1 Description

The counter P is a measuring instrument for counting counter tube pulses, pulse rates or other electrical signals as well as for measuring time and frequency. It is equipped with a 5-digit digital display, a counter tube input with internal voltage supply (500 V–), a built-in loudspeaker for acoustical pulse indication, and two pairs of 4-mm sockets and two light barrier inputs (6-pole) for frequency and time measurements. Thanks to a storage for up to 6 times, the possibilities of time measurement are considerably increased. An integrated calculator enables velocities (e.g. in collision experiments) and acceleration (in the case of accelerated motions) to be determined directly.

2 Scope of supply

1 counter P
1 plug-in unit 230 V / 12 V (562 791)
or
1 plug-in unit 115 V / 12 V (562 792)

Safety notes

- Only low-voltage pulses may be applied to the inputs B, E and F!
- Do not apply voltage to the output OUT!

3 Technical data

Display of measured values: 5-digit
Height of digits: 18 mm
Time base: quartz control
Gate times for counter tube: fixed 10 s, 60 s, 100 s; adjustable up to 9999 s

Connections:

Input A: coaxial socket, counter tube voltage 500 V (at the middle conductor of the socket);
Input B: AC coupling, BNC socket
Inputs E, F: DC coupling, pulses up to 30 V, pair of 4-mm sockets, 6-pole DIN socket
Output: TTL compatible, pair of 4-mm sockets
Voltage supply: hollow socket for plug-in unit, on the back of the housing

Measuring ranges:

Events: 0 ... 99999 pulses
Frequency: 0 ... 99999 Hz,
0 ... 999.99 kHz
Time: 0 ... 99.999 ms,
0 ... 99999 s

General data:

Dimensions: 30.3 cm × 23 cm × 14.3 cm
Weight: 1.35 kg
4 Components

Pushbutton START:
Start of a measurement (apart from frequency measurement, all measurements have to be started manually)

Pushbutton STOP:
(Premature) stop of a measurement

Pushbutton → 0 ←:
Reset display

Pushbutton tₐₓₑₑ:
Selection of one of the times t₁, t₂, t₃, and t₄ stored in the operation mode tₑₓₑ for calculating and displaying the corresponding velocity

\[ v_i = \frac{d}{t_i} \]

from the adjusted width d of the interrupter flag (default value d = 5 mm). In the storage display, the LED corresponding to the selected time shines more brightly than the others.

Pushbutton vₑₓₑ:
Selection of one of the times t₁, t₂, t₃ stored in the operation mode tₑₓₑ and the width d of the interrupter flag (default value d = 5 mm)

\[ a = \frac{v_2 - v_1}{t_{1\rightarrow2}} = \frac{\frac{d}{t_2} - \frac{d}{t_1}}{t_{1\rightarrow2}} \]

from the times t₁, t₂ and t₁→₂ stored in the operation mode tₑₓₑ.

Input A:
Coaxial socket with internal voltage supply (500 V at the middle conductor) for end-window counters (e.g. 559 01)

Input B:
BNC socket, AC-coupled input for frequency measurement.

Inputs E, F:
Pair of 4-mm sockets, lower socket grounded, pulse input for pulses up to 30 V.

6-pole DIN socket, connection of light barriers (337 46 or 337 462)

Output OUT
Pulse output, TTL, lower socket grounded
5 Use

5.1 Pulse counting (operation mode $N_{A,E}$):

Either (cf. 6.2.1-3)
- Connect a function generator (e.g. 522 62), multi-purpose microphone (586 26) or another signal source to the input E (pair of sockets) or B (BNC socket) paying attention to the polarity.

or (cf. 6.2.4)
- Connect the forked light barrier (337 46) or the combination light barrier (337 462) to the input E (6-pole socket).

- Select the operation mode $N_{A,E}$ with the button MODE.

Either
- select a fixed gate time with the button GATE.

or, in order to set a freely selected gate time,
- Press the button GATE and before releasing it the button or, in order to set a freely selected gate time,
- Press the button GATE and before releasing it the button or, in order to set a freely selected gate time,
- Press the button MODE.

- Start pulse counting with START.

When the gate time is over, the measurement is stopped automatically. By pressing STOP, the measurement can be stopped manually.

While pulses from the end-window counter are counted, an acoustical signal is to be heard for every pulse from the counter.

5.2 Frequency measurement (operation mode $f_{E,F}$):

Either (cf. 6.2.1-3)
- Connect a function generator (e.g. 522 62), multi-purpose microphone (586 26) or another signal source to the input E (pair of sockets) or B (BNC socket) paying attention to the polarity.

or (cf. 6.2.4)
- Connect two forked light barriers (337 46) or combination light barriers (337 462) to the input E (6-pole socket).

- Select the operation mode $f_{E,F}$ with the button MODE.

The gate time has a constant value of 1 s, and the frequency measurement starts automatically. It can be stopped manually by pressing the button STOP.

5.3 Time measurement (operation mode $t_{E,F}$):

(cf. 6.3.1-5):
- Connect the forked light barrier (337 46) or the combination light barrier (337 462) to the input E and/or F (6-pole socket).

