Universal Frequency Counter
PM6669

Operators Manual
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SAFETY

Introduction

Read this page carefully before you install and use the PM 6669 Frequency Counter.

This Frequency Counter has been designed and tested in accordance with IEC publication 1010-1, and CSA 22.2 No.231, and has been supplied in a safe condition. The user of this instrument must have the required knowledge of PM 6669. This knowledge can be gained by thoroughly studying this manual.

Safety Precautions

Use generally-accepted safety procedures, in addition to the safety precautions stated in this manual, to ensure personal safety and safe operation of the Frequency Counter.

Caution & Warning Statements

You will find specific warning and caution statements, where necessary throughout the manual. Do not carry out repairs or adjustments to the Frequency Counter without reading the Service Manual, which contains the relevant warnings for such activities.

Symbols

![Symbols]

Indicates where the protective ground lead is connected inside the instrument. Never unscrew or loosen this screw.

If in doubt about safety

Whenever you suspect that it is unsafe to use the instrument, you must make it inoperative, clearly mark it to prevent its further operation, and inform the Fluke service Centre.

E.g. The instrument is likely to be unsafe if it is visibly damaged.
**General**

The PM 6669 is a compact, high resolution, reciprocal Frequency Counter which performs many functions. A number of options are available i.e. HF-input, GPIB-interface, high stability oscillator, and rechargeable battery for field use.

A rack-mount kit and a carrying case are also available as accessories.

**Rear View**

A) Rear feet.
B) Screws for removing the cover.
C) External-reference-input, BNC connector.
D) Voltage-range selector.
E) Power-inlet socket.
F) GPIB interface-connector (optional).
G) GPIB address-selector (option).

---

**Figure 1** Rear View.
**Front View**

H) Large LCD-display.

J) Input-A BNC-connector.

K) Sensitivity control with dual-range push-in/pull-out switch.

L) 50 kHz filter switch (Input-A).

M) Input-B BNC-connector (optional).

N) Power switch.

O) Reset button, doubles as Local button if the Frequency Counter is equipped with an GPIB interface. Starts and stops counting if the TOT A function is selected.

P) Measuring-time selector-button. *

R) Function-selector button. *

S) Display-hold button. Freezes the display. The button is also used for storing $A_0$.

T) Blank digits button. Blanks out one digit for each depression of the button, from the right to the left of the display. (No rounding off).

U) Trigger level setting button.

V) Tilting support.

*The selected function is indicated on the display. A short press on the button moves the cursor one step to the right. A long press makes the cursor scroll.
INSTALLATION

Unpacking

If the Frequency Counter is cold, leave it in the cardboard box until it has reached normal room temperature.

- Lift the Frequency Counter out of the box.
- Remove the polystyrene supports.
- Unpack the Frequency Counter from the plastic bag.
- Reverse the procedure to pack.

Check List

Has the Frequency Counter been damaged in transport?
If it has, file a claim with the carrier immediately, and notify the Fluke sales & service organization to make repair or replacement of the instrument easier.

- Check that the package contains the following items in addition to the Frequency Counter:
  - This Operators’ Manual
  - A power cable with protective earth conductor
  - A Battery unit if ordered *
  - An MTCXO oscillator if ordered *)
  - A GPIB interface if ordered *)
  - An HF-input if ordered *)
  *) Labels on the rear panel indicate which options are fitted in your Frequency Counter.

Voltage-Range Selection

Set the Frequency Counter to the local line voltage before connecting it. As delivered the Frequency Counter may be set to either 115 V or 230 V. The setting is indicated on the voltage range selector on the rear panel.

Grounding

The Frequency Counter is connected to ground via a sealed three-core power cable, which must be plugged into a socket outlet with a protective ground terminal. No other grounding is permitted for this Frequency Counter. Extension cables must always have a protective ground conductor.
WARNING: Never interrupt the protective ground connection intentionally. Any interruption of the protective ground connection inside or outside the instrument, or disconnection of the protective ground terminal is likely to make the instrument dangerous.

Connecting External Reference

If you wish to use an external 10 MHz reference frequency source, connect it via a BNC-cable to the EXT REF INPUT on the rear panel of the Frequency Counter.

When the Frequency Counter starts measuring, it automatically detects the external reference and begins to use it. The EXT REF indicator on the display is switched on.

Installing Options

Introduction

The options ordered at the same time as the Frequency Counter are normally factory-installed. Other options can be fitted when needed. The options fit inside the Frequency Counter, but not all at the same time: The HF-input, the high stability-oscillator and either of the GPIB-interface or the Battery-unit can be installed in one and the same Frequency Counter.

Calibrating the MTCXO

The MTCXO Time-base can easily be recalibrated to any 10 MHz reference. To maintain the accuracy of the MTCXO, use a reference with an accuracy of $3 \times 10^{-8}$.

The PM 9691 oven-enclosed oscillator used in Fluke counters version .5. meet this requirement, if calibrated.

Preparations

If you remove the cover when counter has been switched on, the temperature of the MTCXO will rapidly drop about 10°C. Since the MTCXO must have a stable temperature when calibrated you must wait an hour between removing the cover and calibrating.

If the counter has been switched off more than three hours, you can calibrate it directly.

Removing the Cover

WARNING: When you remove the cover you will expose live parts and accessible terminals which can be dangerous to life.

Loosen the two screws using a Pozidrive No. 1 screwdriver

Figure 5  Loosen These Screws to Remove Cover.

– Make sure that the power cable is disconnected.

WARNING: Although the power switch is in the off position, the line voltage is present on the printed circuit board.

– Loosen the two screws in the rear feet.
– Grip around the front panel and pull the Frequency Counter out of the cover.

Calibration Procedure

– Remove the cover from the counter.
– Allow the MTCXO to adapt the new ambient temperature. (See 'Preparations'.)
– Connect the 10 MHz reference to Input-A.
– Switch ON the counter.
– Adjust the sensitivity control so that the counter counts properly.
– Hold down the CALIB-button, on the main printed-circuit board in the counter, and press the Reset-button.
– Wait about 20 seconds, until the display shows 10.000000 MHz. Now the oscillator is calibrated.
– Switch OFF the counter and disconnect the 10 MHz reference.

Fit the cover.

Figure 6 Location of the CALIB-Button.
OPERATING INSTRUCTIONS

Using the Frequency Counter

<table>
<thead>
<tr>
<th>CONTROL</th>
<th>OPERATING THE CONTROL</th>
<th>DISPLAY</th>
<th>GPB-CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td></td>
<td></td>
<td>No control possible but D gives the same settings as after power-ON.</td>
</tr>
<tr>
<td>STAND-BY</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A short depression of the FUNCTION key moves the cursor in the lower edge of the display one step to the right. If the key is held depressed, the cursor will scroll to the right until released. When the cursor reaches the rightmost position it jumps back to the leftmost position and continues from there.

One code for each function, see below:

Move function cursor to FREQ A
FUNCTION AND RANGE

Switches the power ON and OFF. When switched on, the built in microprocessor switches on all segments of the display then it runs a power-up test, checking the measuring-logic of the Frequency Counter before the counter starts working. This test takes about 2 seconds.

If an error is found, an error code will be displayed. Try switching the Frequency Counter off and on again. If error code 01 - 03 persists, call Fluke service. Look on the last page in this manual for Phone No. and address.

HINTS AND COMMENTS

WARNING: The power switch operates on the secondary side of the transformer. The power cable must be disconnected from the line outlet socket if it is necessary to completely isolate the Frequency Counter from the line.

Error 01 = RAM memory error
Error 02 = Measuring logic error
Error 03 = Internal bus error
Error OF = Overflow in the counting registers

Selects one of the nine measuring functions available.

The cursor does not stop at FREQ C if no Input-C HF-input is installed.

Reciprocal frequency measurement of the signal at Input-A.

Range:
0.1 Hz to 16 MHz (SINGLE measuring-time)
1 Hz to 160 MHz (0.2, 1, and 10 s measuring-time)

If the signal is sine shaped and the input AC coupled, the minimum input frequency is 20 Hz (at specified sensitivity).
<table>
<thead>
<tr>
<th>CONTROL</th>
<th>OPERATING THE CONTROL</th>
<th>DISPLAY</th>
<th>GPIB-CODE</th>
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</thead>
<tbody>
<tr>
<td>FUNCTION</td>
<td>Move function cursor to FREQ B</td>
<td>![Display Image]</td>
<td>FREQ B</td>
</tr>
<tr>
<td>FUNCTION</td>
<td>Move function cursor to FREQ A/A₀</td>
<td>![Display Image]</td>
<td>Not bus selectable</td>
</tr>
<tr>
<td>FUNCTION</td>
<td>Move function cursor to FREQ A-A₀</td>
<td>![Display Image]</td>
<td>Not bus selectable</td>
</tr>
<tr>
<td>FUNCTION</td>
<td>Move function cursor to RPM A</td>
<td>![Display Image]</td>
<td>RPM A</td>
</tr>
<tr>
<td>FUNCTION</td>
<td>Move function cursor to PER A</td>
<td>![Display Image]</td>
<td>PER A</td>
</tr>
<tr>
<td>FUNCTION</td>
<td>Move function cursor to TOT A</td>
<td>![Display Image]</td>
<td>TOTM A</td>
</tr>
</tbody>
</table>
Reciprocal frequency measurement of the signal at Input-B.

Range:
70 to 1300 MHz (PM 9608B)

The counter divides the frequency on Input-A by a constant, $A_0$, that is stored in the counter in the following way:
1) Connect a signal with the frequency to be stored as $A_0$ to Input-A.
2) Select FREQ A.
3) Depress the DISPL HOLD key and hold it depressed until the DISPL HOLD indicator is switched off again. Now $A_0$ is stored.
4) Select FREQ A/$A_0$.
5) Connect the frequency to be measured to Input-A.

If you select this function without storing $A_0$, Frequency A will be displayed.

This function is convenient when an oscillator is to be tuned to the frequency of a reference oscillator. It is much easier to adjust until the display shows 1.0000000 than 7.1223678.

The counter subtracts a constant, $A_0$, from the frequency at Input-A. You can read about how to store $A_0$ in the description for FREQ A/$A_0$.

If you select this function without storing $A_0$, Frequency A will be displayed.

