DEUTSCH • ENGLISH • FRANÇAIS • ESPAÑOL

HAMEG®
Instruments

Programmable Universal Counter HM8122

MANUAL • HANDBUCH • MANUEL

English

Important

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

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

Contents HM8122

HM 8122

HAMEG GmbH Kelsterbacher Str. 15-19 60528 Frankfurt am Main Germany

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General Information

The operator should not neglect to carefully read the following instructions, to avoid any operating errors and to be fully acquainted with the instrument when later in use. After unpacking the instrument, check for any mechanical damage or loose parts inside. Should there be any transportation damage, inform the supplier immediately and do not put the instrument into operation.

Safety

Every instrument is manufactured and tested according to IEC 348 Part1 and 1a (Safety requirements for electronic test and measurement equipment). All case and chassis parts are connected to the safety earth conductor. Corresponding to Safety Class 1 regulations (three conductor AC power cable). Without an isolating transformer the instrument must be plugged into an approved three contact electrical outlet, which meets International Electrotechnical Commission (IEC) safety standards.

Warning!
Any interruption of the protective conductor inside or outside the instrument or disconnection of the protective earth terminal is likely to make the instrument dangerous. Intentional interruption is prohibited.

The instrument must be disconnected and secured against unintentional operation if there is any suggestion that safe operation is not possible. This may occur:

– if the instrument has visible damage,
– if the instrument has loose parts,
– if the instrument does not function,
– after long storage under unfavourable circumstances (e.g. outdoors or in moist environments),
– after excessive transportation stress (e.g. in poor packaging)

When removing or replacing the metal case, the instrument must be completely disconnected from the mains supply. If any measurement or calibration procedures are unavoidable on the opened-up instrument, these must be carried out only by qualified personnel acquainted with the danger involved.

Symbols As Marked on Equipment

Danger - High voltage

Protective ground (earth) terminal

ATTENTION - refer to manual

The max. permissible external voltage applied between inputs and outputs against ground is 42V.

Warranty

Before being shipped, each instrument must pass a 24 hour quality control test. Provided the instrument has not undergone any modifications HAMEG warrants that all products of its own manufacture conform to HAMEG specifications and are free from defects in material and workmanship when used under normal operating conditions and with the service conditions for which they were furnished.

The obligation for HAMEG shall expire two (2) years after delivery and is limited to repairing, or at its option, replacing without charge, any such product which in HAMEGs sole opinion proves to be defective with the scope of this warranty.

This is HAMEGs sole warranty with respect to the products delivery hereunder. No statement, representation, agreement or understanding, oral or written, made by an agent, distributor, representative or employee of, which is not contained in this warranty will be binding upon HAMEG, unless made in writing and executed by an authorized HAMEG employee. HAMEG makes no other warranty of any kind whatsoever, expressed or implied, and all implied warranties of merchantibility and fitness for a particular use which exceed the aforestated obligation are hereby disclaimed by HAMEG be liable to buyer, in contract or in tort, for any special, indirect, incidental or consequential damages, espresses, losses or delays however caused.

In case of any complained, attach a tag to the instrument with a description of the fault observed. Please supply name and department, address and telephone number to ensure rapid service.

The instrument should be returned in its original packaging for maximum protection. We regret that transportation damage due to poor packaging is not covered by this warranty.

Installation

This instrument is intended for connection to 220V or 110V, 50/60Hz mains input voltage. Before installing the instrument, ensure that it is set to the local line voltage. On delivery the unit is set to either 110V or 220V, as indicated on the line voltage selector on the rear panel. If the line voltage setting is incorrect, set the line voltage selector in accordance with the local line voltage before connecting the instrument to the line.

The instrument is protected by two primary fuses. These have to be changed when the line voltage changes. For 220V use 0.315A delayed action fuses and for 110V use 0.63A delayed action fuses. Remove the line plug before fitting the fuses. Ensure that only fuses of the specified type are used.

Universal Counter HM 8122

- **Frequency Range 0 - 1600 MHz; 3 Inputs**
- **9 Measurement Functions; Ext. Gate and Arming**
- **Up to 8-digit Resolution at 1 second Gate Time**
- **100 MHz Time Base with 0.5ppm Stability**
- **IEEE-488 Bus or RS-232 Interface, optional**

... when precision counts

The **HM8122** is a feature-packed Universal Counter and, like all other instruments in the **8100 Series**, prepared for operation in automated test systems as well as for laboratory bench- top measurements. The instrument has three highly sensitive inputs and provides signal measurement capability from **DC** to **1.6 GHz**.

An impressive **10ns** resolution during single pulse measurement is made possible by using a 100MHz reference oscillator. Resolution as fine as **1ps** is obtained through time interval averaging. The **HM8122** displays **low frequency** measurements with an **8-digit** resolution at a 1s gate time.

Besides its **nine** basic functions, the **HM8122** offers such practical features as preselectable number of pulses per rotation, offset, display-hold, **single-shot** measurement, **external ports** for gating, arming, gate-view and trigger-view. The rear panel inputs also allow for measurements of channel A gated by B. An integrated **calibration routine** and extensive power-up self-test ensure proper and accurate operation of the counter.

Since any counter is only as good as its input circuits, great care was taken in considering the technique of input signal conditioning.

