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## Operating instructions


 The unit complies with the corresponding EC guidelines.



Fig. 1: 13604-99 Timer 4-4

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### 1 SAFETY PRECAUTIONS



- Carefully read these operating instructions completely before operating this instrument. This is necessary to avoid damage to it, as well as for user-safety.
- Only use the instrument for the purpose for which it was designed.

- Check that your mains supply voltage corresponds to that given on the type plate fixed to the instrument.
- Only use the instrument in dry rooms in which there is no risk of explosion.
- Install the instrument so that the on/off switch and the mains connecting plug are easily accessible. Do not cover the ventilation slots.
- Before applying mains voltage, ensure that the earth lead of the experimental set-up is properly connected to the mains earth lead. The mains plug is only to be plugged into a mains socket which has an earth lead. Do not use an extension cable without earth lead, as this would negate the protective effect.
- Take care that no liquids or objects enter in through the ventilation slots.
- Do not start up this instrument in case of visible signs of damage to it or to the line cord.

### 2 PURPOSE AND CHARACTERISTICS

The timer unit has four 4-digit displays and has been specifically developed for use in students experiments and in practical work in physics. The starting and stopping of the four built-in independent timers is actuated by the opening or closing of electrical circuits, or by means of light barriers or other TTL signal sources.

The 8 different operating modes allow the timer unit to be adjusted to suit almost any experimental requirement. Four different operating modes are suitable for track experiments (distance-time law for four tracks, measurement of speed at four positions, principles of collisions), and in each case all four displays are utilized. Two further operating modes allow, for example, the measurement of the orbiting time of a rotary movement and the direct measurement of the duration of a

complete swing of a mechanical pendulum. A further function allows a counting of events. If required, two of the 4-digit displays can be combined to give an 8-digit display (0000.0000 to 9999.9999).

### 3 TECHNICAL DESCRIPTION

The Timer 4-4 with USB-interface is held in an impact-resistant plastic housing. Four rubber feet ensure a slip-free and stable stand. The Timer 4-4 with USB-interface can be stacked on other instruments that have the same type of housing, whereby the rubber feet then fit in the pan-shaped depressions of the instrument below and so guard against slippage.

### 4 HANDLING

#### 4.1 Start-up

Fit the instrument plug of the mains cable supplied into the socket that is above the instrument mains switch at the back of the housing. Connect the other end of the cable to the mains supply. Switch the mains switch on. All other functional and operating elements are situated on the front plate of the Timer 4-4. The instrument is ready for use within a few seconds.

Replacement of the primary fuse:

The fuse holder is situated in the upper part of the instrument plug and is only accessible when the mains cable has been unplugged from the instrument. Use a screwdriver to open it. Remove the defect fuse from the fuse holder, insert the new fuse (see the type plate for the fuse rating) and fit the holder back in the instrument plug. Should the fuse blow when the instrument is switched on again, then under no circumstances use a fuse with a higher rating. The instrument then has a serious defect and is to be sent back to our Service department for repair.

#### 4.2 Functional- and operating elements

The picture below shows the functional and operating elements that are on the front plate of the Timer 4-4:

- 1 Reset button  
For resetting the displays to zero and to restore measurement readiness after completion of a measurement.
- 2 Slide switch  
For selection of the triggering edge for the START input; position  $\uparrow$  start of measurement by the increasing flank of a TTL impulse (release of a light barrier) or by the opening of the electrical connection between the sockets of the corresponding input; position  $\downarrow$  start of measurement by the decreasing flank of a TTL impulse (interruption of a light barrier) or by the closing of the electrical connection between the sockets of the corresponding input.
- 3 Socket pair START  
For starting the time measurement in the operating modes 2, 5 and 7; see section 4.3 for a description of the operating modes.
- 4 Pairs of sockets  
For supplying light barriers with an operating voltage of 5 VDC; the sockets which are labelled with the „earth“ symbol are also for use for the control current circuit.
- 5 Control input sockets  
For starting and/or stopping the time measurement in the various display windows according to the operating mode selected with switch 7. For each of the control input sockets, the socket 4 below it which is labelled with the „earth“ symbol serves as reference pole. The mode of action of the control inputs is dependent upon the selected operating mode (see section 4.3).