This function can e.g. be used in a radio to display the received frequency: Set the intermediate frequency as the constant $A_0$. Select FREQ A-$A_0$ and measure the frequency of the local oscillator, and the display will show the received frequency.

The frequency on Input-A is multiplied by 60 and displayed as Revolutions Per Minute.

Range: 6 RPM to 720 000 000 RPM.

When you select SINGLE, the Frequency Counter measures one period, the range is: 100 ns to 200 000 000 s (about 6 years and four months!).

When you select 0.2, 1, and 10 s Measuring-time, the Frequency Counter divides the input frequency by 10 and measures the average period for the No. of cycles in that time.

Range: 8 ns to 1 s.

The Frequency Counter counts the total number of pulses fed to Input-A. You start and stop the totalizing with the TOTALIZE START/STOP key (RESET/LOCAL). If you keep this key depressed for more than one second, the total sum will be reset.

Range: 0 to $1 \times 10^{15}$ pulses

k on the display indicates kilo-pulses (1000) and M indicates Mega-pulses (1 000 000).

The Measuring-time indicator is switched off in TOT A MAN.
<table>
<thead>
<tr>
<th>CONTROL</th>
<th>OPERATING THE CONTROL</th>
<th>DISPLAY</th>
<th>GPIB-CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUNCTION</td>
<td>Move function cursor to WIDTH A</td>
<td></td>
<td>WIDTH A or PWIDTH A</td>
</tr>
<tr>
<td>MEAS TIME</td>
<td>MEAS TIME is operated in the same way as the functions control, see page 8.</td>
<td></td>
<td>MTIME &lt;num&gt;</td>
</tr>
<tr>
<td></td>
<td>where &lt;num&gt; is the time in seconds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range: 10 ms to 10 s. 0 = Single</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Move the measuring-time cursor to SINGLE</td>
<td></td>
<td>MTIME 0</td>
</tr>
<tr>
<td></td>
<td>Move the measuring-time cursor to 0.2 s</td>
<td></td>
<td>MTIME 0.2</td>
</tr>
<tr>
<td></td>
<td>Move the measuring-time cursor to 1 s</td>
<td></td>
<td>MTIME 1</td>
</tr>
<tr>
<td></td>
<td>Move the measuring-time cursor to 10 s</td>
<td></td>
<td>MTIME 10</td>
</tr>
</tbody>
</table>
FUNCTION AND RANGE

The counter measures the positive pulse width of the signal on Input-A.
Range: 100 ns to 200 000 000 s.

HINTS AND COMMENTS

If you are interested in the negative pulse width instead; first measure the period and make a note of the result, then measure the pulse width and subtract it from the period reading.

The set Measuring-time controls the time during which the main gate is opened, allowing pulses to enter the counting logic. A longer Measuring-time gives higher resolution readouts with more digits displayed.

The time the gate is open is not exactly the preset Measuring-time, because the Frequency Counter synchronizes the measurement with the input signal in order to measure complete periods. If the period of the input signal is longer than the set Measuring-time, the main gate does not close again until the period is completed.

For PER A and WIDTH exactly one period or one time interval is measured. The minimum result possible is 100 ns.

The display time will be 100 ms.

When set to SINGLE, FREQ A and, RPM A, the Measuring-time is one cycle of the input signal or 3 ms, whichever is longest. When set to SINGLE and FREQ B, the Measuring-time is 3 ms.

A Frequency-A measurement will result in 6-7 digits on the display.

The input frequency is limited to 16 MHz for FREQ A, PER A, and RPM A.

If external reference is used, the EXT REF indicator will not be switched-on until after the first measurement.

A Frequency-A measurement will result in 7-8 digits on the display.

A Frequency-A measurement will result in 8-9 digits on the display.
<table>
<thead>
<tr>
<th>CONTROL</th>
<th>OPERATING THE CONTROL</th>
<th>DISPLAY</th>
<th>GPIB-CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRIGGER LEVEL A</td>
<td>The TRIGGER LEVEL A control is operated in the same way as the functions control, see page 8.</td>
<td>TLO AUT</td>
<td>One code for each trigger level offset. See below.</td>
</tr>
<tr>
<td>TRIGGER LEVEL A</td>
<td>Move Trigger Level A cursor to AUTO.</td>
<td>TLO POS</td>
<td></td>
</tr>
<tr>
<td>TRIGGER LEVEL A</td>
<td>Move Trigger Level A cursor to / \</td>
<td>TLO SYM</td>
<td></td>
</tr>
<tr>
<td>TRIGGER LEVEL A</td>
<td>Move Trigger Level A cursor to / \</td>
<td>TLO NEG</td>
<td></td>
</tr>
<tr>
<td>BLANK DIGITS</td>
<td>Each depression of the BLANK DIGITS key blanks out one digit starting from the right (Least Significant Digit). When all digits are blanked out, the next depression removes the blanking.</td>
<td></td>
<td>Not bus controllable</td>
</tr>
</tbody>
</table>

PM 6669 - OPERATORS MANUAL
FUNCTION AND RANGE

The normal trigger level of the AC-coupled Input-A is 0 V. This is ideal for symmetrical signals like sine-waves, since their average DC component is 50 % of Vp-p.

Non-symmetrical signals however, might fail to trigger if the trigger level is 0 V. Therefore there are three trigger level settings available; one for small duty factors, one for symmetrical wave forms and one for large duty factors.

When set to Auto the counter first tries the trigger level for symmetrical signals. If that does not work, it tries the other settings.

Auto does not work if TOT A is selected.

Range: Auto works with input frequencies from 100 Hz and up.

Use this setting if the duty factor is below 25 %.
A positive offset voltage is added to the trigger level.

Use this setting if the duty factor is between 25 % and 75 %.
The trigger level is 0 V.

Use this setting if the duty factor is below 75 %.
A negative offset voltage is added to the trigger level.

HINTS AND COMMENTS

It is often possible for the counter to trigger on unsymmetrical signals even though the symmetrical triggering is selected, provided that the sensitivity is high enough. This however, gives poor noise immunity.

If you don’t know the duty factor of the input signal, select Auto. If that does not work (too low input frequency) do as follows;

a) Set the sensitivity to max.
b) Select Trigger level \( \text{max} \).
c) Reduce the sensitivity until the gate indicator stops blinking.
d) Check if trigger level \( \text{min} \) or \( \text{max} \) makes the gate indicator start blinking again. If it does, leave the trigger level in that position, otherwise return to trigger level \( \text{max} \).
e) Turn the sensitivity down until the gate indicator stops blinking, then up slightly until it starts again. The trigger level is now correct.

Each digit that is blanked out is removed and replaced by a -. The numerical value on the display is not rounded off. The blanking is cleared by reset, changing settings or when all digits are blanked and you press the BLANK DIGITS key once more.

This function is used to blank the display of irritating, unstable digits.
RESET/LOCAL, a short press is enough for Reset. When the remote indicator is on, a press will cause the counter to switch back to LOCAL, i.e. control from the front panel.

TOTALIZE START/STOP, one press starts totalizing, the next press stops.

DISPL HOLD Switches ‘on’ or ‘off’ when depressed.

STORE

Connect the signal to INPUT-A via a BNC-cable.

Connect the signal to INPUT-B via a BNC-cable.

Not bus controllable, but Free-run OFF will give a similar function; See GPIB-bus operation.
FUNCTION AND RANGE

When reset is depressed, the display and counting registers are cleared. When reset is released, a new measurement is started. The Measuring-time-, Function and display hold settings are not affected.

If the TOT A function is selected, the RESET/LOCAL key functions as a START/STOP key. One press starts the counting and the next press stops it. A long depression results in reset.

Display hold freezes the display, but not until the measurement in process has been finished. A new measurement can always be initiated via the RESET key.

Store A₀ is used to store the constant used in functions FREQ A/A₀ and FREQ A-A₀. The procedure is described under FUNCTIONS, FREQ A/A₀.

Use this input for all functions except FREQ B.

Range: 10 Hz to 160 MHz
Impedance: 1 MΩ/30 pF
Min. pulse duration: 4 ns

At higher frequencies; use a 50 Ω termination type PM 9585 to avoid interference caused by impedance mismatch.

The illustration below shows which function block each of the input controls affect.

This is the HF-input which must be used when the FREQ-B function is selected. If the Frequency Counter does not include the Input-B option, the BNC-connector is replaced by a plastic plug.

Range:
70 to 1300 MHz.
Impedance:
50Ω
Sensitivity:
10 mV RMS up to 900 MHz,
15 mV RMS 900-1100 MHz
and 40 mV RMS above.
Max voltage:
12 VRMS

HINTS AND COMMENTS

When the counter is controlled from the GPIB-Bus, the LOCAL key can be disabled via the ‘Local Lock out’ command.

Use this input for all functions except FREQ B.

Range: 10 Hz to 160 MHz
Impedance: 1 MΩ/30 pF
Min. pulse duration: 4 ns

At higher frequencies; use a 50 Ω termination type PM 9585 to avoid interference caused by impedance mismatch.

The illustration below shows which function block each of the input controls affect.

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Range:
70 to 1300 MHz.
Impedance:
50Ω
Sensitivity:
10 mV RMS up to 900 MHz,
15 mV RMS 900-1100 MHz
and 40 mV RMS above.
Max voltage:
12 VRMS

Figure 7. Input circuit block diagram.
<table>
<thead>
<tr>
<th>CONTROL</th>
<th>OPERATING THE CONTROL</th>
<th>DISPLAY</th>
<th>GPIB-CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull the SENSITIVITY knob to switch to <strong>AC</strong> coupling. Depress the knob to switch to <strong>DC</strong> coupling. <strong>NOTE:</strong> The potentiometer controls the sensitivity when AC-coupled and Trigger Level when DC-coupled. Turn the knob clockwise to increase and counter clockwise to decrease the trigger level or sensitivity.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One two-position switch. Depress to switch on the <strong>FILTER</strong> and release to switch it off.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connect an external 10 MHz frequency source to the BNC-connector on the rear panel of the Frequency Counter marked <strong>EXT REF INPUT</strong>.</td>
<td>Not adjustable from the bus.</td>
<td>Not bus controllable.</td>
<td></td>
</tr>
</tbody>
</table>
FUNCTION AND RANGE

For frequency-, period-, and ratio measurements:
Select AC coupling and set the sensitivity so that the hysteresis band of the Frequency Counter is about half the amplitude of the signal.