The **three inputs** possess, depending on frequency range, an input sensitivity of between **20mV** and **60mV**. A selectable low-pass filter, switchable input coupling, two 20dB attenuators per channel, and the switchable trigger slope enhance trouble-free operation with nearly all input signals. **Automatic triggering** can be turned off for complex signal measurements.

Any function of the Counter is programmable via the optional **IEEE-488** or **RS-232** Interface.

Option HO85

The standard version of the **HM8122** already includes a high-stability, oven-controlled oscillator with an accuracy of **±5x10^{-7}**. The option **HO85** with a stability of **±5x10^{-9}** is available for higher stability requirements. The oscillator is easily field installable and only an external reference frequency is required for recalibration.

Specifications HM 8122
(Ref. temp.: 23°C±2°C)

Input Characteristics (Input A / Input B)

Frequency range:
0 - 150 MHz (DC coupled), 10 Hz - 150 MHz (AC coupled)
Sensitivity : (normal triggering)
20 mV RMS (sinewave) DC to 80MHz. 80mV pp (Pulse)
60 mV RMS (sinewave) 80 MHz to 150 MHz
50 mV RMS (sinewave) 20 Hz to 80 MHz (Autotrigger)
Min. pulse duration: 5 ns
Rise time: 3 ns nominal
Input noise: 100 µV (typical)
Coupling: AC or DC (switch selectable)
Impedance:
1 MΩII40 pF (0.5 MΩII80 pF when Com. is active)
Attenuation: x1, x10, x100 (switch selectable)
Trigger level range: 0 V to ± 100 V
Autotrigger: (AC coupling)
trigger point is at the 50% peak to peak value
Max. input voltage:
250 V (DC + AC peak) from 0 to 440 Hz
declining to 8 V RMS at 1 MHz
Trigger slope: Positive or negative (switch selectable)
Filter: 50 KHz low pass filter (20 dB/decade)
Trigger indicators: Tri-state LED indicators

Input Characteristics (Input C)

Frequency range: 100 MHz - 1.6 GHz
Sensitivity: 30 mV to 1.3GHz (typical 20mV)
100 mV to 1.6GHz (typical 80mV)
Coupling: AC
Impedance: 50Ω nominal
Max. input voltage: 5 V (DC + AC_{peak})

Input Characteristics:	External Reset	Reference	Gate/Arming
Input impedance:	4.7 kΩ	470 Ω	4.7 kΩ
Max. input voltage:	± 30 V	±30V	± 30V
Sensitivity:	–	typ. 2 V_{pp}	–
High level:	>2V	–	>2V
Low level:	<0.5V	–	<0.5V
Min. pulse duration:	200 ns	–	50 ns
Input frequency:	–	10 MHz	–
Min. eff. gate time:	–	–	20 µs

Measurement Functions

Frequency A/B/C; Period A; Totalize A; RPM A; Ratio A:B; TI A:B; Pulse width; Totalize A during B; TI AVG A:B

Frequency A, B

LSD : (2.5 x 10^{-8} s x FREQ.) : measuring time
Resolution: ± 1 or 2 LSD
Accuracy : ± (Resolution : Frequency + time base uncertainty + trigger error : measurement time)

Period A

Range: 10000 sec - 6.66 ns
LSD: (2.5 x 10^{-8} s x period) : measurement time *1)
Resolution: 1 or 2 LSD
Accuracy: ± (Resolution : Period + time base uncertainty + trigger error : measuring time)

Ratio A/B

Frequency range: DC to 80 MHz
LSD: (2.5 x ratio) : (FREQ. A x measuring time)
Resolution: ± 1 or 2 LSD
Accuracy: resolution : ratio ± (trigger error B : measuring time)

Totalize A	(manual mode)	(Gated by external signal)
Range:	DC - 150 MHz	DC - 150 MHz
Min. pulse duration:	10 ns	10 ns
LSD :	1 Count	± 1 Count
Resolution:	LSD	LSD
Accuracy:	(resol. ±ext. gate error x Freq.A)/total	
Pulse pair res.:	10 ns	10 ns
Ext. Gate error:	—	100 ns

Time Interval / Time Interval Average

(Input A = start, Input B = stop)

LSD: 10 ns (10 ns to 1 ps when averaged)
Resolution: 1 LSD (1 or 2 when averaged)
Accuracy: ± (Resolution + trigger error + systematic error): time interval ±time base uncertainty (systematic error : ≤4ns)

Number of averages:	Measuring time pulse repetition rate
N = 1 to 25	LSD = 10 ns
N = 26 to 2500	LSD = 1 ns
N = 2501 to 250000	LSD = 100 ps
N = 2500001 to 25000000	LSD = 10 ps
N = > 25000000	LSD = 1 ps

RPM (Revolutions Per Minute)

NPR *2) **presetting :** 1 - 65535 counts / revolution
Gate time: 330 ms fixed
LSD: 7.5 x 10^{-8} x revolution speed
Resolution: 1 or 2 LSD
Accuracy: resolution : speed ± (trigger error : 0.33) ± time base error

Offset

Range: same specification as normal measurement
Resolution: same resolution as normal measurement
If the actual gate time is modified, the offset resolution is the resolution of the reference value or the resolution of the current measurement, whichever is smaller.

