

## INSTRUCTIONS FOR USE

1. Pilot lamp. Indicates, when lit, that mains power switch **2** is on.
2. Mains power switch. Rocker switch for power supply. On/Off. Press switch down for power on.
3. Display. 7-digit seven-segment LED display with 20 mm readout height. The result is displayed with correct decimal point and unit indication by LEDs **15** and **16**. By result numbering the second digit from left is blank and the result number is indicated (flashing) by the leftmost digit.
4. INPUT A - electrical impulse. The input is DC coupled with automatic gain control (AGC control). Frequency range DC to 2 MHz. The sensitivity in the range DC to 100 kHz is typically 50 mV<sub>rms</sub>. Sensitivity in the range 100 kHz to 2 MHz increases from the typical 50 mV<sub>rms</sub> to 500 mV<sub>rms</sub>. The input impedance is 1 Mohm / 100 pF. Do not connect higher voltage than 250 volt (DC + peak), or more than 500 volt (peak - peak).  
  
NB! When this input is in use, nothing may be connected to inputs **5** and **6**.
5. INPUT A - switch. Connection for switch.
6. INPUT A - DIN. For plugging in and taking measurements with IMPO microphone and IMPO photocell or other IMPO equipment with DIN multi-pin plugs, e.g. photo-active receiver, reaction time box, stroboscope attachment etc.
7. INPUT B - electric impulse. The input is DC-coupled with fixed sensitivity control for approx. 2 volt peak. Input impedance 100 kohm / 100 pF. Do not connect voltage higher than 100 volt (DC + peak).
8. INPUT B - switch. Connection for switch.
9. INPUT B - DIN. For plugging in IMPO microphone, IMPO photo-cell or reaction time box.
10. FUNCTIONS indicated by LED.  
Change of function is achieved with **13**.

**PASSAGE TIME + TIME INTERVAL  $t_A$ ,  $t_B$ ,  $t_{A \rightarrow B}$  :**

This function is used to demonstrate Newton's second law, using the air track.  
 $t_A$  is the time it takes the vehicle to pass the photo cell connected to INPUT A.  
 $t_B$  is the time it takes the vehicle to pass the photo cell connected to INPUT B.  
 $t_{A \rightarrow B}$  is the time between interruption of light beam A and interruption of light beam B. (From leading edge to leading edge).

As soon as  $t_A$  is finished, INPUT A extinguishes the LED **18** and the input is closed.  
 When  $t_B$  is finished, INPUT B extinguishes the LED **17** and the input is closed.

The result of  $t_A$  is now shown on the display as result No. 1. The other two results are called by pushing the Display Result.

**START A -> STOP B  $t_{A \rightarrow B}$  :**

In input A use either **4**, **5** or **6**, and  
 in input B use either **7**, **8** or **9**.

As one result only appears in this function, the sum is shown in seven digits direct on the display as soon as the measuring has commenced with input A (LEDs **18** and **14** go out and input A is closed). The time measurement is stopped with input B, the LED **17** goes out and the input is closed. The time unit is indicated by the „mSec.“ LED **15**.

When the test is finished, **12** emits a constant light to indicate that the only result available is now shown on the display.

FUNCTION SELECTOR LED **14** is now on again, and when **13** is pushed in the counter prepares itself for function selection (Described under **13**).

**FREQUENCY A**

The signal frequency connected at input A (**4**, **5** or **6**) is continuously shown on the display. The gate time is approx. 1 sec. or 1 period time, if the frequency is lower than 1 Hz. The display unit is Hz, indicated with LED **16**. The LED at input A is on, when the gate is open. DISPLAY RESULT LED **12** is flashing for every measurement completed. FUNCTION SELECT LED **14** is constantly on, as the user may prepare for a new function by pressing F.S. (blue) button **13**.

When the D.R. (red) button **11** is pressed, continuous measuring is stopped, when the current measurement is completed. LED **12** is now constantly on and the input LED **18** goes off. The counter is now in the single measurement function, i.e. by pressing D.R. (red) **11** button a single measurement is made, where the input LED **18** is on until the measurement is completed, and the LED **12** flashes once and the result appears on the display. This may be repeated as often as required (Example: used when measuring the frequency of a tuning fork). To revert to continuous measuring again, press F.S. (blue) **13** once.