For time measurements:
Select DC coupling and set the trigger level to the desired level using the 1 V/division scale on the front panel.

The filter works on Input-A where it suppresses signals with higher frequencies than 50 kHz.

Filter suppression: 40 dB at 1 MHz

The Frequency Counter automatically detects if a suitable signal is connected to the EXT- REF Input-connector.

Suitable signal:
10 ± 0.1 MHz, 0.5 to 15 V_RMS Sine wave.

HINTS AND COMMENTS

1. Set the sensitivity knob fully counter clockwise.
2. Turn it until the input triggers.
3. Continue turning to the 20 mV_RMS position, or to the position where the display turns unstable due to noise.
4. Set the knob to the position inbetween these two points.

You will have a stable reading.

If the sensitivity is too high, the Frequency Counter will be triggered by noise and interference instead of by the signal.

Use external reference when the measurement requires ultra-high stability.

The Frequency Counter must still have the internal time base even if an external reference frequency is used.

If single is selected, the EXT REF indicator on the display is not switched on until after the first measurement.

NOTE: Never use the filter when measuring TIME A-B since the filter delays the signal on Input-A.
Battery Unit

Operation
When a battery unit is installed, the counter can operate for 3 hours without mains supply. The display starts blinking shortly before the battery is discharged.

The counter charges the battery automatically when connected to the mains, no matter how the Power-switch is set. Charging a discharged battery to 75% of full capacity will take 7 hours, and to full capacity, 24 hours.

If the counter is connected to the mains and switched on, it will not switch to battery operation if you disconnect the mains. You must first switch the counter OFF with the power switch, then ON again before the battery unit supplies the counter.

Battery Care
The capacity of the rechargeable battery degrades if the counter is not powered by the battery frequently. To keep the battery from degrading, cycle the battery, from fully charged to fully discharged, occasionally.

The capacity of a degraded battery can be restored by cycling the battery a number of times, but a restored battery will never reach the capacity of a new one.

If you must store your counter for some time without using it, store it in a cool and dry place. Leave the counter with the mains cable connected if possible. If not, don’t disconnect the mains cable until the battery is fully charged, then charge the battery for at least 8 hours every 3 months.

CAUTION: Prolonged storage or use of the counter at temperatures above +40°C shortens the life of the battery.

The battery will freeze if it is not sufficiently charged when stored at a low temperature. 75% charge is sufficient for -40°C.

Error Codes
The counter can display the following error codes if something goes wrong.

- Error OF: Overflow in the counting registers. Select a shorter Measuring-time if you get this error code, unless the counter is set to TOTALIZE, then you must press reset and start again from zero.
- Error 01: RAM memory error
- Error 02: Measuring logic error
- Error 03: Internal bus error

If the counter shows one of these error codes, try switching the counter off and on again. If error code 01-03 persists, call Fluke service. Look on the last page in this manual for Phone No. and address.
GPIB-INTERFACE OPERATION

Introduction
The PM 6669 can be controlled by a computer (controller) via the GPIB-interface option, PM 9604. All functions that can be controlled from the front panel can also be controlled via the bus in a similar way, except selection of measuring functions FREQ A/A₀ and FREQ A-A₀, the filter, the sensitivity controls, and the power switch. The additional micro-processor on the interface board has made it possible to add functions. You can obtain continuously variable measuring-time, bus-learn, high-speed-dump etc., but these functions are only accessible via the bus.

To select a function, you send a command to the counter. We have chosen the text on the front panel as commands, wherever possible, in order to make them easy to remember. E.g. the command to select Frequency-B is FREQ B and the command to select Period A is PER A.

NOTE: The characters in a command can be in both upper and lower case.

What Can I Do Using the Bus?
All the capabilities of the interface for the PM 6669 are explained below. If you want a complete description of all GPIB-interface functions, read the ‘Fluke Instrumentation-Systems Reference-Manual’.

Summary
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<th>Code</th>
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<td>Source handshake</td>
<td>SH1</td>
</tr>
<tr>
<td>Acceptor handshake</td>
<td>AH1</td>
</tr>
<tr>
<td>Control function</td>
<td>CØ</td>
</tr>
<tr>
<td>Talker Function</td>
<td>T5</td>
</tr>
<tr>
<td>Listener function</td>
<td>L4</td>
</tr>
<tr>
<td>Service request</td>
<td>SR1</td>
</tr>
</tbody>
</table>

Source and Acceptor Handshake SH1, AH1
SH1 and AH1 simply means that the counter can exchange data with other instruments or a controller, using the bus handshake lines; DAV, NRFD, NADC.

Control Function, CØ
The counter does not function as a controller.

Talker Function, T5
The counter can send responses and the results of its measurements to other devices or to the controller. T5 means that it has the following functions:

- Basic talker.
- Talk only mode.
- It can send out a status byte as response to a serial poll from the controller.
- Automatic un-addressing as talker when it is addressed as a listener.

Listener Function, L4
The counter can receive programming instructions from the controller. L4 means the following functions:

- Basic listener.
- No listen only.
- Automatic un-addressing as listener when addressed as a talker.

Service Request, SR1
The counter can call for attention from the controller e.g. when a measurement is completed and a result is available.
Remote/Local, RL1
You can control the counter manually (locally) from the front panel, or remotely from the controller. The LLO, local-lock-out function, can disable the LOCAL button on the front panel.

Parallel Poll, PPØ
The counter does not have any parallel poll facility.

Device Clear, DC1
The controller can reset the counter, forcing it to default settings, via interface message DCL (Device clear) or SDC (Selective Device Clear).

Device Trigger, DT1
You can start a new measurement from the controller via interface message GET (Group Execute Trigger).

Bus Drivers, E2
The GPIB interface has tri-state bus drivers.

Connecting the Controller
The bus interface connector is on the rear panel of the counter. If your counter does not have any connector, you must install the GPIB-interface option.

Bus interface connector

![GPIB connector and address switch](image)

Connect the controller via an IEEE-488 cable to the bus connector. If you use IEC-625 cables, an adapter is available, see ordering information at the end of this manual.

Giving the Counter an Address
The counter must have a unique address so that the controller can communicate with it. The address is selected by setting switches to the binary equivalent of the address you want. The switches are located to the right of the interface connector. The OFF position means 0 and the ON position means 1.

### Address Switch Settings

<table>
<thead>
<tr>
<th>Address</th>
<th>Switch Settings</th>
<th>Address</th>
<th>Switch Settings</th>
<th>Address</th>
<th>Switch Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>00000</td>
<td>10*</td>
<td>01010</td>
<td>20</td>
<td>10100</td>
</tr>
<tr>
<td>1</td>
<td>00001</td>
<td>11</td>
<td>01011</td>
<td>21</td>
<td>10101</td>
</tr>
<tr>
<td>2</td>
<td>00010</td>
<td>12</td>
<td>01100</td>
<td>22</td>
<td>10110</td>
</tr>
<tr>
<td>3</td>
<td>00011</td>
<td>13</td>
<td>01101</td>
<td>23</td>
<td>10111</td>
</tr>
<tr>
<td>4</td>
<td>00100</td>
<td>14</td>
<td>01110</td>
<td>24</td>
<td>11000</td>
</tr>
<tr>
<td>5</td>
<td>00101</td>
<td>15</td>
<td>01111</td>
<td>25</td>
<td>11001</td>
</tr>
<tr>
<td>6</td>
<td>00110</td>
<td>16</td>
<td>10000</td>
<td>26</td>
<td>11010</td>
</tr>
<tr>
<td>7</td>
<td>00111</td>
<td>17</td>
<td>10001</td>
<td>27</td>
<td>11011</td>
</tr>
<tr>
<td>8</td>
<td>01000</td>
<td>18</td>
<td>10010</td>
<td>28</td>
<td>11100</td>
</tr>
<tr>
<td>9</td>
<td>01001</td>
<td>19</td>
<td>10011</td>
<td>29</td>
<td>11101</td>
</tr>
<tr>
<td>10</td>
<td>01010</td>
<td>20</td>
<td>10100</td>
<td>30</td>
<td>11110</td>
</tr>
</tbody>
</table>

* Factory setting.

**NOTE:** 31 is the bus command for "Untalk" and should not be used. If 31 is selected the counter will work as if address 0 is selected.

Talk-Only
The leftmost switch in the address switch block is the TALK ONLY switch. If you set it to ‘1’, the counter will output measurement results on the bus continuously. It will not react to any incoming commands.

This setting may only be used if the counter is connected to a ‘Listen only’ device such as a printer. Set the switch to ‘0’ when you want normal bus communication.

Talk only is set to ‘0’ on delivery.

The counter is now ready for bus control.

Checking the Communication
To check if the counter and the controller can communicate, address the counter and execute the following sequence: (The programming example is for an HP-85 controller.)

**Type on Controller:**

<table>
<thead>
<tr>
<th>Type on Controller</th>
<th>This Should Happen</th>
</tr>
</thead>
<tbody>
<tr>
<td>REMOTE 710</td>
<td>The remote indicator should be switched on.</td>
</tr>
<tr>
<td>OUTPUT 710;<em>ID?</em></td>
<td>Ask for the counter identity.</td>
</tr>
<tr>
<td>ENTER 710;A$</td>
<td>Input result from counter.</td>
</tr>
<tr>
<td>DISP A$</td>
<td>The response on the display of the controller is the identity of the counter.</td>
</tr>
</tbody>
</table>

If everything is OK, the counter will identify itself as:

```
PM6669/YZW/MN
```

where:

- **Y** = 4 if the counter has an HF-input, otherwise 0.
- **Z** = 3 for MTCXO, otherwise 1
- **W** = 6 (GPIB-bus is installed)
- **M** = Revision No. of counter firmware
- **N** = Revision No. of GPIB-bus firmware
Two Ways of Programming
The simplest way of programming the counter is by manually setting up the measurement you want from the front panel of the counter, then let the controller ask the counter how it is set up. The data the controller gets from the counter can be used to set up the same measurement over and over again. This method is called 'Bus-learn' and will be explained later.

The other method is to make a program message where each step of the set-up is separately specified.