Gate Time

Range: 1 ms - 10 sec in 199 steps (Input A/B)
Range: 2 ms - 10 sec (Input C)
Range: (cannot be shorter than 1 period)
External gate range: min. 20 µs
Actual measuring time: Gate-Time + start synchronisation time + stop synchronisation time + calculation time (approx. 10 ms) (synchronisation time depends on input signal).

Time base

Frequency: 100 MHz clock rate; 10 MHz crystal
Accuracy: ± 5 x 10^{-7} between 10°C and 40°C
Stability: ± 5 x 10^{-7} between 10°C and 40°C
Aging: <2.5 ppm/year
Warm up time: typ. 10 min. to specified accuracy
Option HO85: OCXO; ±5x10^{-9} per day; 23°C ±2°C
±5x10^{-8} per day;10°C to 40°C

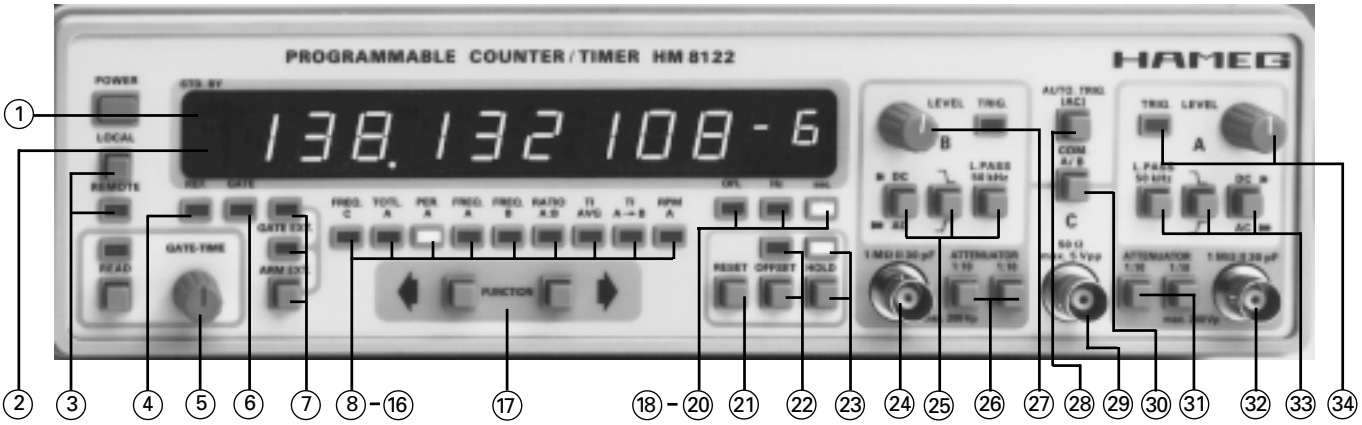
General

Display: 9 digits, sign and exponent, 1 leading digit for sign, ST.By, error messages
Power requirements: 110/220V ±15%; 45-60 Hz, 40 VA
Ambient temperature: 40°C to +70°C (storage),
Ambient temperature: +10°C to +40°C (operation)
Humidity: 10%-90%, no condensation, 5%-95% RH
Dimensions: 285x85x365mm (WxHxD),
Weight: approx. 4 kg
Safety: Class I, According to IEC 348

*1) When the resolution exceeds the display range, the displayed result is shifted to the right.
*2) NPR = Number of pulses per revolution

Accessories

HZ33, HZ34: 50Ω Coaxial cable BNC-BNC; HZ24: BNC 50W attenuators (3 / 6 / 10 / 20 dB);
HZ42: 19" rack mount kit; **HZ72-S/L:** Double shielded IEEE-488-Bus cable, 1m/1.5m.
HO85: OCXO, stability ± 5x10^{-9}/day; **HO88:** IEEE-488 Interface;
HO89: RS232 Interface.



① **Power On/St.By**
This is a secondary power switch. In the out (St.By) position, power is supplied only to the oven stabilising circuit of the oscillator.

② **9 digit display** (7 segment LEDs, 10.9 mm high)
for the measuring result and for digital readout of: measuring time, exponential notation, constants for RPM, error messages, calibration informations and indication of "Stand by". The "Stand By"-mode is indicated by two vertical segments, lit at the leftmost digit of the display.

③ **Remote**
The remote-LED is lit when the instrument is operated via the IEEE-488 bus. Return to local by pushing the local-switch is possible, provided the instrument is not in local lockout state.

④ **External Reference** (LED)
This LED is lit when an external reference frequency is applied to the rear input ㉟.

⑤ **Gate Time** (Setting and reading)
The gate time is adjustable from 1ms to 10sec in steps of 1ms, 10ms, 100ms and 1sec. (depending on value) by means of the gate time potentiometer. The "Read" - switch enables to read the selected gate time on the display (LED "Read" is lit). When the RPM-function is selected in read-mode the display shows the number of preselected pulses per revolution. Gate-time setting is possible either by depressing the "Read"-switch or during measurements. Gate time setting is not possible in totalize function and external gate mode.

⑥ **Gate** (LED)
The gate indicator is lit when the gate is open for measurements. This time equals the preselected gate time and a synchronisation time. The gate cannot be open for a time smaller than 1 period of a signal.

⑦ **External Gate / External Arming**
When this control is in the GATE EXT position, the counter will expect an external control signal, and will not measure until such a signal is supplied. If it is set to ARM EXT the counter will measure on an active transition from low to high of the EXT. signal.