**UNIT COUNTING A**Selection of function/timer:

After the UNIT COUNTING A function has been selected with F.S. (blue) push button **13**, one of the following count functions may be selected with D.R. (red) push button **11**:

„00“: Infinite ( $\infty$ ) counting with manual start/stop with D.R. (red) push button **11** and continued counting without reset.

Reset is executed with F.S. (blue) push button after stop of counting with D.R. (red).

„01“: Single measurement with a gate time of 1 sec.  
 Start by pressing D.R. (red) button.

„06“: As „01“, but the gate time is 6 secs.

„10“: As „01“, but the gate time is 10 secs.

„60“: As „01“, but the gate time is 60 secs.

**11 DISPLAY RESULT push-button**

The push button is used to bring results onto the display screen, also to control single measurements, frequency and period time and for impulse counting start/stop. See **12** below.

**12 DISPLAY RESULT LED**

Off: Push button **11** is not active and no results are ready.

Constant light: There are no „unknown“ results in the memory and the result shown is the latest (singular). (If the display **3** is totally dark, the counter is in the programming condition and **11** is active).

Flashing light: A result is being shown on the display and new ones may be called by pressing **11**. Exception: by continuous frequency and period time measurements the results are automatically shown on the display consecutively.

### 13 FUNCTION SELECTOR push-button

Used for selection of function and also to clear counter for new measuring operation.

See **14** below.

### 14 FUNCTION SELECTOR LED

Constant light: When **13** is pressed the counter will prepare for function selection. The LEDs **14** plus the one indicating the function selected will now flash. If the button is not pressed again within 5 seconds, the LEDs will show constant light again and the counter is ready to start measuring.

Flashing light: By pressing **13** the LED **10** by the function descriptions will switch to the next function by pressing **13** again to the next function and so on until the button **13** has not been pressed for about 5 seconds. The LEDs will then revert to constant light.

LED off: The push button **13** is not active, and nothing happens, when the button is pressed.

### 15 mSec. LED

When this LED is on, the result being shown on the display is indicated in milli-second units.

### 16 Hz LED

When this LED is on, the result being shown on the display is indicated in Hz units.

### 17 INPUT A LED

By continuous measurements of period time the LED will flash in time with the measurements as the input is opening and closing all the time.

### 18 FUSE HOLDER

Carries wire fuse (fine-fuse 250 volt/1 amp. slow) for the protection of 6 volt AC supply to IMPO photo units.

### 19 EARTH LEAD SOCKET

4 mm for connecting external equipment to the electrical earth (through the mains cable).

### 20 MAINS POWER SUPPLY CABLE

For connecting counter to 230 volt AC mains supply. Consumption approximately 60 VA. The counter has a built-in wire fuse for mains supply (0.35 amps. slow).

#### Additional test functions:

- Counter and display test:  
Turn off power **2**. Press the DISPLAY RESULT **11** push-button constantly and turn on the power **2**. The internal counters and the display circuit are now tested by the microprocessor.
- Program version number:  
Turn off power **2**. Press the DISPLAY RESULT **11** AND the FUNCTION SELECTOR **13** push buttons constantly and turn on the power **2**.  
The display will now show the version of the internal program memory.

## COUNTER AC7E

### Inputs

#### 4 Input A - electrical impulse

Red input: Positive signal terminal, DC-coupled to input amplifier, 1 Mohm input resistance, frequency range from DC to 2 MHz,  
sensitivity: DC - 100 kHz: Typ. 50 mV<sub>rms</sub>  
100 kHz - 2 MHz: Typ. 500 mV<sub>rms</sub>

Black input: GND (chassis)

#### 5 Input A - switch input

Blue input: + 8 Volt DC for switch, current = 1.7 mAmp.  
Black input: GND (chassis)

#### 6 Input B - DIN 6 pins for IMPO equipment

Cap: GND (chassis)

Pin 1: GND

Pin 2: + 8 Volt DC supply voltage for microphones, stroboscope accessories etc.