Programming Check-List
Check that the following steps have been taken to ensure correct programming of the instrument.

Normally only the six first steps must be programmed.

- Do you know the current setting of the counter? If not, send device clear 'D' to get the default settings.
- Select Measuring-function;
  (Default: Frequency-A.)
- Select Measuring-time;
  (Default: 0.2 s.)
- Select Trigger-level offset;
  (Default: Positive)

For advanced programming, check the following steps.

- Select Trigger-slopes;
  (Default: AUTO)
- Set Output separator;
  (Default: LF.)
- Set EOI mode;
  (Default: OFF.)
- Set service request(SRQ) -mask;
  (Default, No SRQ.)
- Select Free-Run on or off;
  (Default: ON.)
- If Free-Run is off, select Time-Out if desired;
  (Default: Infinite, programmed as 0 s.)
- Set Output-mode;
  (Default: Normal output format, High-speed dump OFF and MTCXO compensation ON.)

All functions and commands in the checklist will be explained later.

NOTE: You only have to program the changes from the previous set-up.

Syntax
What is a Programming Command?
A programming command consists of a header, addressing the function you want, and a body instructing the function what to do.

EXAMPLE:
TRGSLP POS
HEADER, addressing Trigger Slope
BODY, switching slope to positive

NOTE: Some programming commands consists only of the Header, e.g. trigger command 'X'.

What is a Programming Message?
A programming message is a number of programming commands with separators between them. E.g. the commands necessary to set up a measurement.

EXAMPLE: PER A;MTIME 0

Input Separator
All communication between the counter and the controller uses sequences of ASCII-characters terminated by a separator. Input separators are the separators sent by the controller. They are used in four different places:

Between header and body
As unit between bodies
To end a program message

<space> <comma> <semicolon> <linefeed>
FREQ A,B:FRUN ON

The separators in the example above are the ones normally used in respective place. The counter will however accept any one in any place.

The following separators will also work in any of the four places: colon, CR, ETB, ETX, the separator selected as output separator, as well as an active EOI-signal.
Order of Commands in a Program Message

Normally, the programming commands in a programing message can be placed in any order. However, the following commands must always be placed at the end of a program message since any command sent after them will disable the selection:

- INPA?
- MEAC?
- FNC?
- BUS?
- ID?
- OUTM 4

These commands will be ignored if found anywhere but in the end of a message.

<number>

In some program commands, the body is replaced by the term <number> or <num>. Here you must enter a numerical value. <number> can be entered in any format you like e.g. 1.23 can also be entered as 0.00000123×10^-7 or 1230000×10^-6. If you enter more digits than the counter needs, your entry will be truncated. The counter will stop if an entry is out of the counters range. To proceed, the status message 'Programming error' must be reset, see 'Status byte'.

Selecting Output Separator

Output separators terminate messages from the counter to the controller. The separator needed is different for different controllers; see the Operators' Manual for your controller.

At power on, the output separator of the counter is linefeed 'LF'(10 decimal).

The output separator can be changed by sending SPR <number> to the counter. <number> is the decimal value of the ISO (ASCII)-code for the desired separator. It can be 0-26, 28-31, ESC code, 27, is not accepted.

Only one <number> can be entered as separator. If you want the combination of CR+LF (13 dec + 10 dec), it is selected by 'SPR 255'.

EXAMPLE:

- SPR 13 changes the output separator to CR
- SPR 255 changes the output separator to CR+LF

The counter can signal EOI together with the last output separator in responses and output data.

EOI ON switches on the function.

EOI OFF switches it off.

Default setting is EOI OFF.

The selected separator and EOI will not be altered by LOCAL from the front panel nor by LOCAL or 'Device clear' from the bus.

How to Select Function

Standard Functions

Functions are selected by sending the appropriate function command to the counter, e.g. FREQ A. The space between FREQ and A indicates the input separator that you always must insert.

<table>
<thead>
<tr>
<th>Function</th>
<th>Command</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>FREQ A</td>
<td>Default</td>
</tr>
<tr>
<td>Frequency</td>
<td>FREQ B</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>A/A</td>
<td>Make a FREQ A measurement and then perform the ratio calculation in the controller.</td>
</tr>
<tr>
<td>Frequency</td>
<td>A-A</td>
<td>Make a FREQ A measurement and then calculate the frequency difference in the controller.</td>
</tr>
<tr>
<td>RPM A</td>
<td>RPM A</td>
<td></td>
</tr>
<tr>
<td>Period A</td>
<td>PER A</td>
<td></td>
</tr>
<tr>
<td>Totalize A</td>
<td>TOTM A</td>
<td>See 'Totalize start/stop'.</td>
</tr>
<tr>
<td>Pulse-width A</td>
<td>WIDTH A</td>
<td>The counter will also accept PWIDTH A.</td>
</tr>
</tbody>
</table>

Selecting Measuring-Time

The Measuring-time can be set to any value between 10 ms and 10 s, or SINGLE-measuring. Any value below 10 ms will be interpreted as SINGLE. Values above 10 s will be out of range and cause an error. The program command is MTIME <number>. Always enter the Measuring-time in seconds. The entered value will be truncated to the nearest 10 ms increment.

<table>
<thead>
<tr>
<th>Meas Time</th>
<th>Command</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 s</td>
<td>MTIME 0.2</td>
<td>Default</td>
</tr>
<tr>
<td>10 ms</td>
<td>MTIME 0.01</td>
<td>You will not be able to see the gate indicator blinking if the Measuring-time is below 50 ms</td>
</tr>
<tr>
<td>7.34567 s</td>
<td>MTIME 7.34567</td>
<td>The Measuring-time will be 7.34 s.</td>
</tr>
<tr>
<td>2 ms</td>
<td>MTIME 0.002</td>
<td>Out of range. Measuring time will be SINGLE.</td>
</tr>
<tr>
<td>SINGLE</td>
<td>MTIME 0</td>
<td>A display time of 50 ms is set so that you can see the Gate-indicator.</td>
</tr>
<tr>
<td>25 s</td>
<td>MTIME 25.0</td>
<td>Out of range and error, the counter will stop. It can indicate programming error by sending an SRQ if selected in the SRQ-mask.</td>
</tr>
</tbody>
</table>
The Measuring-time cursor on the display will indicate 0.2 s for all programmed Measuring-times except SINGLE, which will be indicated as usual.

**Selecting Triggering**

The trigger level can be selected in the same way as from the front panel.

<table>
<thead>
<tr>
<th>Trigger-level offset</th>
<th>Code</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>TLO AUT</td>
<td>Default</td>
</tr>
<tr>
<td>⊕</td>
<td>TLO POS</td>
<td></td>
</tr>
<tr>
<td>⊖</td>
<td>TLO SYM</td>
<td></td>
</tr>
<tr>
<td>⊖</td>
<td>TLO NEG</td>
<td></td>
</tr>
</tbody>
</table>

The trigger-level cursor on the front panel will indicate the setting.

<table>
<thead>
<tr>
<th>Trigger slope</th>
<th>Command</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>TRGSLP POS</td>
<td>Default</td>
</tr>
<tr>
<td>Negative</td>
<td>TRGSLP NEG</td>
<td>Negative slope is only available via the bus and is used when you want to measure the negative Pulse-width.</td>
</tr>
</tbody>
</table>

When the counter switches to local, the trigger slope will switch back to positive. Trigger slope is not indicated on the display.

**Totalize Start/Stop**

When TOT A is selected, the gate is opened and closed by the controller instead of by pressing the button on the front panel. To start the counting after selecting TOTM A, the gate must be opened.

<table>
<thead>
<tr>
<th>Totalize</th>
<th>Command</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>GATE OPEN</td>
<td>Starts counting.</td>
</tr>
<tr>
<td>Stop</td>
<td>GATE CLOSE</td>
<td>Stops counting.</td>
</tr>
</tbody>
</table>

**NOTE:** Multiple GATE OPEN/GATE CLOSE will accumulate the results in the counting registers. Any other command but GATE OPEN/GATE CLOSE will stop the totalizing and reset the counting registers to zero.

**Free-Run/Triggered**

The counter can work in two different ways:

1. **Free-Run**, where it starts a new measurement as soon as the previous measurement is finished. The first measuring result that is ready after the counter receives a read command, will be sent to the controller. When the result has been read, the output buffer is reset to zero until a new result is ready. One and the same measuring result can only be read once.

2. **Triggered**, where the counter waits for trigger command GET or 'X' from the controller before it starts a measurement. When the measurement is completed, the counter will wait until the controller reads the measuring results, then the output buffer is reset. The function is the same as when Displ Hold is selected from the front panel and you start a new measurement by pressing the reset button.

**Free-Run/Command**

<table>
<thead>
<tr>
<th>Command</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>FRUN OFF</td>
</tr>
<tr>
<td>On</td>
<td>FRUN ON</td>
</tr>
</tbody>
</table>

Free-Run ON or OFF will not be indicated on the display. When the counter switches to LOCAL, Free-Run will always be ON but when the counter switches back to remote, it will return to its previously programmed settings.

**Time-Out**

When Free-Run is switched off it is possible to set a time-limit (time-out) between the start of a measurement and the time when a result is expected to be ready. If no result is achieved before the set time is out, the counter can output a Service Request, SRQ. Time-Out must be selected in the SRQ-mask; see 'Service Request'. The programming command is TOUT <number>. The timeout can be set to any value between 100 ms and 25.5 s, the minimum increment is 100 ms.

**Time-Out/Command**

<table>
<thead>
<tr>
<th>Command</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ms</td>
<td>TOUT 0.1</td>
</tr>
<tr>
<td>Off</td>
<td>TOUT 0</td>
</tr>
</tbody>
</table>

Time-Out is not indicated on the display. When the counter switches to LOCAL, Time-Out is off, but when switched to remote again, the set Time-Out will be active again.

* Time-out can be switched on when free-run is on but it will not serve any purpose.
Bus Triggering

'X' will always cause the counter to start a new measurement. X will work as group execute trigger, GET. 'X' must always be placed in the end of a program message.

Service Request

The counter can send a service request, SRQ, when it wants service from the controller. After an SRQ, the controller must execute a serial poll which means that it must ask each of the instruments for status information until it finds the SRQ-giving instrument, evaluate the Status-byte of the instrument and then make a decision what to do.