⑧ **Function indicators**
LEDs ⑧–⑯ (Refer to "Measuring functions")

⑰ **Function**
The "left" and "right" push buttons select the desired function. The appropriate LED is lit when a function is selected. The default value when switching power on is Frequency A.

⑱–⑳ **OFL** (Overflow)
This LED is lit when an overflow occurs. This depends on the selected gate time and of the frequency of the signal applied.
Hz: Indicates the measurement of a frequency.
Sec: Indicates the measurement of time.

㉑ **Reset**
Stops a measurement and clears the display in normal measurement mode. When depressing the button in "Display Hold"-mode the counter performs a single measurement (one shot) on release of the button. When the "Offset"-mode is activated, depressing RESET shows the reference value (which is the actual offset). Reset is active as long as the button is depressed.

㉒ **Offset**
The displayed value becomes the reference value. (Not available with the TOTALIZE function).

㉓ **Display Hold**
Depressing the DISPLAY HOLD pushbutton sets the display time to infinity and freezes the last measurement result. A new measurement can be initiated using the reset pushbutton or an external reset. Measuring will restart when **Display Hold** is switched off. **Display Hold** starts and stops counting in TOTALIZE function mode.

㉔ / ㉙ / ㉜ **B/C/A input channels**

㉕ / ㉝ **DC/AC - Low Pass 50kHz - Slope** Input controls

㉖ / ㉛ **Attenuation 1:10** Input signal attenuators

㉗ / ㉞ **Trigger Level** (Refer to section "Operation")

㉘ **Auto Trigger (AC)**
With Auto Trigger active the counter measures the positive and negative peak value of the input signal and triggers to the 50% value. Auto Trigger should always be used with AC-coupling.

㉚ **Common**
Connects channels A and B internally. This decreases the input impedance to 500 kΩ. The input control elements of both channels remain active.

㉟ **External Reference Input**
BNC-socket for connection of an external 10 MHz reference frequency.

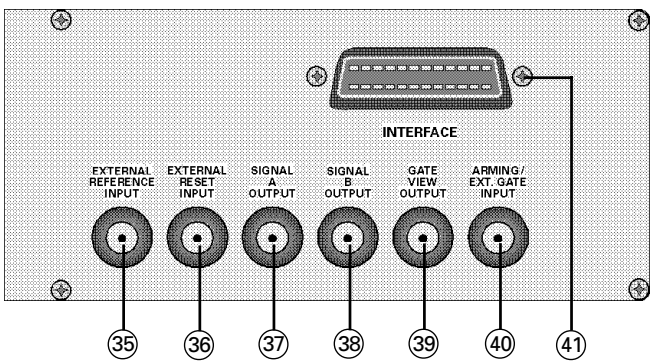
㊱ **External Reset Input**
BNC-socket for an externel reset signal (TTL level), equivalent to the front panel RESET control.

㊲ **Signal A (B) Output** ㊳
BNC-socket for trigger signal output channel A (B). Allows the trigger levels of channel A (B) to be observed with an oscilloscope. Note that input attenuation of the signals is disregarded, and that the output trigger level range is limited to 0V...5V.

㊴ **Gate View Output**
A monitor output to allow observation of the measured time interval. This output is active (high) when the gate is open . It shows the actual measurement time and is specially useful with time interval measurements.

㊵ **External Arming / External Gate Input**
Allows the measurment of the input signal, controlled by an external source.

㊶ **IEEE bus interface** (Option HO88).



Definitions

Relative Error

The **inaccuracy** (relative error = RE) of a measurement depends on 4 factors:
– rel. resolution
– rel. trigger error (if any)
– rel. time base error (if any)
– rel. systematic error (if any)
RE = ± (rel. resolution + rel. time base error
+ rel. trigger error + rel. systematic error)

Trigger error (TE)

Trigger error is the absolute measurement error due to input noise, causing triggering which is too early or too late
TE at FREQUENCY, PERIOD, RATIO
TE = ± Total Noise voltage (RMS): Signal slew rate (V/s)
TE = ± 1/Freq x Pi X S/N-ratio (sine wave)
TE at TIME INTERVAL A-B, PULSE WIDTH
TE = ± Total Noise Voltage /Slew rate (at start point)
± Total Noise Voltage /Slew rate (at stop point)
* Total Noise Voltage = Square root of (trigger noise) E2 + (signal noise at trigger point) E2

Resolution

Multiple events measurements
At FREQUENCY, PERIOD, RATIO, the resolution is the smallest increment between two measuring results. The measuring resolution is due to the ±1 count error. After calculation, the result to be displayed is truncated to include only significant digits giving a measuring resolution of 0.2 .. 2 LSD units. Total resolution, including LSD resolution, is therefore 1 LSD unit or 2 LSD units but can always be reduced to 1 LSD unit by increasing the measuring time somewhat.

Single event measurements

The resolution is one clock pulse period, regardless of the measuring time.

Systematic error: <4ns (for time interval)

Time Base Error (TBE)

The relative time base error is the relative deviation of the clock pulse frequency from 10 MHz.
Rel. TBE = Δ f/10 MHz.

Measuring Functions

FREQ. C: Sets the instrument to measure the frequency of the signal connected to input C.

