; equal to the standard deviation (1σ). The random uncertainty can be reduced to $<1*10^{-10}$ or <100 ps as residual time uncertainty, by increasing the measuring time or by averaging over N cycles for time interval related functions.

Trigger Error

Trigger error is an input signal dependent random uncertainty caused by external and/or internal noise, thereby resulting in too early or too late start- and stop-triggering. The trigger error in start- and stop- trigger points respectively is expressed as an rms time error:

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

Vnoise-input: 200 µV rms typical

Vnoise-signal: The rms noise of the input signal over a 225 MHz bandwidth.

Total trigger error (to be used in the formulas in table 1) is:

$$\sqrt{(Start\ Trigger\ Error)^2 + (Stop\ Trigger\ Error)^2}$$

Systematic Uncertainty

Systematic uncertainties can be measured and compensated for by inserting external delays or using internal math functions to provide nulling.

Trigger Level Timing Error

This timing error is due to trigger level setting error, input amplifier hysteresis and input signal slew rate and causes start- and stop- trigger level timing error.

Time Interval, Pulse Width, Rise and Fall Time, Duty Factor: x1 attenuation

$$\frac{0.02V + 1\%\ of\ set\ trigger\ level\ (V)}{Slew\ rate\ (V/s)\ at\ start\ trigger\ point} \pm$$

$$\pm \frac{0.02V + 1\%\ of\ set\ trigger\ level\ (V)}{Slew\ rate\ (V/s)\ at\ stop\ trigger\ point} \pm$$

$$\pm \left(\frac{0.015\ V}{Slew\ rate\ (V/s)\ at\ start\ trigger\ point} - \frac{0.015\ V}{Slew\ rate\ (V/s)\ at\ stop\ trigger\ point} \right)$$

Phase: For sine wave signals >100 mV rms, trigger levels 0 V and x1 attenuation settings (V_{pk} in volt)

$$\left(\frac{0.3}{V_{pk}\ of\ A} + \frac{0.3}{V_{pk}\ of\ B} \right)^{\circ} \pm \left(\frac{1}{V_{pk}\ of\ A} - \frac{1}{V_{pk}\ of\ B} \right)^{\circ}$$

1.5 ns Systematic Error

The 1.5 ns Systematic Error is due to interchannel asymmetry and internal amplifier rise time and varies for the selection of measuring mode and input trigger settings. Typical error is <0.7 ns, (identical input signal, trigger level and slope in Time Interval A to B).

Time Base Error

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 values are 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). Measuring times > 1s can give significance in >10 digits.Two additiona digits can be displayed by using the math function. LSD blanking is available to reduce displayed resolution. Up to 12 digits mantissa is available over the GPIB interface.

Crystal Oscillator Options

Stability against	Model Options			
	/.1.	*/.2.*	*/.4.*	*/.5.*
		PM 9678B	*PM 9690*	*PM 9691*
	Standard	*TCXO*	*Oven*	*Oven*
Ageing: /24h	n.a.	n.a.	$< 1.5 * 10^{-9}$*	$< 5 * 10^{-10}$*
Ageing: /month	$< 5 * 10^{-7}$	$< 1 * 10^{-7}$	$< 3 * 10^{-8}$	$< 1 * 10^{-8}$
Ageing: /year	$< 5 * 10^{-6}$	$< 5 * 10^{-7}$	$< 1.5 * 10^{-7}$	$< 7.5 * 10^{-8}$
Temperature: 0 to 50°C ref. to + 23°C	$< 1 * 10^{-5}$	$< 1 * 10^{-6}$	$< 3 * 10^{-8}$	$< 5 * 10^{-9}$
Line Voltage ± 10%	$< 1 * 10^{-8}$	$< * 10^{-9}$	$< 5 * 10^{-10}$	$< 5 * 10^{-10}$
Warm-up Time to Reach 10^{-7} of Final Value	n.a.	n.a.	< 15 min	< 15 min

* after 48 hours of continuous operation

Table 13-1 *Stability of crystal oscillators*

GPIB (Option PM 9626)