To enable the counter to send service requests, you must set an SRQ-mask telling the instrument which conditions will cause SRQ.

Command Comment
MSR <number> <number> is a decimal value depending on selected SRQ reasons.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Decimal value</th>
<th>Reason for SRQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>128</td>
<td>Not used.</td>
</tr>
<tr>
<td>6</td>
<td>64</td>
<td>Time-Out.</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
<td>Hardware fault.</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>Programming error.</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>Measuring start enable.</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>Ready for triggering.</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>Measuring result ready*.</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Measuring stop enable.</td>
</tr>
</tbody>
</table>

* If SRQ for Measuring result ready is selected, the counter will stop and wait until the controller fetches the result before a new measurement can start.

Write down the binary word for the required SRQ, then convert it to a decimal value and insert the value as <number>.

EXAMPLE: If you want SRQ to be sent when the time-out elapses, when the counter is ready for triggering and when the result is ready, the binary word required is 01000011 which is decimal 67; see table below.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Value if the bit is 1</th>
<th>Example</th>
<th>Binary word</th>
<th>Decimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>128</td>
<td>Time-Out</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>64</td>
<td></td>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>Ready to trigger</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Meas. result ready</td>
<td>1</td>
<td>1 +</td>
</tr>
</tbody>
</table>

Send MSR 67 to the counter.

Status Byte

The counter sends its status byte to the controller on a serial poll. The bits in the status byte reflects different events or conditions in the counter. There are two types of status bits:

A conditional bit indicates the current condition of what its monitoring, all the time.

An event bit indicate that an event has occurred. When the event occurs, the bit is set to 1. It is not reset to 0 until a new measurement starts.

The different bits indicate the following information:

<table>
<thead>
<tr>
<th>Bit</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Always 0</td>
</tr>
<tr>
<td>6</td>
<td>1 = SRQ has been sent*, otherwise 0 (Event bit).</td>
</tr>
<tr>
<td>5</td>
<td>Abnormal bit. Always 0 during normal measurements, 1 if something is wrong. Affects bit 0-3, see below (Event bits.)</td>
</tr>
<tr>
<td>4</td>
<td>0 = Main Gate closed, 1 = Main Gate open**</td>
</tr>
<tr>
<td>3-0</td>
<td>Depends on Abnormal bit, see below (Event bits.)</td>
</tr>
</tbody>
</table>

* Only if SRQ-mask is set for Service-Request.

** This is a conditional bit that monitors the Main-Gate in the counter. When TOT MAN is selected the bit will always be 0.

Measuring start enable indicates that the counter logic is ready to start a measurement.

Measuring stop enable indicates that the counter logic is ready to stop a measurement.

These bits can be used to detect if the input signal to the counter is present; If the counter never stops it’s measurement and the status byte stops at:

XX00X1XX No input signal. The measurement is ready to start (bit 2 = 1) but the Main Gate has not opened (bit 4 = 0).

XX011XXX Input signal lost during measurement. The measurement is ready to stop (bit 3 = 1) but the main gate is still open (bit 4 = 1)

(X = don’t care)

NOTE: SRQ is normally not used for these bits.

Ready for triggering indicates that all preparations for a measurement is completed. The preparation time depends on selected functions. It can be up to 700 ms (when auto triggering is selected).

If triggered mode is selected, the counter waits to be triggered, otherwise it proceeds with the measurement. You can have the SRQ-mask set for SRQ at ready for trigger-
ing. This way the controller knows when it is possible to trigger the counter.

**Measuring result ready** indicates that the measurement and calculation of the result is completed and that the result is present in the output buffer. If SRQ for is selected for this event, or Free-run is OFF, the counting will stop until the controller has read the result.

**Programming error** is generated if the counter receives messages with illegal syntax or values out of its range.

If 'Programming error' is generated, the counter will stop measuring. It will continue to receive and store correct programming messages and use them when the error status is reset and a new measurement starts.

Correct the program before resetting the status message.

Use one of the following bus commands to reset the status byte:

Go to local (GTL), Device clear (DCL) or selective device clear (SDC).

Any of the following messages will have the same effect on the counter:

D, FNC?, MEAC?, INPA?, ID? or BUS?.

A serial poll will also reset the status message if the SRQ mask is set for 'SRQ at Programming error'.

**Hardware fault** is generated when the counter displays the codes described in 'Error codes' in the 'Operating instructions' in this manual.

**Time-Out** is generated when the set time-out period has elapsed.

### Possible Status Messages

#### Normal Measurement

The status byte changes as follows during a normal measurement:

0, 2, 6, 22, 30, 14, 15, 0, ........

<table>
<thead>
<tr>
<th>Decimal</th>
<th>Binary 76543210</th>
<th>Important bits (X = don't care)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>00000000</td>
<td>Preparing a measurement or, High-speed dump or Volt measurements in progress.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>00000010</td>
<td>XX0XXX1X</td>
<td>Preparations ready. If Free-run OFF</td>
</tr>
</tbody>
</table>

#### Error Conditions

<table>
<thead>
<tr>
<th>Decimal</th>
<th>Binary 76543210</th>
<th>Important bits (X = don't care)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>00100001</td>
<td>XX1XXXXX1</td>
<td>Programming error.</td>
</tr>
<tr>
<td>34</td>
<td>00100010</td>
<td>XX1XXXX1X</td>
<td>Hardware fault.</td>
</tr>
<tr>
<td>36</td>
<td>00100100</td>
<td>XX1XXXXX1</td>
<td>Time-out.</td>
</tr>
</tbody>
</table>

* If Service request (SRQ) is enabled for an event, the decimal value of the status message for that event will be increased by 64. The reason for this is that bit 6 will be set to one at the same time as the bit indicating the event.

### Output Mode

Setting the output mode selects the format in which the counter will output measuring results to the controller.

Select output mode by sending OUTM <number> where <number> is a decimal value between 0 and 4 depending on the selected output mode.

<table>
<thead>
<tr>
<th>&lt;number&gt;</th>
<th>High-speed dump</th>
<th>Output format</th>
<th>MTCXO compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>OFF</td>
<td>NORMAL</td>
<td>ON</td>
</tr>
<tr>
<td>1</td>
<td>OFF</td>
<td>SHORT</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td>NORMAL</td>
<td>OFF</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>SHORT</td>
<td>OFF</td>
</tr>
<tr>
<td>4</td>
<td>ON</td>
<td>FOR HIGH</td>
<td>OFF **</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPEED</td>
<td>DUMP</td>
</tr>
</tbody>
</table>

Default <number> is 0, when switching to local and back again, the <number> will be reset to 0.

The MTCXO compensation can be switched off to increase the measuring speed, providing a result with five digits accuracy is sufficient. The time gained will be up to 400 ms/measurement.

** Must be in the end of a program message.
Output Format

Normal
When you select normal output format, the output will be as follows:

- Function command Header, 3-6 characters (same Header as used for selecting the function).
- Measurement result, always 9 digits and a decimal point. Same number of significant digits as on the display of the counter, leading zeroes fill out the rest of the 9 positions. The leftmost digit can be replaced by a (minus sign).
- Separates the exponent from the digits.
- Exponent sign, + or -. Exponent, one digit.
- Output separator.
- LF if CR+LF is selected as output separator.

```
FM1111111222222S(S) 21(22) characters
```

**EXAMPLE:**

Normal operation:
PER 000001.667E-4

Overflow:
PER O9.99999999E+9

Short
Short format means that function command and leading zeros are not sent to the controller. When you select short output format, the number of digits may vary depending on the measurement result. The example below shows a result with five significant digits:

- Measurement result, same number of digits as on the display of the counter; may vary between 1 and 9 digits, plus decimal point. No leading zeros are sent.

```
X.XXXE±XS(S)
```

**EXAMPLE:**

Normal operation:
1.667E-4

Overflow:
9.99999999E+9

High-Speed Dump

The most time-consuming part of a measuring cycle is calculating the result. The calculations limit the number of possible results/second to about 5, even when the Measuring-time is short.

When however High-Speed dump is selected all calculations are left to the controller instead, and the counter can concentrate on measuring at a rate of over 100 measurements/second.

High-speed dump cannot be used for voltage measurements nor for Totalize manually. MTCXO compensation is not possible.

Starting

**NOTE:** Always make sure you have input signal and that the input triggers correctly before turning on high-speed dump! (See stopping below.)

If triggered mode is OFF
When High-speed dump is programmed the counter will immediately start transmitting results, so the OUTM 4 command must always be placed at the end of the program message.

If triggered mode is ON
After receiving OUTM 4 the counter waits for bus command GET before it starts.

**NOTE:** The minimum time between OUTM 4 and GET is 70 ms.

Stopping

Any programming command from the controller will end High-Speed dump. High-speed dump is stopped inbetween two measurements. If you switch on high speed dump without having an input signal, the counter must be switched off/on to regain control over the counter.

**NOTE:** The Power-switch is the only front panel control that will stop High-Speed dump, the LOCAL-key will not have any effect.

Output Format

The output format will always be two letters followed by 12 hexadecimal digits. The two letters will tell the controller how to evaluate the twelve hex-digits, which represent the contents in the internal registers of the counter.

```
FM1111111222222S(S) 15(16) characters
```

* The counter cannot signal EOI together with the output separator when High-speed dump is selected.
Hex-Digits
All 12 digits together represent register 3.

When the digits are divided into two groups, the first six digits represent register 1 and the last six digits represent register 2.

Formula
Depending on the selected measuring function different calculations must be made to convert the register contents to readable measuring results.

The first letter (F) in the output data indicates which formula you must use.

If `F` = Use this formula
C \[ \text{Reg. 2} \times 10^7 \] \[ \text{Reg. 1} \]
F \[ \text{Reg. 3} \]
G \[ \text{Reg. 2} \] \[ \text{Reg. 1} \]
I \[ \text{Reg. 1} \times 10^{-7} \] \[ \text{Reg. 2} \]
J \[ \text{Reg. 3} \times 10^{-7} \]
K \[ \text{Reg. 2} \times 10^{-7} \] \[ \text{Reg. 1} \]

Multiplier
The second letter (M) in the output data represents a multiplier which you must multiply the results by before presenting it.

