E01-631B-Y02

Photogate Electronic Timer Instruction

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Introduction：

The device is designed for the improvement of students with unclear concept, data errors or time-consuming analysis when conducting motion experiments.

The design is to work with the fundamentals -- Received data of the sensing time of the captured object passing through the same photogate more than two times and sensing time of two different photogates. Either the students will calculate the length based on the fense or the modes will self-analyze on the auto-calculated speed and accelerated speed. Consisting of millisecond ms, speed m/s, accelerated speed m^2/s and other auto-switched units. The minimum measuring value is $10^{-5}s$ which is 1/100,000 sec measuring accuracy.

Specification:

1. Model#：E01-631B-Y02
   Size：L25cm x W12cm x H5cm
   Monitor: seven-segment display
   Device: USB Photogate Channel - 5 sets & Computer Channel Port -1 set
   Button: Function Select x2 (next & previous button), Data Select x2 (next & previous button) , Reset, Stop Start, Switch off &Electromagnet button.
2. Power: 12VDC, 1A max DC power
3. Photogate (additional selection): compatible infrared photogate 3pcs maximum.
4. Internal part: Integral circuit board without jumper wire
5. Function: Time, Speed, Accel, Rotate and Count modes, subdivided into 14 function modes & self test
6. Time Range: 0.00001~9.99999 sec. Auto reset to continue timing repeatly.
7. Counting Range: 0~9999 times. Auto reset to continue counting repeatly.
8. Time Precision: $10^{-5}s$
9. Data display: Auto display, update every 3 seconds

Detail:

- One Gate & Two Gate: Infinite repeated sensing datasets
- Free Fall: Release the electromagnet, the timer synchronous measures the time between 3 photogates.
- Pendulum: Measure the period of 10 swings.
- Collision: 2 photogates individually memorize 2 data sets.
- Pulley&Frequencyc：60 timing intervals using a picket fence
- Frence：10 timeing intervals of uniformly accelerated linear motion using a picket fence (width: 1cm)
- Counting range: 0~9999 counts. Auto reset to continue counting repeatly.
- Power supply: Input 110VAC/60hz Output 12VDC，1Amax DC power

Instruction：

● **Main Function Select:**

1. **Function Button：**

   Press “Next” for the next mode, “Previous” for the previous mode.

   Seven-segment display on top of the display, total two digits.

2. **Data Button：**

   Press Next for the next data, Previous for the previous data.

   The data displays on bottom of the seven-segment display, total six digits.

   Data unit light on the right side of data.

3. **Reset：**

   Press to reset the data and reset the experiment.

4. **Stop and Start：**

   Stopwatch mode, first press to start timing, press again to pause, press third time to continue timing from the paused time and so on.

5. **Switch off ：**

   Electromagnet release for free fall experiment, press Switch off to release the electromagnet and start timing

● **〈Function & Data〉**

The digits on the top of the screen represent the function.

With function data button, before data measuring, the two digits on the upper row of the seven-segment display show the items of function.

With the data button after the capture of data, the two digits on the upper row of the display: T for time, D for speed and others (Details on p3~p6), A for accelerated speed.

The type of data can be determined by the unit light.。

The six digits on the lower row of the display shows the data captured or the data after the calculation of microcomputer.

Err shows the measuring time over 9.99999 secs. displayed ⊓ for the circular ratio when using the function 8.

● **Unit light**

The four LED lights located on the right side of the data value of the display coordinate with each unit: and others.