TOTL. A: The counter will totalize events (pulses or cycles) on input A. Measurement stops and display freezes as soon as the input signal is removed or DISPLAY HOLD is depressed. Depressing RESET during totalizing clears the display and starts a new measurement when releasing the button. Reset is active as long as the switch (21) is depressed. When connecting the TRIGGER B output (38) at the rear panel to EXTERNAL GATE input (40), and at the same time applying a "gate signal" to the B input, **Totalizing A during B** is performed as soon the EXTERNAL GATE mode (7) is selected.

Totalizing A during External Gate is performed applying a TTL signal to the Ext. Gate Input (40).

Per. A: Sets the counter to measure the period duration of the signal connected to input A.

Freq. A: same as Freq. C

Freq. B: same as Freq. C

Ratio A/B: Sets the counter to measure the frequency ratio between the signals connected to channels A and B. The higher frequency should be always applied to channel A, to achieve the highest resolution possible.

TI AVG.: Sets the counter to measure the average Time Interval between events on channels A and B during a measuring cycle.

TI A to B: Like TI AVG. with only one interval measured. Resolution is 10 ns.

RPM: Sets the counter to measure the number of revolutions per minute. The result is displayed without dimension.
The number of pulses per revolution (NPR) is preselectable up to 65535 (default = 1).

Installation

Before connecting the instrument to the line, ensure that it is set to the local line voltage. On delivery the counter is set to either 110 V or 220 V, as indicated on the line voltage selector on the rear panel.
If the voltage setting is incorrect, set the line voltage selector in accordance with the local voltage before connecting the instrument to the line.
The counter is protected by a primary fuse and a thermal fuse inside the mains transformer. The primary fuse has to be changed when the mains voltage setting is changed. For 220 V use a 0.315 A delayed action fuse and for 110 V use a 0.63 A delayed action fuse. Remove the line plug before fitting a fuse. Ensure that only fuses of the specified type are used.

Power switch

In position power off (St.By) only the supply voltages for the logic circuits and the analog inputs are switched off. The power supply for the oven oscillator is still connected. The "Stand By"-mode is indicated by two vertical segments lit in the leftmost digit.
Warning! This is a secondary power switch. Also in off position there will be live parts inside the instrument. To separate the instrument completely from the mains, the mains cable must be disconnected.

Power-on test

When the installations for local line voltage have been made, switch the power on. Now a practical test of the correct operation of the HM 8122 is run automatically. This self check programm starts every time power is switched from ST.by to on.
As soon as power is applied, the display shows type and version of the actual instrument and the GATE indicator appears.
Then the first display is replaced by the date of the last calibration. While the date appears all LEDs are lit and the eprom and all functions of the counter are tested.

The test runs for about 2 seconds. If an error is detected it is indicated by an "E" at the leading digit and followed by the number of the test that failed. The default function after this test is frequency A.

Operation

This chapter describes the operation of the HM8122 from the viewpoint of its application, and gives practical advice to this end. The principle functions are described, as are the use of auxiliary facilities. In addition, a few hints and tips are included. Knowledge of the controls, indicators and connectors is assumed.

The use of the IEEE-488 bus is described in the manual of the HO88.

Input Triggering

As the input signal can have very different waveforms,it is necessary to shape the signals so that the counting circuits can handle the signals.

The HM 8122 offers a variaty of signal shaping possibilities to improve triggering, such as trigger slope, AC/DC coupling and three trigger level ranges (–1....+1V, –10...+10V, –100...+100V).

Also a switch selectable 50 kHz low pass filter prevents false high frequency triggering at low frequency signals.

The trigger level can be set in one of two ways: either by autotrigger or with the two trigger level potentiometers.

In Autotrigger mode the counter automatically measures and sets the triggering to the 50% level of the input signal. When this mode is selected AC coupling is necessary.

When the trigger level controls have been set in the manual trigger mode, the functioning of the trigger circuits can easily be checked on the trigger indicators, one for each channel. The LEDs show the state of triggering.

On: the signal is above the trigger level

Off: the signal is below the trigger level

Blinking: the signal is crossing the hysteresis band, correct triggering.

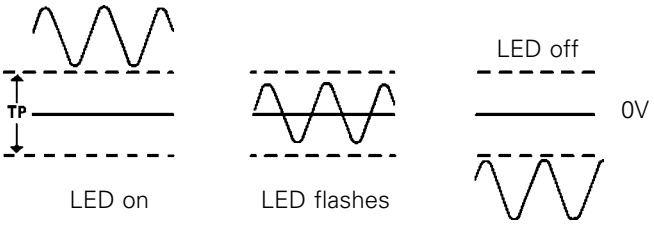


Figure 1

For reliable triggering the trigger level should, in always most cases, be at 50% of the signals peak-to-peak voltage.

Selecting the correct attenuation is important to obtain the best results from your instrument. If the attenuation is to high, the measurement will be affected by the noise of the input comparator. This results in an unstable display. With an input signal too great, the input stage may saturate and thus producing overshoots which result in a display which is twice too high e.g. at frequency measurements.

Always try to set the controls to AC-coupling and use as much attenuation as possible for frequency measurements and DC-coupling with no attenuation for time measurements.

In many cases it is vital to have a good impedance matching to avoid reflections which might make the trigger level setting very difficult. Always use a 50Ω termination in 50Ω systems.