If `M` = Multiply results by:
H \[ 60 \]
L \[ 256 \]
N \[ 0.1 \]
O \[ 10 \]
P \[ 1 \]

EXAMPLE 1:
The following HP-85 program sets up a High-Speed dump Single-period measurement.

OUTPUT 710;"PER A,MTIME 0"
ENTER 710;\$A$

A$ \text{PER} \ 000001.667E-4$

OUTPUT 710;OUTM 4
ENTER 710;\$A$

EXAMPLE 2:
The following HP-85 program sets up a High-Speed dump Frequency A measurement with 1 s Measuring-time.

OUTPUT 710;"FREQ A,MTIME 1"
ENTER 710;\$A$

A$ \text{FREQ} \ 006.000006E3$

OUTPUT 710;OUTM 4
ENTER 710;\$A$

A$ \text{CO98555B000257}$

Formula `'C` is:
\[ \frac{\text{Reg. 2}}{\text{Reg. 1}} \times 10^7 \]

98555B is the hex-contents of register 1, and 000257 is the hex-contents of register 2. Both register contents must be converted to decimal numbers and put into the formula;

\[ (2 \times 16^2 + 5 \times 16 + 7) \times 10^7 \]
\[ 9 \times 16^5 + 8 \times 16^4 + 5 \times 16^3 + 5 \times 16^2 + 5 \times 16 + 11 \]
\[ = 600.0006209.. \]

This number is multiplied by multiplier 'O' to get the measuring result:

\[ 600.0006209 \times 10 = 6000.0006209 = 6.000006209 \times 10^3 \text{ Hz} \]

How Many Digits Are Significant?
Select the formula for `LSD displayed` in the `Specifications`. There are different formulas for different measurements.

Frequency:

\[ \text{LSD displayed} = \frac{2.5 \times 10^{-7} \times \text{FREQ}}{\text{Measuring-time}} \]

\[ \text{LSD displayed} = \frac{2.5 \times 10^{-7} \times 6000..}{1} = 0.0015 \]

LSD = 0.001 Hz

The result is 6.000006\times10^3\text{ Hz}
Bus Learn

– Set the counter to LOCAL and select the functions you want from the front panel.
– If required, set the counter to Remote and program special bus-functions from the controller.
– Check that the counter/controller performs the intended functions.
– If it does, send the five queries from the controller to the counter and store the responses in the controller for later use.

These are the five queries:

<table>
<thead>
<tr>
<th>Query</th>
<th>Response</th>
<th>Max No. of Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>FNC?</td>
<td>Functions setting; e.g. FREQ A</td>
<td>9</td>
</tr>
<tr>
<td>MEAC?</td>
<td>Measurement control; MTIME &lt;number&gt;,FRUN ON TOUT &lt;number&gt;</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>INPA?</td>
<td>Input-A settings; TRGSLP POS</td>
<td>10</td>
</tr>
<tr>
<td>BUS?</td>
<td>Bus interface commands; MSR &lt;number&gt;,OUTM &lt;number&gt; EOI OFF,SPR &lt;number&gt;</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

As you can see, the responses are the same commands as you use for normal programming. So if you have to change anything in a program made using bus learn, or add functions which are not selectable from the front panel, these program messages can easily be edited in the controller.

NOTE: MEAC? and BUS? result in a response sent as two lines, each terminated by the selected separator.

NOTE: The counter will stop measuring until all lines of the response have been read or the response has been terminated.

NOTE: The query command must always be the last command in a program message.

Programming Data Out

Any one of the queries used for Bus Learn can be used to ask the counter about its current setting, see ‘Bus Learn’ above.

What Happens When I Switch to Local?

Switching to LOCAL causes the counter to adapt the settings indicated on the display, see ‘How to select function’. This means that the counter will never have settings in LOCAL which are not possible to set via the front panel.

When switching to remote again, the LOCAL-setting will remain. Bus-functions like SRQ mask, output separator, EOI, etc. will not be altered by switching to LOCAL and back again.
Summary of Bus Commands

Function Selecting Commands
- **FREQ A**: Frequency measurement on Input-A.
- **FREQ B**: Frequency measurement on Input-B.
- **RPM A**: Revolutions/minute on Input-A.
- **PER A**: Period on Input-A.
- **WIDTH A**: Pulse width on Input-A.
- **PWIDTH A**: Pulse width on Input-A.
- **TOTM A**: Totalize A, start/stop by GATE OPEN/CLOSED on the bus.
- **FNC?**: Output the current function setting.

Input Setting Commands
- **TLO AUT**: Auto trigger level.
- **TLO POS**: Positive trigger level offset \( U \)
- **TLO SYM**: No trigger level offset \( \sqrt{ } \)
- **TLO NEG**: Negative trigger level offset \( \sqrt{ } \)
- **TRGSLP POS**: Triggering on positive slope.
- **TRGSLP NEG**: Triggering on negative slope.
- **INPA?**: Output the current Input-A settings.

Measurement Control Commands
- **GATE OPEN**: Starts the totalizing in TOTM A.
- **GATE CLOSE**: Stops totalizing.
- **MTIME <num>**: Set Measuring-time. \( <num> = 0.01-10 \text{ s} \). \( 0 = \text{SINGLE} \)
- **FRUN ON**: Selects Free-Run.
- **FRUN OFF**: Selects Triggered mode.
- **TRIG OFF**: Selects Free-Run.
- **TRIG ON**: Selects Triggered mode.
- **TOUT <num>**: Sets Time-Out. \( <num> = 0.1 - 25.5 \text{ s} \). \( 0 = \text{Time-Out OFF} \)
- **MEAC?**: Output the current Measurement control settings.

Bus Related Commands

<table>
<thead>
<tr>
<th>OUTM &lt;number&gt;</th>
<th>High-speed dump</th>
<th>Output format</th>
<th>MTCXO compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 OFF</td>
<td>NORMAL</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>1 OFF</td>
<td>SHORT</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>2 OFF</td>
<td>NORMAL</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>3 OFF</td>
<td>SHORT</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>4 ON</td>
<td>FOR HIGH</td>
<td>OFF*</td>
<td></td>
</tr>
</tbody>
</table>

- **MSR <num>**: Sets SRQ-mask, see ‘Service request’.
- **EOI ON**: Selects EOI-mode ON.
- **EOI OFF**: Selects EOI-mode OFF.
- **SPR <num>**: Select output separator, see ‘Output separators’.
- **X**: Device trigger, starts a new measurement.
- **D**: Device clear, returns to default settings.
- **BUS?**: Output the current bus related settings.
- **ID?**: Output identity and which options are installed.

* This command must be placed at the end of a program message.
Programming Examples

For HP-85 Controller

This program illustrates high measuring rate obtained with High-speed dump.

The actual measuring function is selected by the user in Local-mode. When the program runs, two beep's can be heard from the HP-85. Between these beep's, the counter performs 500 measurements and the result of each measurement is transferred from the counter to the HP-85.

The output rate is approximately 125 readings/second in this example.

10 DEMO PROGRAM DUMP MODE
20 PM6669 WITH HP85 AS CONTROLLER
30 DUMP MODE WITH FREE RUN ON CLEAR
60 DIM Z$(7508) ! BUFFER FOR 500 MEASUREMENTS WITH 15 BYTES 
70 DIM B$(14)
80 I=060 BUFFER Z$
90 LOCAL 710
100 DISP "SELECT FUNCTION IN LOCAL MODE!"
110 DISP "MEASURING TIME WILL BE SELECTED BY HP85 (SINGLE)!"
120 DISP "ANSWER Y WHEN READY TO START!"
130 INPUT A$
140 IF A$="Y" THEN 130
150 DISp "MAKE 500 MEASUREMENTS"
160 OUTPUT 710 ;"TRIG OFF,MTIME 0,OUTM 4"
180 JOBEEP
190 E=TIME
200 TRANSFER 710 TO Z$ FHS ; COUNT 7500
210 F=TIME
220 TIME
230 DISP "READY! ELAPSED TIME: " ; F-E ;"s"
240 !SHOW 5 RESULTS"
250 DISP "FIRST 5 RESULTS:"
260 FOR K=1 TO 5
270 ENTER Z$ ; B$
280 !GET FORMULA CHARACTER 
290 F$=B$[1,1]
300 !GET MULTIPLIER CHARACTER
310 M$=B$[2,2]
320 !EVALUATE REGISTER 1
330 R1=0
340 FOR I=1 TO 8
350 S=NUM(B$[I,1])-48
360 IF S>=10 THEN S=S-7
370 R1=R1*16+S
380 NEXT I
390 !EVALUATE REGISTER 2
400 R2=0
410 FOR I=9 TO 14
420 S=NUM(B$[I,1])-48
430 IF S>=10 THEN S=S-7
440 R2=R2*16+S
450 NEXT I
460 !EVALUATE RESULT
470 IF F$="C" THEN R=100000000*R2/R1
480 IF F$="F" THEN R=R1*16^6*R2

Example of a result:

MEASURING TIME WILL BE SELECTED BY HP85 (SINGLE)!
ANSWER Y WHEN READY TO START!
?
Y
MAKE 500 MEASUREMENTS
READY! ELAPSED TIME: 3.931 S
FIRST 5 RESULTS:
JP0000000000310000049
JP000000000030000048
JP0000000000310000049
JP0000000000310000049
JP0000000000310000049
5053
For IBM PC with PM 2201

Example 1
The following example runs on an IBM compatible PC equipped with Fluke PM 2201 GPIB interface. The installation and starting up of the PC program is not described, only the application program. Line 1 to 100 must contain the declaration described in the PM 2201 manual.