Pin 3: Input for photounit or mech. switch (as blue input #5)

Pin 4: 6.3 Volt AC supply voltage for photounit

Pin 5: 6.3 Volt AC supply voltage for photounit

Pin 6: Input for microphone etc.  
AC coupled input amplifier, 4.7 kohm input resistance,  
sensitivity 2 V<sub>rms</sub> (5 Hz - 20 Hz range)

#### 7 Input B - Electrical impulse

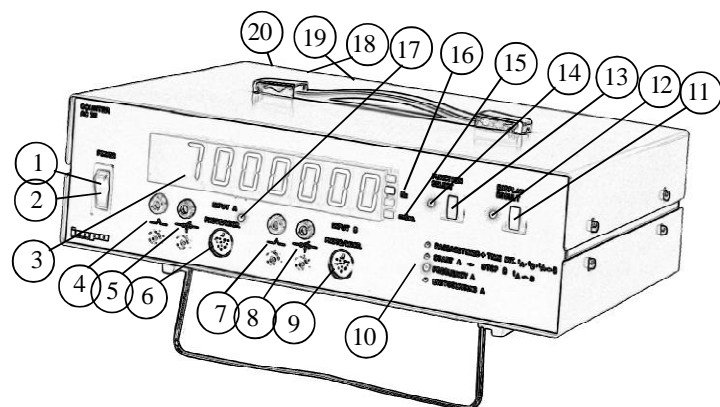
Red input: Plus signal input  
DC coupled input amplifier, 100 kohm input resistance,  
Sensitivity 2 Volt<sub>peak</sub>.

100 Volt maximum input voltage (DC + peak)

Black input: GND (chassis)

#### 8 Input B - same data as input A #5

#### 9 Input B - same data as input A #6



### AC7 summary

- 1 Pilot lamp for 230 volt AC mains.
- 2 Mains switch.
- 3 8-digit LED (light emitting diode) display.
4. Electrical impulse input A.
5. On/off switch input A.
6. DIN input A.
7. Electrical impulse input B.
8. On/off switch input B.
9. DIN input B.
10. Functions with LED indication.
11. Display Result push-button.
12. Display Result LED.
13. Function selector push button.
14. Function selector LED.
15. Milliseconds LED.
16. Kilocycles LED.
17. Input A LED.
18. Fuse holder for 6 volt AC wire fuse in DIN socket.
19. Earth socket for connecting chassis to earth.
20. Cable for connection to 230 volt AC 50-60 cycles mains supply.

# AC7E

## Interface user manual

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## 1. Introduction

The IMPO AC7E Counter is the most recent version of this high-performance universal purpose counter.

The fact that the counter is microprocessor-controlled enables counter-control to be entirely taken over by the serial interface. This opens up the way for entirely new and very exciting experiments, which have not previously been practicable within the framework of ordinary teaching.

## 2. Connecting the AC7E

The following is a description of how to use the counter with the serial interface. Reference is made to the general operating manual, where more detailed information is required.

### 2.1 Connection

A 25-pin „Cannon“ plug is located on the back of the counter. This is where to connect the cable from the serial port RS232C/CCITT V.24 of the computer.

The computer must be configured to:  
(see computer manual as to how)

1 start bit  
8 data bit (ASCII)  
no parity  
1 stop bit  
1200 baud (bit/sec.)

- if other bit rate (baud rate) is desired, the AC7E counter must be set to such.

The counter can now be switched on and will start up in function no. 1. The counter can then be programmed to the desired function. The functions and operating modes of the AC7E are the same as when manually operated using the push buttons on the front panel, except that read-out of the results on the display is different.

## 3. Programming

### 3.1 General

The AC7E should be programmed (set) to the desired function with the appropriate commands, which are described below.

The function LEDs will light up by way of a check for the selected function, but the actual function selector key will not be functional. The Display Result pushbutton will be active as normal, except where it has been programmed not to function using the command „R“.

Programming is done by sending the counter a command, such as „F4“ in the following way with Basic (or whatever language the computer works in): PRINT#2, „F4“, if it is port#2 which is opened as serial output port.

## 4. Commands

4.1 **F1** Function 2: Passage time + run-time  $t_A$ ,  $t_B$ ,  $t_{A-B}$

4.2 **F2** Function 3: Start A - Stop B  $t_{A-B}$

**F** Deletes read-out and prepares for new start-stop measurement.

### Definitions:

Range: From the smallest value to the biggest that gives a correct result.

Resolution: The smallest change (difference) that can be read from the result caused by a minimum change in input signal.

Accuracy: The extent to which the result deviates from the correct value.