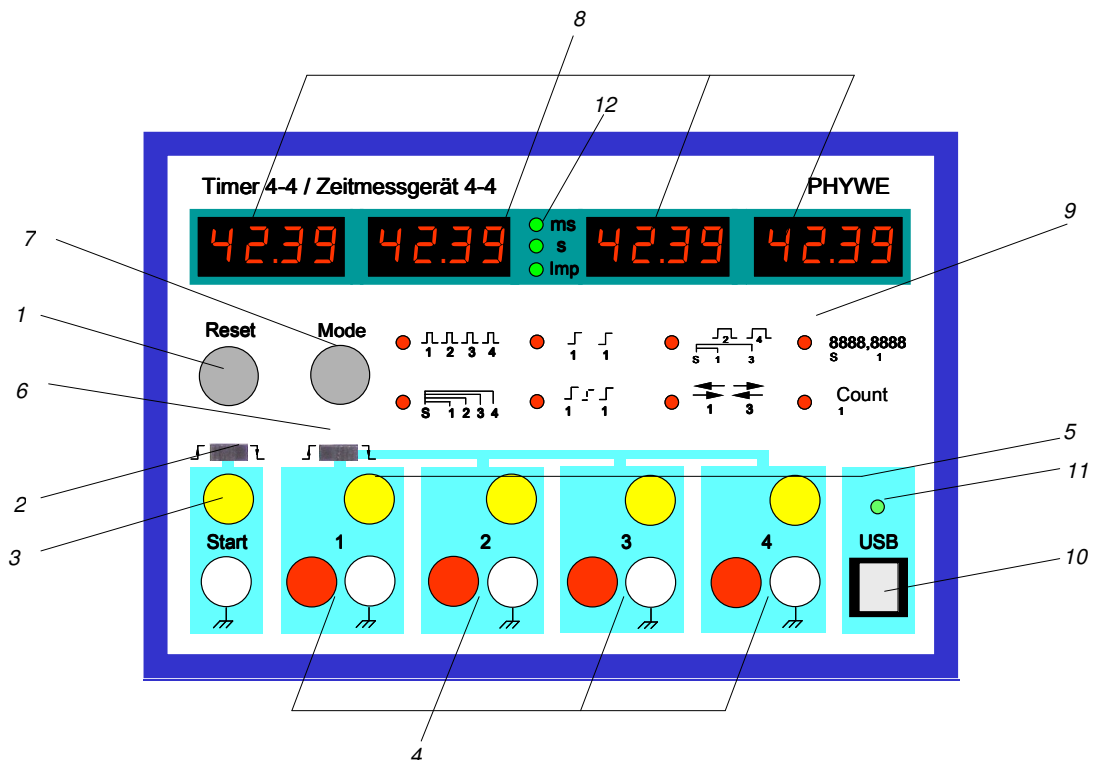




Fig. 2: Functional- and operating elements.

## 6 Slide switch

For selection of the triggering edge for the control inputs 1 to 4 (5). The symbol next to the position of the switch relates in each case to the first switching process („Start“ in the operating modes 1, 3, 4 and 6; „Stop“ in the other operating modes); if the measurement is started and stopped over the same input, then the triggering edge for the second switching process („Stop“) is dependent upon the operating mode selected (see section 4.3).

Position  triggering by the increasing flank of a TTL impulse (release of a light barrier) or by the opening of the electrical connection between the sockets of the input; position  triggering by the decreasing flank of a TTL impulse (interruption of a light barrier) or by the closing of the electrical connection between the sockets of the input.

## 7 Step switch

For the selection of one of the 8 available operating modes (see section 4.3).

## 8 Digital displays

For the display of the time measured within the range 0.000 to 9.999 s. By combining the two left-hand displays (mode of operation 7) an 8-digit display results, which has a 1000 fold resolution and allows measurements of up to 9999.9999 s.

## 9 LED's

to show the 8 available modes.

## 10 USB-Buchse

The USB port is used only for firmware update via PC. The green LED lights up, when connected to a PC.

## 11 LED USB

LED is „on“ permanently during communication with a PC, blinking during data transfer.

## 12 LED's

the units display (ms , s und Imp).