The program sets up the counter for 10 Period A measurements and presents the average result on the screen.

```
100 'DEMO PROGRAM (NO 1)
110 'PM6669 AND IBM PC
120 'WITH PM2201 GPIB INTERFACE
130 'AS CONTROLLER
140 CLS 'CLEAR SCREEN
150 ADDR=710 'COUNTER ADDRESS
160 SC=1 'SYSTEM CONTROLLER
170 RES$ = SPACE$(25) 'RESULT
180 ACT = 0 '# READ CHARACTERS IN RES$
190 MAX = 24 'MAX CHARACTERS TO READ IN RES$
200 TIME=10 'TIMEOUT AFTER 10 SECONDS
210 CALL IOINIT(AD,SC) 'INIT INTERFACE
220 CALL IOTIMEOUT(AD,TIME) 'SET TIMEOUT
230 CALL IOCLEAR(ADDR) 'SEND SDC
240 'SELECT PERIOD A, TRIGGERED MODE
250 'AND 1 S MEASURING-TIME
260 SEND$ = "PER A,TRIG ON,MTIME 1"
280 CALL IOOUTPUTS(ADDR,SEND$,LENGTH)
290 Z=0
300 FOR i = 1 TO 10
310 CALL IOTRIGGER(ADDR) 'TRIGGER COUNTER
320 CALL IOENTERS(ADDR,RES$,MAX,ACT) 'READ RESULT
330 Z = Z + VAL(MID$(RES$,8,13))
360 NEXT I
370 PRINT "AVERAGE:";Z/10;"S"
380 CALL IOLOCAL (ADDR) 'GO TO LOCAL
390 END
```

Example of a result:
```
AVERAGE: 9.98004E-06 S
```

Example 2
This program example illustrates the 'program data out' feature of PM 6669. By asking a set of queries, the counter responds with its current setup. The output format of these answers to the queries is identical to the programming command format. The answers can be stored and used later for reprogramming (bus learn).

```
100 'DEMO PROGRAM
110 'PM6669 AND IBM PC WITH PM2201
120 GPIB INTERFACE AS CONTROLLER
130 AD=7 'ADAPTOR NUMBER
140 ADDR=710 'COUNTER ADDRESS
150 SC=1 'SYSTEM CONTROLLER
160 CALL IOINIT(AD,SC) 'INIT INTERFACE
```

Example of a result:
```
COUNTER SETTING:
TIME A,B
MTIME1.00,FRUN ON
TOUT 00.0
MSR 000,OUTM 000
EIO OFF,SPR 010
INPA:
TRGSLP NEG
INPB:
```

Example of a result:
```
COUNTER TYPE:
PM6669/016/22
```
Example 3
This program prompts the user to input a programming sequence. The sequence is then sent to the PM 6669 and the corresponding measuring result is read.

Let us as an example select Single Period measurements, without AUTO-triggering (gives faster operation).

Example of a result:

```
INPUT YOUR PROGRAMMING MESSAGE?
(TO QUIT THE PROGRAM, ANSWER *)
PER A,MTIME 0

RESULT READ AS: PER 0000001.00E-5

INPUT YOUR PROGRAMMING MESSAGE?
(TO QUIT THE PROGRAM, ANSWER *)
```

For IBM PC with IBM GPIB

This example runs on an IBM PC with an 'IBM General Purpose Interface Bus Adapter' instead of the Fluke PM 2201 interface.

The following set of device parameters is suitable for a PM 6669 with address 10. The device parameters are set with the configuration program 'IBCONF', see the IBM adapter manual.

```
<table>
<thead>
<tr>
<th>Device Name: COUNTER</th>
<th>DEVICE PARAMETERS</th>
<th>Number: D 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>NEW VALUE</td>
<td>VALID NAME</td>
</tr>
<tr>
<td>Access Adapter Name?</td>
<td>GPIB1</td>
<td>[GPIBx]</td>
</tr>
<tr>
<td>Primary GPIB Address?</td>
<td>0AH</td>
<td>[0H to 1EH]</td>
</tr>
<tr>
<td>Secondary GPIB Address?</td>
<td>00H</td>
<td>[60H to 7EH; 0H disables]</td>
</tr>
<tr>
<td>Timeout setting?</td>
<td>T10s</td>
<td>[T10us to T1000s; TNONE disables]</td>
</tr>
<tr>
<td>EOS Byte?</td>
<td>0AH</td>
<td>[0H to FFH or 'character']</td>
</tr>
<tr>
<td>Terminate Read on EOS?</td>
<td>Yes</td>
<td>[Yes or No]</td>
</tr>
<tr>
<td>Send EOI with EOS byte?</td>
<td>No</td>
<td>[Yes or No]</td>
</tr>
<tr>
<td>Use 8-bit Compare on EOS?</td>
<td>No</td>
<td>[Yes or No]</td>
</tr>
<tr>
<td>Send EOI with last byte of Write?</td>
<td>Yes</td>
<td>[Yes or No]</td>
</tr>
</tbody>
</table>
```

Example 1
The following program sets up the counter for 10 Period A measurements and presents the average result on the screen.

Example of a result:
```
AVERAGE: 9.980422E-06 S
Ok
```
SPECIFICATIONS

Measuring Functions

Frequency A or B

Range,

Freq A: 0.1 Hz to 160 MHz
Freq B: 70 MHz to 1.3 GHz (option PM 9608B)

Mode: Reciprocal frequency counting.

LSD unit displayed: \( 2.5 \times 10^{-7} \times FREQ \)

Frequency A/A0

A Frequency A measurement is performed. The measured frequency is divided by the constant A0 before display. The resolution of the displayed ratio is determined by the FREQ A measurement. At power on A0 is set to 1 (default).

Frequency A-A0

A Frequency A measurement is performed. The value of the constant A0 is subtracted from the measured frequency before display. The resolution of the displayed difference is determined by the FREQ A measurement. At power on A0 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 to 720 \( \cdot 10^6 \) RPM

Period A

Range: 8 ns to \( 2 \times 10^8 \) s

Mode: Single period measurement (SINGLE) or period average measurement (at 0.2, 1 or 10 s Measuring-times).

LSD Displayed:

SINGLE period measurement: \( 100 \) ns \( (TIME < 100s) \)
\[ \frac{5 \times \text{PERIOD}}{10^9 \text{s}} \] \( (TIME > 100s) \)

Period average measurement: \( 2.5 \times 10^{-7} \times \text{PERIOD} \)

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 to \( 1 \times 10^{15} \) with indication of k or M (Kilo-pulses or Megapulses). The result is truncated if out of display range.

Frequency Range:

Sine-Wave: 0 Hz to 16 MHz
Pulse: 0 Hz to 16 MHz

Pulse Pair Resolution: 8 ns

LSD displayed: 1 unit count (counts < \( 10^9 \))
5\( \times \)counts/\( 10^9 \) (counts \( \geq 10^9 \))

Width A

A positive Pulse Width measurement is performed. Measuring time selection is not valid (always SINGLE measurement).

Range: 100 ns to \( 2 \times 10^8 \) s
LSD Displayed: 100 ns \((\text{Time} < 100 \text{ s})\)
\[
\frac{5 \times \text{WIDTH}}{10^9 \text{ s}} \quad (\text{Time} > 100 \text{ s})
\]

NOTE: Triggering on 50% of amplitude will occur only if the duty factor of the signal is 0.5.

**Definitions**

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, and Period A: Resolution can be 1 LSD unit or 2 LSD units.

\[
\text{LSD} \times \frac{\text{Measuring time}}{\text{FREQ or PERIOD}} < 10^{-7}
\]

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 WIDTH
\(\pm\) relative trigger error
\(\pm\) relative time base error

Relative trigger error, Freq A, Period A:

\[
\pm \frac{\text{noise voltage \ A } (V_{pp})}{\text{signal slope \ A } (V/s)} \times \text{meas time}
\]

Relative time base error:  \(\pm\) \(\frac{\text{deviation from 10 MHz}}{10 \text{ MHz}}\)

**Input specifications**

**Input-A**

**Frequency Range:** 0 Hz to 160 MHz

**Sensitivity,**

**Sine:** 10 mV\(\text{RMS}\) 10 Hz to 120 MHz
30 mV\(\text{RMS}\) typically 120 MHz to 160 MHz

**Pulse:** 30 mV\(\text{RMS}\) 0.1 Hz to 120 MHz

**Coupling:** AC

**Impedance:** 1 MΩ // 30 pF

**Attenuation:** Continuously variable in two ranges between x1 and x400.

**Filter:** Switchable 50 kHz low pass noise filter, on Input-A, with a suppression of 20 dB at 200 kHz.

**Trigger Levels:** Three different levels for triggering on signals with various duty factors, and AUTO.

\(\perp\perp\) symmetrical input signals, should be selected for input signals with a duty factor of 0.25 to 0.75%.

\(\perp\) positive pulses, for input signals with duty factor < 25%.

\(\perp\perp\) negative pulses, for input signals with duty factor > 75%.

**AUTO Trigger Levels:** The counter will make test settings and automatically selects 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.

**Maximum Voltage:** 350 V (DC + AC\(\text{peak}\)) between 0 and 440 Hz, falling to 11 V\(\text{RMS}\) at 1 MHz.

**Input-B**

*(option PM 9608B)*

**Frequency Range:** 70 MHz to 1.3 GHz

**Coupling:** AC

**Operating Input Voltage Range:**
10 mV\(\text{RMS}\) to 12 V\(\text{RMS}\), 70 MHz to 900 MHz
15 mV\(\text{RMS}\) to 12 V\(\text{RMS}\), 900 MHz to 1.1 GHz
40 mV\(\text{RMS}\) to 12 V\(\text{RMS}\), 1.1 to 1.3 GHz
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

Vibration Test: According to IEC 68Fc
Bump Test: According to IEC 68Eb
Handling Test: According to IEC 68Ec

Display

Read Out: 9 digit LCD display with unit indication.

Unit Indication: MHz, kHz, Hz, mHz, s, ms, µs, ns, M, k, m, µ, 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.

Time Base (Crystal Oscillator)

Choice of:
- Uncompensated crystal oscillator (order no PM 6669/.1.)
- MTCXO, i.e. Mathematically Temperature Compensated Crystal Oscillator (order no PM 6669/.3.). The MTCXO can be ordered separately for later upgrading of the counter (option PM 9607).

MTCXO Working Principle: 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 mathe-
matically corrected for the time-base frequency temperature error, before being displayed.