**Counter AC7E data****Input data (input A and B):**

|                         |          |   |
|-------------------------|----------|---|
| Range,                  | input A: | DC to 2 MHz   |
| Sensitivity,            | input A: | Typ. 50 mV <sub>rms</sub> to 100 kHz<br>Typ. 500 mV <sub>rms</sub> to 2 MHz |
|                         | input B: | Typ. + 2 volt peak  |
| Input coupling:         |          | DC  |
| Impedance,              | input A: | 1 M ohm with abt. 100 pF in parallel  |
|                         | input B: | 100 k ohm   |
| Attenuator,             | input A: | automatic gain control (AGC)  |
|                         | input B: | fixed gain  |
| Trigger level:          |          | abt. 2/3 of signal peak value   |
| Trigger slope:          |          | negative slope  |
| Voltage range, input A: |          | 50 mV <sub>rms</sub> to 250 V <sub>rms</sub>                                |
|                         | input B: | 2 V <sub>peak</sub> to 100 V <sub>peak</sub>                                |

**Passage time + Time delay  $t_A$ ,  $t_B$ ,  $t_{A \otimes B}$ :**

|   |  |
|---|--|
| Range:                                    | 10 m secs. to 100 secs.  |
| Resolution:                               | 10 $\mu$ secs. in 1 m sec. to 1 sec. range<br>100 $\mu$ secs. in 1 sec. to 10 secs. range<br>1 m sec. in 10 secs. to 100 secs. range |
| Results stored:                           | 3 timings  |
| Results read-out                          | Successive read-out of the 3 numbered results with up to 5 significant digits.   |
| Time unit:                                | „m sec.“ indicated by decimal point on display   |
| Overflow indication<br>at $t > 100$ sec.: | Results flashing   |

**Start A  $\otimes$  Stop B  $t_{A \otimes B}$ :**

|                   |  |
|-------------------|--|
| Range:            | 10 $\mu$ sec. to 100 sec.                                    |
| Resolution:       | 10 $\mu$ sec.  |
| Results read-out: | continuous read-out of count with up to 7 significant digits |
| Time unit:        | „m sec.“ indicated by decimal point                          |

**Frequency A**

|                       |  |
|-----------------------|--|
| Counting technique:   | Reciprocal counting technique                        |
| Range:                | 0,01 Hz to 2 MHz                                     |
| Resolution:           | 0,001 Hz to 1 Hz depending upon input signal         |
| Gate time:            | 1 sec. or 1 period of the input, whichever is longer |
| Start of measurement: | Continuously automatic or manual single start        |

**Impulse counting A:**

|                           |  |
|---------------------------|--|
| Range:                    | 0 to 2 x 10 <sup>6</sup> impulses per sec.   |
| Gate control, man. start: | 1, 6, 10, 60 sec. as well as $\forall$       |
| Resolution:               | 1 impulse                                    |
| Read-out:                 | Continuous sum value. For the selected time. |

**General:**

|                    |  |
|--------------------|--|
| Display:           | 7 digits 7 segment red light emitting diode (LED) display 20 mm high |
| Temperature range: | 0° to +40° C   |
| Time base:         | 12 MHz crystal controlled time base                                  |
| Mains voltage:     | 230 V <sub>rms</sub> $\pm$ 10%<br>48 - 65 Hz<br>18 VA max.           |
| Weight:            | 5.0 kg   |
| Dimensions (mm):   | Width 350, height 105 (incl. support), depth 260                     |

If this command is given once measurement has started, the measurement is rejected.

- 4.3 F3** Function 4: Frequency A (single measurement) Measurement can be started with the „D“ command or by pressing pushbutton D.R. Repeat D“ when new measurement is required.
- D** Starts measurement.
- R** Puts Display result pushbutton on front panel out of function until the next command is executed.
- 4.4 F4** Function 6: pulse counting A
- .1 T0** Infinite counting with start/stop either by means of the „D“ command or D.R. pushbutton and continuous counting without zeroing-out first.
- .2 T1** Single measurement with a count time (gate time) of 1 second. Start with „D“ or by pressing D.R. pushbutton.
- .3 T2** Same as preceding, though count time is 6 seconds.
- .4 T3** Same as preceding, though count time is 10 seconds.
- .5 T4** Same as preceding, though count time is 60 seconds.
- .6 R** Puts D.R. pushbutton out of function until next command has been executed.
- .7 D** Start / Stop measurement.
- 4.5 F** Deletes read-out (display) and prepares for an experiment using the same function again.
- 4.6 D** In principle, performs same function as pressing Display Result pushbutton. The command is described under the functions for which it is used.
- 4.7 R** Puts Display Result pushbutton on front panel out of function until the next function has been executed. The command is described under the functions for which it is used.
- B** Baud rate command (ex. B1200). Valid values: 300, 1200, 2400, 4800, 9600.
- ?** Help menu text lines returned.
- V** Shows version number

**5 Interface Standard**

Serial communications acc. to standard RS 232C / CCITT V.24 interface.