Other units are differ from the measuring request of the modes. (details in the specification of the Function)

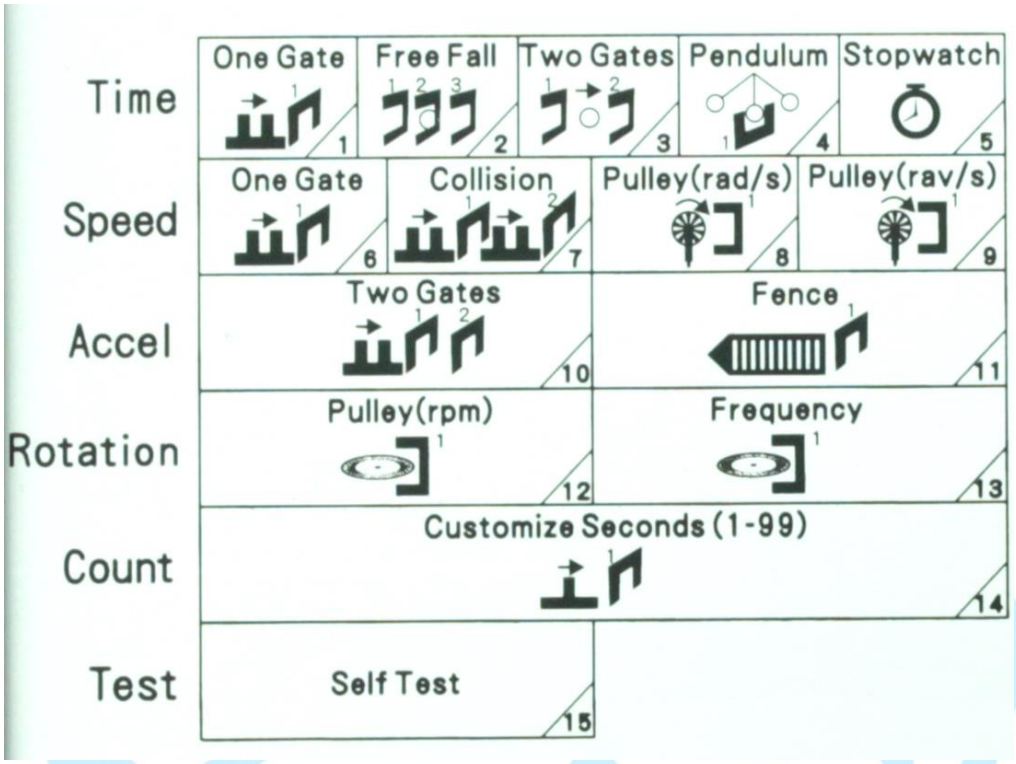
●Installation of photogates

Base on the different modes of the display, the amount of the photogate installations would be relatively different. (details in the specification of the function)

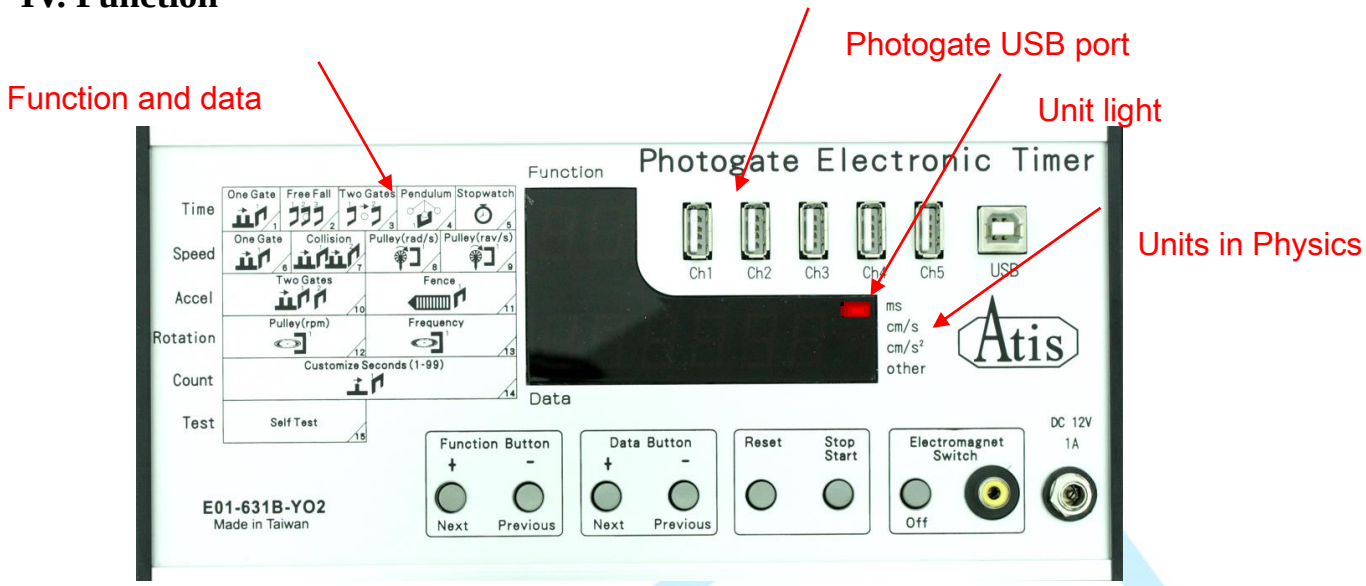
Generally, the installion will go by orders from Ch1 to Ch5 according to the amount of the photogates.