The C-input facilitates no input signal conditioning controls and needs no trigger level setting. The input signal is triggered from 50 mV up to the maximum input voltage of 5V. The input frequency for the C-input must always be in the frequency range from 100 MHz to 1600 MHz. For frequencies lower than 100 MHz the measurement result may be erroneous.

Frequency measurement

Counters are used for both, frequency and time interval measurements. However, frequency and time interval measurements have contradictory requirements in respect of correct triggering.

For frequency measurements, too high a sensitivity means that the counter is to sensitive to noise. Therefore do not use higher sensitivity than needed for correct triggering.

Signals which are superimposed on a DC voltage, must be separated via an input coupling capacitor (i.e. AC-coupling). The advantages of AC coupling are: no DC-drift and good protection against DC overload.

AC coupling, however, gives a drop in sensitivity for very low frequencys. The low-pass filter is helpfull in those cases were a low frequency signal is superimposed with an unwanted high frequency.

Time interval measurement

In TIME A-B single mode, the time (e.g. number of 10 ns clock pulses) is measured between a start event at channel A and a stop event at channel B. The start and stop triggering can be set individually with respect to: coupling, trigger level, slope and attenuation.

In single source time measurements (e.g. Pulse width) only input A is connected. The input B connector is disconnected. However, when depressing COM, channel B is internally connected to input A. The resolution of the single measurement is 1 clock pulse (10ns).

By using the time interval average measuring technique, which means multiple measurements of a repetive signal, the measuring accuracy and resolution are greatly improved. Compared to single time interval measurements, the basic 10 ns resolution is improved by a factor of ($\sqrt{N}$), where N is the number of time intervals being averaged during the measuring time..

Note that the input signal must be repetitive and must not have a phase relation with the reference frequency.

For time interval measurements, too low a sensitivity, means that different signal slopes at the start and stop trigger point cause different delays between the trigger level crossing and the trigger point, resulting in incorrect measurements. By lowering the trigger level on positive trigger slopes and raising it on negative slopes or vice versa, one can compensate to the errors due to hysteresis. The highest possible sensitivity which does not overload the input stage, is the ideal.

DC-coupling, trigger slope selection and a continously variable setting of the trigger level is necessary for setting the trigger level at any required point of the input signal, independent of waveform and duty factor. Two identical inputs are also necessary to minimize the systematic channel mismatch error.
Autotriggering requiring AC-coupling is also possible.

Pulsewidth measurement

Select the TI A : B or TI AVG function with the function selection keys.
Apply the measurement signal to channel A. Depress common. The B input is now disabled, except its signal conditioning controls. Select the complementary slope of input A on input B. Select DC coupling and set the same attenuation for both channels. Set trigger level potentiometers for correct triggering (or select autotrigger with AC-coupling).
Remember always that the A signal is the start signal and the B signal is the stop signal.
The display resolution changes with the number of measurements taken from the signal. In the single measurement mode (TI A to B) the resolution is 10 ns, whereas the resolution in the TI AVG mode may be as small as 1 ps, depending directly on the measurement time set with the gate time potentiometer (4) and the repetition rate of the input signal.

Frequency Ratio measurement

The function RATIO A/B measures the ratio between signals connected to input A and input B.
A ratio measurement is useful, for instance, when calibrating oscillators with an odd frequency. For example say that the frequency should be 27.458934 MHz. This is difficult to recognize on the display.
By connecting such a reference signal to input B and measuring the ratio instead, the oscillator is correctly calibrated when the display shows 1.000000, which is much easier to read.

Measuring time and resolution

The measuring time can be varied in 199 steps between 1ms and 10 sec.. The gate time may be modified during a measurement or while the gate time is displayed.
The set measurement time can be displayed by depressing the READ pushbutton. Pressing READ again returns to the previous measuring function. In the reciprocal mode (at all frequencies with HM8122), the counter totalizes the input cycles until the set measuring time has elapsed and the synchronisation conditions are met. Hence, the effective measuring time (also called gate time) is longer than the set measurment time.
The measurement in the HM8122 is always synchronised to the input signal. This is called the input synchronized or reciprocal method.
In this mode, both the opening and closing of the main gate are synchronized with the input signal, so that only completed input cycles are counted. This means that a ±1 input cycle error is avoided. During the gate time, the counter totalizes the number of clock cycles. When the preselected gate time is over, the counter waits for the next active transition of the input signal to stop counting.
If the recurrence of this signal is low, e.g. with long period times, the stop synchronisation time may be long compared to the preset gate time. In that case the effective gate time may be very different from the preset value (If the signal was removed during measurement, this time becomes infinite and the measurement finishes never).
The resolution in the input synchronized mode is caused by truncation of the clock pulses, which results in ±1 clock pulse error (10 ns). The resolution of the measurement thus only depends on the measurement time. For example, the resolution for 1s measuring time is 10^{-8}, independent of input frequency.
In conventional counters the gate time is synchronized with the clock singal. The first and last input cycle can therefore be truncated, causing a ±1 cycle error. This results in a good resolution for high frequency measurements, but a poor resolution for low frequency measurements (±1 : frequency, for 1sec. measuring time). For this reason the HM8122 with its very fast internal clock, uses the reciprocal mode for all frequencies.