Full programmable to the following bit rates:  
300, 1200, 2400, 4800, 9600 bit/sec. (basic setting 1200)  
Full-duplex communications.

## 6. Functions

### 6.1 Passage time + run-time $t_A, t_B, t_{A-B}$

- . 1 Make selection using the command „F2“. If the input signals (photo units) are OK, the input LEDs will remain constantly lit. Once the experiment has been concluded, the results will be ready for reading.
- . 2 The computer program used for reading can be a loop solution, or a straight forward one:
  - Read a result from AC7
  - Store the result in variable A
  - Read a result from AC7
  - Store the result in variable B
  - Read a result from AC7
  - Store the result in variable AB
- . 3 As will appear from the above, the results appear in the same sequence as shown on the front panel.
- . 4 Immediately the last result has been sent from the counter, preparation is automatically made for a new experiment.

### 6.2 Start A - Stop B

- . 1 Select the function using the command „F3“. In this function, enumeration is shown directly on the display, as when the counter is manually operated. When the time is stopped with input B, the result is ready for reading by the computer. The result remains on the display and the inputs are „locked“, as with manual operation, until the command „F“, which prepares the counter for the next time measurement, is received from the computer.
- . 2 There is only one result to be read in this function:
  - Read the result from AC7
  - Store the result in a variable AB

### 6.3 Frequency A

- . 1 Select the function using the command „F4“. The counter is now ready to receive a command „D“ which will initiate measurement. The D.R. push-button can be used to start a measurement, instead (as with manual operation of the counter). The D.R. push-button can, however, be put out of function with the command „R“, which renders the push-button ineffective until some other command has been executed (usually „D“).
- . 2 Once measurement has been started, i.e. the input port has been opened and there is a signal at the port, the counter cannot be interrupted while measurement is in progress. Only when the result of the single measurement is ready, the communication with the counter can be resumed. The result is shown on the display.
- . 3 The next measurement is begun, when the command „D“ is received (with D.R. push-button, if necessary).
- . 4 An example of a possible program structure:
  - Send command „F4“ to AC7.
  - DO UNTIL no more measurements are required:
    - Send command „D“ to AC7
    - Read result from AC7

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```

Store the result in variable HZ
Display variable HZ on monitor
Investigate whether more measurements are required
END DO

```

#### 6.4 Pulse Counting

- . .1 Select the function with the command „F6“.
 

The timer time must then be selected with the command „Tn“, where n is any number from 0 to 4. All numbers outside this range will be rejected by the counter.
- . .2 Infinite counting is selected with the command „TO“.
 

Start/stop is effected with the command „D“ or with the D.R. push-button, if this is not put out of function by the command „R“. After every stop, the result is ready for reading by the computer.
- . .3 Program structure:
 

```

Send command „F6“ to AC7
Send command „TO“ to AC7
DO UNTIL no more counts are required
  Wait here until counting is to be started
  Send command „D“ to AC7
  Wait here until counting is to be stopped
  Send command „D“ to AC7
  Read the result from AC7
  Display the result on the monitor
  Investigate whether or not more counts are required
END DO

```
- . .4 Select a timer time of 1 second using the command „T1“.
- . .5 Start single measurement using the command „D“ or with the D.R. pushbutton, if this is not put out of function by the command „R“. After one second, the result is ready for reading by the computer.
- . .6 Program structure:
 

```

Send command „F6“ to AC7
Send command „T1“ to AC7
DO UNTIL no more measurements are required
  Wait here until measurement is to be started
  Send command „D“ to AC7
  Read the result from AC7
  Display the result on the monitor
  Investigate whether more measurements are required
END DO

```
- . .7 Select timer time of 6 seconds using the command „T2“.
 

Same as above, except for count time, which is 5 secs.
- . .8 Select timer time of 10 seconds using the command „T3“.
 

Same as above, except for count time, which is 10 secs.
- . .9 Select timer time of 60 seconds using the command „T4“.
 

Same as above, except for count time, which is 60 secs.

... END ...

# USER MANUAL

## COUNTER AC7E

Version 1.1