Currently, the maximum usage only requires 3 photogates, Ch4 and Ch5 will be used for the expansion update afterwards.

● **Function and data**



IV. Function



Timing function：	
Function 1：One Gate	
Instruction	Accessory：Photogate ×1, U-shaped fence Instruction：Combine the object with U-shaped fence to go through the photogate. Display：The time difference in two sensing processes. Note：Calculated speed V=L/T ， L：The interval distance of two sensing, L=1cm
Function 2：Free Fall	
Instruction	Use three photogates, the released positions from the fall after it's cut off of the electromagnet(em) to the positions of Ch1, Ch2 and Ch3. The passing through time by order: Steps: The usage of free fall must be synchronized with electromagnet. Setting up the device and reset. Press the electromagnetic button to cut off the power to release free fall. The time t0, t1, t2 after passing the positions Ch1, Ch2 and Ch3 display by orders. Take the distances H1, H2 and H3 between the photogate positions Ch1, Ch2 and Ch3 to the position of fall released, draw x-t diagram and do linear analysis or other ways to get the accelerated gravity speed value g. Reset and set up the device once again to capture the data. Note：1. Arrange the photogates to sense in order - Ch1、Ch2、 Ch3。 2. Auto power cutoff in 30 secs for protection, in case the electromagnet gets too hot and damaged. Accessory：photogatesx3, electromagnet , steel ball Steps：Reset to zero. The installation for photogates from up to bottom by orders

	and synchronized with electromagnet. Press the switch to cut off the power of electromagnet to release the steel balls to pass through the photogate by order.

Function 3：Two Gate	
Instruction	Use two photogates to show the interval time of the sensing. Note that the sensing run by orders: Ch1, Ch2. One set of data memory. Indefinitely repeated induction. Applicable experiments: pendulum experiment
Function 4：Pendulum	
Instruction	Use a photogate to measure the period of the simple harmonic motion of pendulum or object on the spring. One cycle for the passing through the gate back and forth three times. The timer can record ten data sets. One data set display each time. It can be used for Pendulum experiment. **Measuring range**：Maximum cycle time is not more than 9999.99(ms) **Note:** For pendulum experiment, not to release the pendulum object before pressing the reset button. Only release afterwards and measure the cycles.
Function 5：Stopwatch	
Instruction	Press Start to start timing, press Stop to stop timing. Press Start to continue timing. One data set display. **Measuring range**：0.01~9999.00 (ms)，skip shift automatically 10000.0~99999.9 (ms) Auto reset and count continuously.