### 4.3 Description of the modes of operation

The step switch 7 allows a choice of eight different modes of operation. The modes of operation are labelled on the front plate with graphic symbols. The active control inputs for the various modes of operation are indicated below the graphics (S for START and 1 to 4 for the correspondingly labelled control inputs on the front plate). In the following paragraphs of these operating instructions, we have numbered the modes of operation 1 to 8 and have given each mode of operation a name, which corresponds to a typical application.

Mode of operation 1: „ $v(s)$ “,

Particularly for the measurement of the speed at four different positions on the air cushion track. Each of the four displays (in succession, from left to right) are started by the control impulse edge selected with switch 6 and stopped again by the inverse edge. The START input and switch 2 have no function here.


It is purposeful to use the same set-up for this measurement as that previously used for a measurement in mode of operation 2. The switch position 6 is also unchanged. Calculate the speed  $v$  from the measured shade times  $t$  and the length  $l$  moved on the air cushion track to the diaphragm positioned on it, using the formula  $v = l / t$ . When the light barriers are displaced by  $l/2$ , in the direction of the starting point, from their positions in the measurement in mode of operation 2, then the speed/time law  $v(t)$  law for the corresponding movement processes can be worked out from the times de-

termined in the first measurement and the speeds calculated here.

In this mode of operation also, it is possible to work with less than four light barriers. The displays belonging to the unused inputs will stay at 0.000 s.


Mode of operation 2: „ $s(t)$ “,

Particularly for the investigation of the distance/time law of movement on air cushion tracks. All four timers are started simultaneously by the START input; switch impulses at the control inputs 1 to 4 stop the displays belonging to them from left to right.

Four forked light barriers are required for the measurement. They are distributed along the track and connected with the inputs 1 to 4. To start movement, we recommend our starter system 11202-13, whose contact switch must be connected to the START input. If a starting device with contact switch is not available, then a light barrier can also be used at the START input. In any case, switch 2 and switch 6 must be in position .

It is not absolutely necessary to connect all control inputs. The displays belonging to the unused inputs will stop automatically at 9.999 s.

Mode of operation 3: „Rotation“

In this mode of operation the time measurement in the left-hand display is started by a control impulse edge selected with switch 6 at control input 1; when the same edge appears a second time, the measurement is stopped. These conditions are required, for example, for the measurement of the orbiting time of a rotary movement. When the measurement is started and stopped by interrupting a light barrier, then switch 6 must be in position .

Mode of operation 4: „Pendulum“

This mode of operation differs from mode of operation 3 only in that, after the start, not the second but the third identical control impulse edge stops the measurement. It can be therefore used with a light barrier, for example, to measure the complete swing time of a pendulum.

Mode of operation 5: „ $s(t)$  ,  $v(s)$ “

This operating mode can be used to measure 2 different times with up to 1 light barriers. First you can measure the time between Start impuls and Stop and consequently the shade time of the first light barrier connected to socket 1. When a second light barrier is connected to socket 3 the same function is available. Their results are given in different displays: The two left-hand displays belong to input 1, and the two right-hand displays to input 3. This mode is used when during an accelerated motion of a body up to two momentary and average speed have to be calculated.

Mode of operation 6: „Collision“

Particularly for the evaluation of collision experiments on the air cushion track. Only the control inputs 1 and 3 are active. At each of the inputs, two measurements can be carried out in succession without having to press the RESET button between them. Their results are given in different displays: The two left-hand displays belong to input 1, and the two right-hand displays to input 3. The function of the trigger edges is as in mode of operation 2 (start and stop by inverse edges for measurement of the shade duration).

For experiments on elastic collisions, position the two light



barriers connected to inputs 1 and 3 on the track so that each barrier is passed by one of the colliding carriages before and after the collision. Switch 6 must be at the position . Calculate the speed from the length of the diaphragm and the measured shade times.

Mode of operation 7: „Short-term and long-term measurements“

For the measurement of both short times with tenfold sensitivity (1  $\mu$ s), as well as for long times up to 9999.9999 s. For this purpose, the two left-hand displays are combined to a single 8-digit display. The start is initiated over the START input; The measurement is stopped by a signal at control input 1. The trigger edges for start and stop can be selected independently of each other with the switches 2 and 6.

A typical application of this mode of operation is the measurement of the speed of sound in air. To start the counter and simultaneously generate a sound impulse, strike together two short support rods which are connected to the START input (e.g. the support rods with 4 mm drill-holes for the connection of connecting wires, order no. 02036-00). The sound probe 03542-00 is suitable for stopping at the end of the measurement track.