The signal source must not bounce (no switches or the like) as the time for each pair of edges (dark period or light period) is recorded.

- Select the operation mode $t_{E,F}$ with the button MODE.

- Start the time measurement with the button START.

In the storage up to 4 dark periods (light barrier bright at START) or light periods (light barrier dark at START) are recorded along with the first two periods between successive equal edges (e.g. the time between E and F on the track or half periods of a pendulum).

- If desired, stop the time measurement manually with the button STOP.

If the storage is full, the time measurement is stopped automatically.

- Read the storage by pressing the button $t_{E,F}$.

The values recorded in the storage are indicated by LEDs. The time currently displayed is marked by an LED that shines brighter than the others. In addition, the LEDs E and F of the storage display indicate at which input the respective time has been measured.

Setting the width of the interrupter flag:
- The width of the interrupter flag is needed for calculating the velocities. The default value is 5 mm.

- Press the button GATE.

The set width is displayed.

- Increase the set value with the button GATE, or decrease it with the button MODE.

Calculating the velocities:
- From the width of the interrupter flag and the stored dark periods, the magnitudes of the velocities can be determined. The sign is determined by the experimental setup and - e.g. in the case of collisions - has to be taken into account afterwards.

- Press the button $v_{E,F}$.

The velocity currently displayed is indicated in the storage display by an LED that shines more brightly than the others. Moreover, the LEDs E and F of the storage display indicate at which input the respective dark period has been measured.

Calculating the acceleration:
- From two velocities and the time interval “in between”, the acceleration can be determined.

- Press the button $a_{E,F}$.

The acceleration currently displayed is indicated by three LEDs that shine more brightly than the others.

5.4 Measurement of the time delay (operation mode $t_{E,F}$):

Either (cf. 6.4.1-2)
- Connect two forked light barriers (337 46) or combination light barriers (337 462) to the inputs E and F (6-pole sockets).

or (cf. 6.4.3-4)
- Connect a switch, multi-purpose microphone (586 26) etc. to the inputs E and F (pairs of sockets) paying attention to the polarity.

- Select the operation mode $t_{E,F}$ with the button MODE.

- Start the measurement of the time delay with the button START.

The time measurement is started by the first pulse edge at the input E and stopped by the first pulse edge at the input F. All other pulse edges are disregarded. In contrast to time measurement in the operation mode $t_{E,F}$, therefore bouncing signal sources (e.g. for measuring the propagation time of sound) can also be used.

5.5 Manual stop clock (operation mode $t$):

- Select the operation mode $t$ with the button MODE.

- Start the time measurement with the button START and stop it with the button STOP.

- Before making a new time measurement, reset the display to zero with the pushbutton $\rightarrow 0 \leftarrow$. 
6 Experiment examples

6.1 Pulse counting
6.1.1 Counting pulses from a counter tube

The pulses are triggered by radioactive radiation in an end-window counter. An arbitrary gate time can be selected.

6.2 Frequency measurement
6.2.1 Measuring the frequency of a tuning fork

6.2.2 Determining the upper audibility limit

6.2.3 Determining the frequencies exciting standing waves

Generating standing waves on a rubber string (or on a helical spring) with a motor and a tacho-generator, which is driven by the function generator.

6.2.4 Determining the natural frequencies $f$ of a rubber string

Counting the number $n = 2f$ of light barrier interruptions per second caused by the oscillating string.

6.3 Time measurement
6.3.1 Measuring time and determining velocities

Continuously increasing or decreasing the frequency between 10 kHz and 20 kHz with the function generator. Measuring the frequency which is just heard or not heard by the test person.

Measuring the interruption time of the light barrier E and calculating the average velocity during the interruption from the width of the interrupter flag.
6.3.2 Measuring time and determining the acceleration

Measuring the two dark periods at the two light light barriers and the time delay between the two dark periods. Calculating the velocities and the average acceleration from these values and from the width of the interrupter flag.

6.3.3 Measuring time and determining the acceleration

Measuring the two dark periods at the light barrier and the time delay between the two dark periods. Calculating the velocities and the average acceleration from these values and from the width of the interrupter flags.

6.3.4 Time measurement and collision of two trolleys

Recording the velocities before and after the collision.

6.3.5 Measuring the period of a thread pendulum

The dark periods of the light barriers as well as the time intervals between the first and the second dark period $t_{1 \rightarrow 2}$ and between the first and the third dark period $t_{1 \rightarrow 3}$ are stored. The period corresponds to the time interval $t_{1 \rightarrow 3}$.

6.4 Measuring time delay

6.4.1 Measuring time delay with two light barriers

Measuring the time interval between the interruptions of the light barrier E and the light barrier F.
6.4.2 Measuring time delay with a holding magnet and a light barrier

Measuring the time from the start of the motion (interruption of a circuit involving the holding magnet) until the trolley reaches the light barrier.

6.4.3 Measuring the time delay in free fall

Measuring the time from the start of the motion (interruption of a circuit involving the holding magnet) until a contact is made (the experiment body reaches the contact plate).

6.4.4 Measuring the sound propagation time

Measuring the propagation time between the sound generation (by slamming together the two stand rods) and the sound detection by the multi-purpose microphone.