Special functions

External Arming

Arming enables the counter to avoid starting on unwanted signals. The external arming input (40) allows an additional trigger condition. When input (40) is low (TTL-Level), the counter is prevented from starting a new measurement. However, the counter makes all preparations for a measurement. When input (40) returns to high (>2V), the measurement is prepared to start with a minimum of delay (the delay is approx. 50 ns) according to the synchronisation delay. The counter waits for an active slope of the input signal.
The measurement will be performed according to the settings of the instrument (gate time, display hold, offset). If a new transition arrives on the EXT. ARMING Input while the counter is busy, this transition will be ignored and the counter starts with the next active transition after completion of the measurement cycle.

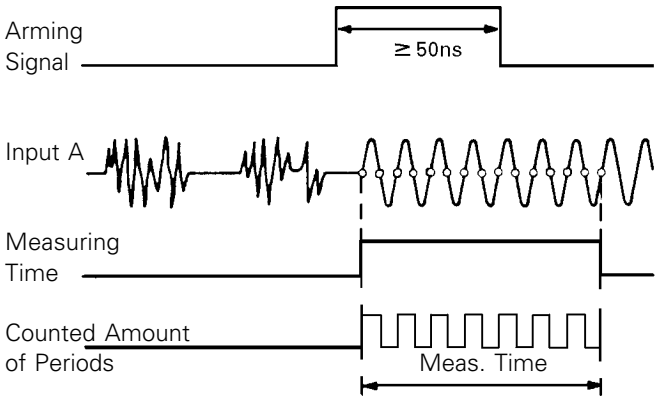


Figure 2

External Gate

The external gate function allows full control of the start and stop of the measurement. When EXT GATE is selected (7) and the control input signal (40) is low, the counter makes all necessary preparations for a measurement.

With the high level of the gate signal, measurement starts when the input signal triggers after a synchronisation delay. Measurement stops on the first trigger after the gate signal changes from high to low. The external gate overrides the set measurement time.
The external gate signal must be in the range 50 ns .. 10 sec. but the effective gate time will never be smaller than 20 µs.

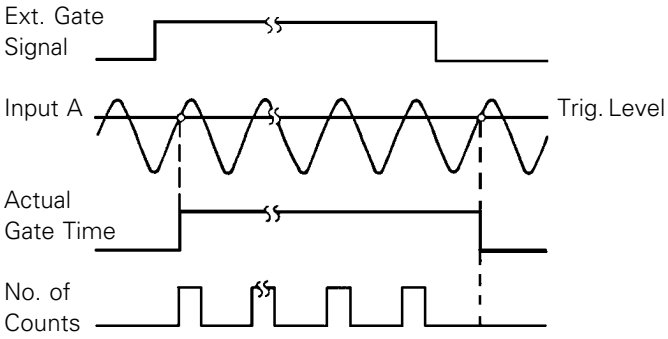


Figure 3

Either external gate or external arming are selected by means of the pushbutton (7) and indicated by means of LEDs. Example applications are multiple burst frequencies and masked time intervals. Note that if RF bursts are to be measured using frequency C, the burst should contain at least 128 cycles.
While external arming is slope sensitive, external gating is active according to the level applied to the input (40). The external gate signal may have a duration as short as 50ns. Nevertheless, the effective gate time is min. 20µs.

External Reset

External Reset (Rear panel input 36) provides an equivalent function to the front panel reset push button. The counter is reset when the input is set to high logic level (>2V). A new measurement can be made when input (36) has returned to low (<0.5V).

External Reference

If an external reference frequency is applied to the ext. ref. input (35) at the rear panel of the HM8122, the internal crystal oscillator is switched off. The external reference must have a frequency of 10MHz with a max. deviation of ±30ppm. The amplitude required is approx. $2V_{pp}$.

RPM (NPR setting) (Number of pulses per revolution)

Using the RPM function the counter enables the measurement of revolutions per minute. The default setting for pulses per revolution at start up is 1. The HM8122 permits to preselect a number of pulses per revolution, ranging from 1 to 65535.

NPR-setting:

1 Depressing READ (5) shows 00001 on the display with the rightmost digit highlighted.
2 Change this digit in incremental steps of 1 by depressing the ARM/EXT Gate pushbutton (7).
3 When the desired value is reached use the function keys (17) to shift to the next digit.
4 Returning the NPR setting by pushing READ (5) once again, stores the value until power is switched off or a new value is selected.

Exceeding a NPR of 65535 indicates error 5. Returning to RPM with Error 5 indicated, keeps the previous value of NPR.

Gate View (Output 39)

The HM8122 is equipped with a gate open output for monitoring the gate time on an oscilloscope. Note that the gate open signal is longer than the set measuring time due to the synchronisation time.

Calibration

The calibration mode offers two possibilities:
a) setting a new date without recalibration
b) setting a new date and carry out a complete recalibration.
When making a recalibration, the internal crystal oscillator will only be compensated for deviation in frequency due to aging.
The mean time between recalibration, **MTBRC**, can be calculated when the **Total Tolerated Error** is known. The total tolerated error is defined as:

TTE = Deviation of intern. ref. frequency : Nominal intern. = ref. freq.