Speed function	
Function 6：One Gate	
Instruction	The method is to fix the fence on the moving body and make the fence sensed by the photogate twice to obtain the time difference T and the velocity V = L / T. Use the value L to calculate the velocity V = L / T. t0= time difference T, d1=velocity V. One set of data memory. Indefinitely repeated induction. Applicable experiment: Newton's laws of motion. **Note: L= the value of the velocity calculated by the width of the U-shaped fence 1 cm**

Function 7：Collision	
Instruction	Use two photogates and a U-shaped fence to do elastic collision or non-elastic collision experiments. We use a motion cart to collide a static cart, the mass of the carts can be the same or not. The motion cart should be put outside the two photogates and the static cart should be placed in between the two photogates. Fix the U-shaped fence on the cart, during the motion, we can obtain the time difference T. By measuring the width L of the fence, we can calculate the instantaneous velocity V=L/T when the cart passes through the photogate. t0= The time difference of photogate Ch1 by the 1st time t1= the time difference of photogate Ch1 by the 2nd time t2= the time difference of photogate Ch2 by the 1st time t3= the time difference of photogate Ch2 by the 2nd time d1= the instantaneous velocity of photogate Ch1 by the 1st time d2= the instantaneous velocity of photogate Ch1 by the 2nd time d3= the instantaneous velocity of photogate Ch2 by the 1st time d4= the instantaneous velocity of photogate Ch2 by the 2nd time **L= the value of the velocity calculated by the width of the U-shaped fence 1 cm** To get the accurate data, the collision will only take place after the static cart go through the photogate for sensing. Applicable experiments: collision motion experiment ****The speed is calculated by the build-in U-shaped fence with the width 1.5cm.** **The interval distance of the two sensing L = 1cm.**

Function 8：Pulley（rad/ s）	
Instruction	Light unit is 1 / s, π is displayed on the screen, represented by the symbol ㄇ. For example, 2 ㄇ means the speed is 2π / per second, which also means that it takes one second to make a revolution. Applicable experiments: centripetal force experiment
Function 9：Pulley（rev/ s）	
Instruction	Use a photogate and a fence of a cycle of 10 times, and fix the fence on a moving body. Because the data updates every three second, this is more suitable for stable frequency measurements. The light unit is rev / min, and rev means revolution. Applicable experiments: centripetal force experiment

Accelerated speed function:	
Function 10：Two Gate	
Instruction	Use two photogates U-shaped fence to measure the instantaneous time difference t1 and t2 (for calculating instantaneous velocity) and the interval time t3 (for calculating acceleration). t0 = the time difference of photogate Ch1 t2= the time difference of photogate Ch2 t3 = the time difference from Ch1 to Ch2. d1 = the speed when U-shaped fence passes through photogate Ch1 d2 = the speed when U-shaped fence passes through photogate Ch2 A1= the acceleration of Ch1 and Ch2 Applicable experiment: Newton's laws of motion ****The speed is calculated by the build-in U-shaped fence with the width 1.5cm.** **The interval distance of the two sensing L = 1cm.** Thus, D value sensing interval distance 1cm, calculate the speed and A value accelerated speed.
Function 11：Fence	
Instruction	Use a photogate and a 10-grid fence to do linear motion, and measure the interval time. The grids of the fence are from t0-t9, and the width is 2cm. We use these known values to calculate the speed d0 to d9 and the acceleration a1 to a9. Applicable experiments: free fall, Newton's laws of motion.

Rotation function	
Function 12：Pulley(rpm)	
Instruction	Use a photogate and a fence of a cycle of 60 times, and fix the fence on a moving body. Because the data updates every one second, this is more suitable for stable frequency measurements. The light unit is rev / min, and rev means revolution. Applicable experiments: centripetal force experiment.
Function 13：Frequency	
Instruction	Use a photogate and a fence of a cycle of 60 times, and fix the fence on a moving body. Because the data updates every one second, this is more suitable for stable frequency measurements. The light unit is Hz. Applicable experiments: centripetal force experiment.

Counting function	
Function 14：Customize seconds (1-99)	
Instruction	Set up the time of count down in 1~99 sec. Use a photogate Ch1 to calculate the amount of the sensing time in the count down after passing through the photogate synchronously. Range: 0~9999 Reset automatically and continue to count repeatly after it reaches 9999 times.

Test function	
Function 15：Self Test	
Instruction	The numbers are from 0 to 9. ms represents unit light number 1; cm/s represents unit light number 2; cm^2/s represents unit light number 3; other represents other unit light numbers.

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