GPIB Functions

Programmable Functions: All front panel accessible functions including AUX MENU

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 2000 readings/s, depending on measurement function and internal data format

Internal Memory Size: 764 or 2600 readings, depending on measurement function and internal data format

Max Bus transfer rate: 150 to 1000 transfers/s, depending on internal data format and output data format

Data Output Format: ASCII, IEEE double precision floating point

Time Out: 100 ms to 25.5s in 100 ms steps, or off

Analog Output

An analog output voltage, derived from three consecutive digits selected from the measurement result

Voltage Range: 0 to 4.98 V

Resolution: 20 mV

Output impedance: 200 Ω

General Specifications

Environmental Conditions

MIL-T-28800D for Type III, Class 3, Style D

Temperature:

Operating: 0°C to +55°C

Fan option PM 9628 is required when:

1. Ambient temperature >50°C or

2. Internal rack temperature >45°C; while mounted with no free air convection space and when oven oscillator PM 9690 or PM 9691 is installed

Storage: –40°C to +70°C

Warm-up Time: <20 min

Reliability: MTBF 30 000 h

Safety: IEC 348 Class 1, CSA 22.2 No. 231

EMC: VDE 0871 Level B, FCC Part 15J Class A

Power Requirements

90 to 265 V rms, 45 to 440 Hz, 30W

Dimensions and Weight

Width: 315 mm (12.4 in),

Height: 86 mm (3.4 in),

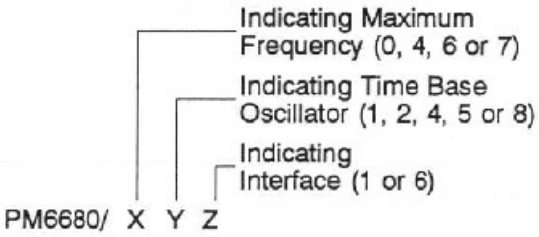
Depth: 395 mm (15.6 in)

Weight: Net 3.7 kg (8 lb): Shipping 7 kg (15 lb).

Ordering Information

Models

The PM 6680 ordering number consists of the basic type number and a 3 digit XYZ suffix, specifying the required configuration.



Type No.Description

PM 6680/011 Basic 225 MHz Timer/Counter incl. Standard Time Base, $5*10^{-7}$/month

PM 6680/4.. As PM 6680/011 but incl. 1.3 GHz Input C, PM 9621

PM 6680/6.. As PM 6680/011 but incl. 2.7 GHz Input C, PM 9624

PM 6680/7.. As PM 6680/011but including 4.5 GHz Input C, PM 9625

PM 6680/.2. As PM 6680/011 but incl. TCXO Time Base PM 9678B, $1*10^{-7}$/month

PM 6680/.4. As PM 6680/011 but incl. Ovenized Time Base PM 9690, $1.5*10^{-9}$/24h

PM 6680/.5. As PM 6680/011 but incl. Ovenized Time Base PM 9691, $5*10^{-10}$/24h

PM 6680/.8. As PM 6680/011 but incl. ext. Reference Frequency Multiplier PM 9697 (1 or 5 MHz)

PM 6680/..6 As PM 6680/011 but incl. GPIB-Interface PM 9626

Options

PM 9611/80 Rear panel inputs

PM 9621 1.3 GHz HF-Input

PM 9622 Rack-Mount Kit PM 6680

PM 9624 2.7 GHz HF-Input

PM 9625 4.5 GHz HF-Input

PM 9626 GPIB-Interface incl. Analog Output

PM 9628 Fan Option

PM 9629 TimeView time analysis software

PM 9678B TCXO Time Base

PM 9690 High Stability Oven Oscillator Time Base

PM 9691 Very High Stability Oven Oscillator Time Base

PM 9697 External Reference Frequency Multiplier (1 or 5 MHz). Can only be installed together with the standard time base.

Options ordered together with PM 6680 are factory installed. The PM 9622 Rack-Mount Kit must be assembled by the user. All options except PM 9611/80 can also be retrofitted in the field.