The meantime between recalibration is defined as:

MTBRC = (Acceptable error Temperature stability) : Ageing

If recalibration is necessary it is carried out as follows:

1 Select function FREQ. A
2 Apply a frequency standard of 5, 10 or 100 MHz to input A and adjust channel A settings for a stable reading.
3 Depress Reset (21) and gate time read (5) together, for approx. 10 secs.
4 After 10 secs. the display shows C ... during the pushbuttons are depressed.
5 When the switches are released the display shows C 00 00 00 to set the date of the last (actual) recalibration. (Same procedure as RPM, 2-3).
6 You may leave the calibration mode without changing anything by depressing reset (21).
For changing only the date you have to leave the calibration mode when the right most digit is highlighted. Firstly now depress the right shift key (17) and then depress the reset key (21).
7 To start the recalibration, depress only the right function shift key.
8 The actual calibration frequency is displayed.
9 During the calibration procedure which lasts at least for approx. 10 secs., the display shows the following informations:
C ... if the standard frequency applied to the A input is not accepted.
C ... 5x10E6 if the counter has recognized a 5 MHz standard.
C ... 10x10E6 if the counter has recognized a 10 MHz standard.
C ... 100x10E6 if the counter has recognized a 100 MHz standard.

In the first case the counter cannot be recalibrated either because no signal is connected, or the input signal deviates to much from one of the 3 accepted frequency standards. The result of the calibration is tested at the end of the calibration routine. If the test fails, the counter starts a new calibration cycle.

Internal Test Programs

At power up the internal test program checks all functions of the counter. When the tests are completed satisfactorily, the counter sets the display to zero and selects the default measuring function. If an error is detected, it is indicated by an "E" followed by the test number that failed.

E 1 microprocessor RAM error
E 2 program ROM error
E 3 counting chain error
E 4 attempt to calibrate the counter while a signal is connected to the external reference input.
E 5 attempt to set an invalid NPR number (RPM function)

Options

Specifications HO85

The optional HO85 is a high stability ovenized crystal oscillator to fit into the HM8122 universal counter. The option is field installable by simple changing the oscillator unit. Subsequently the counter has to be recalibrated.

The high frequency stability of the HO85 is obtained by means of a temperature controlled "crystal oven". The temperature stability is approx. 0.1°C in the entire working temperature range from +10°C to +60°C. Thus the high stability of $5x10^{-8}$ per day is achieved. The specified accuracy is obtained after a warm-up of 15 min.

Specifications: (after 48 hours of continuous operation)

Frequency stability: ± $5x10^{-8}$ per day
±$1.5x10^{-7}$ per month
± $1x10^{-6}$ per year
Ambient temperature: +10°C to +60°C (working)
–55°C to +90°C (storage)
Frequency repitition accuracy
after 24 hours of "power off": ±$5x10^{-8}$

The interfaces HO88/HO89

The test instruments of the HAMEG series HM8100 have all been designed to permit their use in automated testing environments. In order to connect them, either the interface HO88 (IEEE-488) or HO89 (RS232C) option is required. Series HM8100 instruments equipped with the IEEE-488 bus interface comply with the stipulations of the IEC-625-1 and IEEE-488 standards.
If the HO88/HO89 interface is ordered together with the HM8122 counter, it is installed whithin it at the factory. The interfaces are also available as a separate option for retrofitting purposes at a later time.

Installation of HO88/89

To install the interface see HO88 or HO89 manual. Connect CON1/HO88-89 to CN604/HM8122 and CON3/HO88-89 to CN606/HM8122.

Command Codes HO88

Device-dependent messages that are understood by the HM8122:
("*" indicates a default setting, i.e. corresponding the state of the HM8122 when initialized or when the command "CLR" is received. "XXXXX" represents a positive integer with between 1 and 5 digits.)

Functions

FRC : Measure frequency on channel C
TOT : Totalize events on channel A
PRA : Measure period on channel A
FRA* : Measure frequency on channel A
FRB : Measure frequency on channel B
RAB : Calculate frequency ratio of channel A to channel B
TIA : Measure average time interval A-B
TI1 : Measure time interval A-B (single measurement)
RPM : Measure revolutions per minute (channel A)

Measurement control

SMTXXXXX : Set measurement time to XXXXX ms
TRG : Trigger new measurement
XAR : Select external arming mode
XGT : Select external gate mode
XC* : No external control
DH1 : Select display hold mode
DH : Reset display hold (auto measurements)
WT1* : Select wait time between measurements
WT : No wait time between measurements
STR : Start TOTALIZE function (TOT)
STP : Stop TOTALIZE function
NPCXXXXX : Set no. of pulses per rev. to XXXXX (RPM function)
OF1 : Select OFFSET mode
OF : Reset OFFSET mode

Display control

RES : Display Reset
REF : Recall and display reference value in offset mode
DT1 : Display measurement time
DT* : Reset measurement time display function
DS1* : Select DISPLAY ON
DS : Select DISPLAY OFF
DN1 : Display NPR value in RPM mode
DN : Reset display NPR value

Bus and output control

SR1 : Set service request ON
SR : Set service request OFF
CLR : Clear (initialize to default settings)
CNF : Poll counter settings (configuration)
NOP* : Set output mode to NORMAL
COP : Set output mode to COMPRESSED
RM : Reset to local mode
LK1 : Local lock out active
LK0 : Local lockout desactive
ID? : Device identification