<table>
<thead>
<tr>
<th>Oscillator Version:</th>
<th>Uncompensated</th>
<th>MTCXO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability against:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ageing per month</td>
<td>&lt; 5 \times 10^{-7}</td>
<td>&lt; 1 \times 10^{-7}</td>
</tr>
<tr>
<td>per year</td>
<td>&lt; 5 \times 10^{-6}</td>
<td>&lt; 5 \times 10^{-7}</td>
</tr>
<tr>
<td>Temperature changes 0 to 50°C</td>
<td>&lt; 1 \times 10^{-5}</td>
<td>&lt; 2 \times 10^{-7}</td>
</tr>
<tr>
<td>Line voltage changes 10%</td>
<td>&lt; 1 \times 10^{-8}</td>
<td>&lt; 1 \times 10^{-9}</td>
</tr>
</tbody>
</table>

**Auxiliary Functions**

**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 or B manual mode.

**Measuring-Time**

A measuring-time of 0.2 s, 1 s, 10 s or SINGLE can be selected.

**NOTE:** 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 A0**

The DISPL HOLD/STORE A0 button has two functions:

- **DISPL HOLD** The result of the current measurement will be frozen on the display. A new measurement starts when RESET button is pressed.

- **STORE A0** 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 A0, 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.

**Optional Accessories**

**GPIB-Interface, PM 9604**

**Mounting:** Inside counter cabinet.

**Interface Functions:** SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, E2

**Address Setting:** Switch selectable at rear panel between 0 and 30. Factory preset at 10.

**Programmable Device Functions:**

- Measuring functions
- Measuring-time
- Trigger slope
- Manual Totalize gate control
- Output separator selection
- Device clear
- Device trigger
- High-speed dump
- MTCXO on/off
- Short output format
- Free run/Triggered measurements
- Set SRQ-mask
- Program data out queries
- Device identity query

**Programming Code Format:** 7-bit ISO code (ASCII) characters. Both upper and lower case characters are accepted.

**Input Separator:** The counter accepts the following characters as separators: ETX, ETB, CR, LF, ‘ ’(space), ‘,’(comma), ‘:’(colon), ‘;’(semicolon).
Output Data Separator: Default separator at power-on is LF. The separator can be programmed to be any non-printable ASCII-code with decimal equivalent 0-31, except 27 (ESC).

In addition the combination 13+10 (CR+LF) can be programmed. The EOI-line can be programmed to be active together with the last output byte sent.

Output Format:
Measuring result is sent as:

```
FFFFFOXXXXX...XEXS(S)
```

When you select 'Short output format' FFFFFF and leading zeroes are omitted.

High-Speed Dump
The contents of the counting registers are transferred to the controller, without being processed by the counter. The processing must be done in the controller instead. Max output rate is approximately 100 readings/s.

The output format is FMXXXXXXXXX(S) where F is calculation formula, M is multiplier, X.X = 12 hex-digits representing the register contents, and S(S) is the set output separator.

Ranges: Same as for normal operation, with the following exceptions:

- **Frequency:** Max measuring time: 1 s
- **Period, Average:** Max measuring time: 1.4 s
- **Time Interval, Average:** 0 ns to 1.6 s Max measuring time: 4 s
- **Ratio A/B:** 0 and 6×10⁻⁷ to 1.6×10⁶
- **Ratio B/A:** 0 and 6×10⁻⁸ to 1.6×10⁷
- **Ratio C/A, C/B:** 8 to 4×10⁹
- **Max Data Output Rate:** Normal mode gives >5 readings/s. High-speed dump gives >100 readings/second.

The highest output rate is obtained at SINGLE Measuring-time.

Output Time for Measuring Data;
Normal operation: Approx. 10 ms (21 bytes)
High-speed dump: Approx. 4 ms (15 bytes)

Response time for addressing: Approx. 5 µs

Response Time for Trigger Command (GET):
Normal Operation: Approx. 10 ms
High-Speed Dump: Approx. 2 ms

Response Time for Serial Poll: Approx. 1.5 ms

Input Buffer Size: 28 bytes

Typical Read Time for Programming Data: Approx. 1 ms/byte (unless input buffer is full)

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: 3 hours of continuous 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 to +40°C
  - **Storage:** −40 to +50°C

Weight: 0.8 kg

Rack Mounting Adapter, PM 9606/01
The PM 9606/01 is a 19" wide Rack Mounting Adapter. It can host one PM 6662, PM 6665, PM 6666 or PM 6669 Counter only.

Rack Mounting Adapter, PM 9606/02
The PM 9606/02 is a 19" wide Rack Mounting Adapter. It can host one PM 6662, PM 6665, PM 6666 or PM 6669 Counter together with a second instrument.
That second instrument can be a Philips PM 2534 to 35 or a FLUKE 8840 Digital Multimeter, or another PM 666X counter.

High Stability Time-Base PM 9607
See specifications for optional MTCXO time-base.

HF-Input PM 9608B
See specifications for optional Input-C.

Ordering Information

Versions
The PM 6669 ordering number consists of the basic type number and a 3 digit XYZ suffix, specifying the required configuration.

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM 6669/011</td>
<td>Frequency counter, 160 MHz frequency range, uncompensated oscillator $5 \times 10^{-7}$/month, incl. operators manual.</td>
</tr>
<tr>
<td>PM 6669/4..</td>
<td>As above, but including 1.3 GHz HF-input PM 9608B.</td>
</tr>
<tr>
<td>PM 6669/.3</td>
<td>As above, but including crystal oscillator PM 9607 (MTCXO).</td>
</tr>
<tr>
<td>PM 6669/.3</td>
<td>As above, but including battery unit PM 9605.</td>
</tr>
<tr>
<td>PM 6669/.6</td>
<td>As above, but including GPIB interface PM 9604.</td>
</tr>
</tbody>
</table>

Example: PM 6669/416 means a PM 6669 frequency counter, including both an 160 MHz and a 1.3 GHz input channel, an uncompensated oscillator and a GPIB interface.

Options and Accessories

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM 9604</td>
<td>GPIB-interface</td>
</tr>
<tr>
<td>PM 9605</td>
<td>Battery unit</td>
</tr>
<tr>
<td>PM 9606</td>
<td>Rack-mount kit</td>
</tr>
<tr>
<td>PM 9607</td>
<td>MTCXO time-base</td>
</tr>
<tr>
<td>PM 9608B</td>
<td>1.3 GHz HF-input</td>
</tr>
<tr>
<td>PM 9609</td>
<td>Carrying case</td>
</tr>
<tr>
<td>PM 2296/50</td>
<td>IEEE to IEC adapter</td>
</tr>
<tr>
<td>PM 2295/05</td>
<td>IEEE cable, 0.5 m</td>
</tr>
<tr>
<td>PM 2295/10</td>
<td>IEEE cable, 1 m</td>
</tr>
<tr>
<td>PM 2295/20</td>
<td>IEEE cable, 2 m</td>
</tr>
<tr>
<td>PM 8911</td>
<td>1.5 GHz, 500$\Omega$ probe set, 1:10</td>
</tr>
<tr>
<td>PM 8922</td>
<td>120 MHz, 1 M$\Omega$ probe set, 1:1 and 1:10</td>
</tr>
<tr>
<td>PM 8943</td>
<td>650 MHz, 1 M$\Omega$ FET probe set</td>
</tr>
<tr>
<td>PM 9581</td>
<td>50$\Omega$ termination, 3 W</td>
</tr>
<tr>
<td>PM 9585</td>
<td>50$\Omega$ termination, 1 W</td>
</tr>
</tbody>
</table>

All options mentioned above can be installed by the customer.

NOTE: The GPIB interface PM 9604 and the battery unit PM 9605 can not be installed together in a PM 6669 counter.

Manuals

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4822 872 20021</td>
<td>Operators Manual</td>
</tr>
<tr>
<td>4822 872 20022</td>
<td>Operators Manual (German)</td>
</tr>
<tr>
<td>4822 872 20023</td>
<td>Operators Manual (French)</td>
</tr>
<tr>
<td>4822 872 25006</td>
<td>Service Manual</td>
</tr>
<tr>
<td>4822 872 20016</td>
<td>GPIB Pocket Guide</td>
</tr>
</tbody>
</table>
Checking the Sensitivity of Counters

Introduction
The sensitivity of a counter is normally specified as the minimum signal voltage on which the input of the counter will trigger correctly.

When you use a signal-source with an output-impedance of 50Ω, constant-output-amplitude, and the counter has a 50Ω input-impedance, the input signal of the counter is in theory independent of the cable length. However, if the input impedance deviates from 50Ω there will be standing wave reflections which will cause changes in the amplitude of the signal between the signal-source and the counter input.

Two factors determine the magnitude of the changes, i.e. frequency and capacitive load.

EXAMPLE: For a 1 MΩ/35 pF input, the 35 pF parallel capacitance is approximately equal to a 50Ω capacitive load at 100 MHz.

Consequently, it is of the utmost importance to know how sensitivity is measured.

Recommended Instruments
- Signal-source with a 50Ω output impedance.
- >350 MHz oscilloscope with a 50Ω input impedance.
- BNC T-piece.
- Two BNC-cables, one short and one long.

Preparations
Connect the instruments as illustrated in the figure above. Set the counter to maximum sensitivity.

Method 1
- Adjust the amplitude of the signal-source to the minimum level accepted by the counter.
- Read the amplitude on the oscilloscope.
- Check that the reading is the same as, or less than, the sensitivity level in the counter specifications.

Method 2
- Adjust the amplitude of the signal-source until the oscilloscope indicates the sensitivity limit in the counter specifications.
- Check that the counter is operating correctly.

Low-Impedance Inputs (50Ω)
If you have a calibrated signal-source
- Adjust the signal-source to the sensitivity limit of the counter.
- Connect it directly to the input of the counter.
- Check that the counter is operating correctly.

If you don’t have a calibrated signal-source
Use either of the following methods

**Method 1**
- Connect the output of the signal-source directly to the input of the counter.
- Turn off AUTO and set the counter to maximum sensitivity (if adjustable).
- Adjust the amplitude of the signal-source to the minimum level accepted by the counter.
- Disconnect the cable from the counter and connect it to the oscilloscope.
- Read the amplitude on the oscilloscope.

- Check that the reading is the same as, or less than, the sensitivity level in the counter specifications.

**Method 2**
- Connect the signal-source to the oscilloscope.
- Adjust the output amplitude of the signal-source until the oscilloscope indicates the sensitivity limit in the counter specifications.
- Disconnect the cable from the oscilloscope and connect it to the counter.
- Set the counter to maximum sensitivity (if adjustable).
- Check that the counter is operating correctly.

These procedures ensure unambiguous measurements of the signal voltage at the input of the counter.
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