Betriebsart 8: "Count"

This operating mode can be used to count the number of shade times when a light barrier is connected to input 1. Usable e.g. for pendulum experiments or to count the number of drops.

## 5 NOTES ON OPERATION

This high-quality instrument fulfils all of the technical requirements that are compiled in current EC guidelines. The characteristics of this product qualify it for the CE mark.

This instrument is only to be put into operation under specialist supervision in a controlled electromagnetic environment in research, educational and training facilities (schools, universities, institutes and laboratories).

This means that in such an environment, no mobile phones etc. are to be used in the immediate vicinity. The individual connecting leads are each not to be longer than 2 m.

The instrument can be so influenced by electrostatic charges and other electromagnetic phenomena that it no longer functions within the given technical specifications. The following measures reduce or do away with disturbances:

Avoid fitted carpets; ensure potential equalization; carry out experiments on a conductive, earthed surface, use screened cables, do not operate high-frequency emitters (radios, mobile phones) in the immediate vicinity. Following a blackout failure, operate the on/off switch for a reset.

This instrument corresponds to Class A, Group 1 of the EN 55011 Standard and can only be operated without limitation outside of residential areas. Should electromagnetic disturbances occur in surrounding residential areas although operation is limited to the technical room of a school or other training facility, then it can be demanded of the operator that he carries out adequate measures (e.g. screening, greater distance, reduction in the operating time) at his own cost.

### Important note:

Should you use an electromagnetic starting device, then the induction surge that occurs on switching a coil on and off could influence the electronics of the counter. This can be acted against by the parallel connection of an attenuating diode (e.g. 39106.02) to the coil. The coil is operated by direct current and the diode is in the blocking direction. When the coil is switched off, the diode forms a short circuit and weakens the induction surge.

## 6 ADDITIONAL EQUIPMENT

The use of the following devices with the Timer 4-4 13604-99 brings particular advantages.

Light barrier	
Light barrier, compact	11207-20
Light barrier with counter	11207-30
Falling sphere apparatus	02502-88
Starter system for air track	11202-13
Measuring microphone	03542-00
Cobra4 Drop Counter	12635-00

## 7 TECHNICAL SPECIFICATIONS

(typical for 25 °C)

Operating temperature range 5... 40 °C

Relative humidity < 80%

### Digital displays

Type of display	LED
Digital display	four 4-digit, 7-segment
Character height	9 mm

### Display of units

Type of display	LED
	ms ; s ; Imp

### Gate inputs ( Start, Gate1, Gate2, Gate3, Gate4 )

Signal bandwidth	DC, 1 MHz
Signal level	TTL-compatible
Switching threshold	TTL-compatible
Maximum permissible overvoltage	$\pm$ 30 V

### 5 V Outputs

Output voltage	5 V
Output current	max. 1 A
Overload capacity	short circuit proof

### Time measurement (Mode 1 bis 6)

Display range	0...9.999s
Resolution	0.001 s

### Time measurement (Mode 7)

Display range	0...9999.9999s
Resolution	1 $\mu$ s

### Impulszählung (Count)

Display range	0...99999999 Imp
Resolution	1 Imp

### Mains supply

The instrument corresponds to protection class I. It is only to be connected to a socket with an earth lead connection.

Connecting voltage (±10%)	see type plate
Mains frequency	50/60 Hz
Power consumption	18 VA
Mains fuse (5 mm x 20 mm)	see type plate
Housing dimensions (W, H, D)	206 x 130 x 160 (mm)
Weight	approx. 1.1 kg

## 8 NOTES ON THE GUARANTEE

We guarantee the instrument supplied by us for a period of 24 months within the EU, or for 12 months outside of the EU. Excepted from the guarantee are damages that result from disregarding the Operating Instructions, from improper handling of the instrument or from natural wear.

The manufacturer can only be held responsible for the function and technical safety characteristics of the instrument, when maintenance, repairs and alterations to the instrument are only carried out by the manufacturer or by personnel who have been explicitly authorized by him to do so.

## 10 WASTE DISPOSAL

The packaging consists predominately of environmentally compatible materials that can be passed on for disposal by the local recycling service.



Should you no longer require this product, do not dispose of it with the household refuse.

Please return it to the address below for proper waste disposal.

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