



**SS20120
20-MEMORY TIME COUNTER**

1. INTRODUCTION

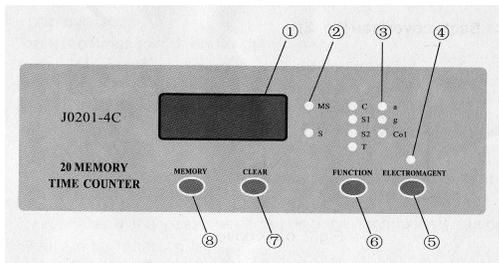
The model SS20120 20-Memory Time Counter is a general-purpose laboratory timer-counter. In conjunction with the included photogate sensors, it performs a variety of pre-programmed counting and event timing functions to facilitate calculation of such physical quantities as position, velocity, and acceleration. The unit features a 20-event memory so that data collected during an experiment may be reviewed and recorded. It is primarily intended for use in classroom demonstrations of such phenomena as uniform motion, accelerated motion, conservation/exchange of momentum, harmonic motion, and free-fall.

2. TECHNICAL SPECIFICATIONS

- Input power: 120vac 60Hz
- Operating conditions: -10°C to +40°C, RH <85%
- Duty cycle: continuous
- Dimensions: 212mm x 176mm x 78mm
- Weight: ~930g (excluding photogates)
- Timing range: >0.2 millisecond to 999.9 seconds
- Timing resolution: to 0.01 milliseconds
- Counting range: 0 - 9999
- Over-range indication: "1"
- Memory capacity: 20 events
- Integrated control for electromagnetic ball release
- Included accessories: qty (2) infra-red photogate sensors with mounting brackets

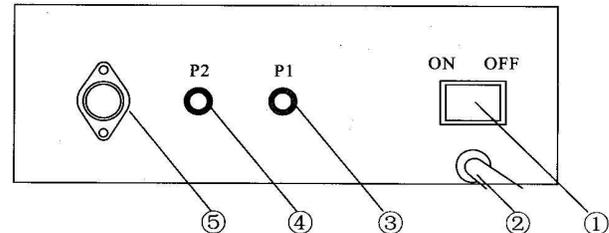
3. CONTROLS AND CONNECTORS

3.1 Front Panel



- (1) 4-digit display
- (2) Range indicator LEDs (ms and s)
- (3) Function indicator LEDs
- (4) Electromagnet LED
- (5) [Electromagnet] pushbutton
- (6) [Function] pushbutton
- (7) [Clear] pushbutton
- (8) [Memory] pushbutton

3.2 Rear Panel



- (1) Power switch
- (2) Power cord
- (3) Photogate plug P1
- (4) Photogate plug P2
- (5) 5-pin DIN jack

4. PREPARATION FOR USE

- Step 1: Connect the two included photogates to the rear-panel receptacles P1 and P2. Both photogates must be connected, even if only one is to be used. (Alternately, if a free-fall experiment is to be performed, connect a 5-pin DIN plug from the apparatus to the rear-panel DIN jack. In this case, P1 and P2 must be vacant.)
- Step 2: Plug the power cord into a 120vac receptacle.
- Step 3: Turn the power switch to the "ON" position. The timer will execute a brief self-test. If the test passes, the timer will initially be in the "C" function, and the display will indicate "0". A disconnected or blocked photogate will cause an error code to be displayed, showing the number of the faulted photogate.

5. FUNCTIONS

5.1 Event Count (C)

This function is used to count successive passages of a single flag through one photogate. Either photogate P1 or P2 may be used, but both must be connected.

- Step 1: Connect both photogates. Position either one on the apparatus as appropriate.
- Step 2: Put the apparatus in its initial state.
- Step 3: Press the [Function] button repeatedly until the "C" function LED is illuminated.
- Step 4: Set the apparatus into motion. The timer display will increment with each successive passage of the flag through the photogate.
- Step 5: Press the [Clear] button to reset the display and re-initialize the function.

5.2 Interrupt Time (S1)

This function is used to measure the duration of a single passage (such as by a single flag) through one photogate. Either one or both photogates may be used, but both must be connected in either case. Data for the first 255 events are displayed as they occur, with the first 20 events stored in memory.

- Step 1: Connect both photogates. Position one or both on the apparatus as appropriate.
- Step 2: Put the apparatus in its initial state.
- Step 3: Press the [Function] button repeatedly until the "S1" function LED is illuminated.
- Step 4: Set the apparatus into motion. The timer will display the duration of each event as it occurs. If the duration of a single event exceeds ~1 second, event duration and event number will be displayed alternately.
- Step 5: Press the [Memory] button after all data has been collected. The timer will display the number of each event followed by the duration of that event, starting with the first event (C1) and incrementing up to display all stored data to a maximum of 20 events. After data for the last event is displayed, the process starts again at C1.
- Step 6: Press the [Memory] button to pause; press [Memory] again to resume.
- Step 7: Press the [Clear] button to clear the memory, reset the display, and re-initialize the function.

5.3 Interval Time (S2)

This function is used to measure the elapsed time between two successive passages (leading edge to leading edge, such as by a double flag) through one photogate. Either or both photogates may be used, but both must be connected in either case. Data for the first 255 events are displayed as they occur, with the first 20 events stored in memory.

- Step 1: Connect both photogates. Position one or both on the apparatus as appropriate.
- Step 2: Put the apparatus in its initial state.
- Step 3: Press the [Function] button repeatedly until the "S2" function LED is illuminated.
- Step 4: Set the apparatus into motion. The timer will display the duration of each event as it occurs. If the duration of a single event exceeds ~1 second, event duration and event number will be displayed alternately.
- Step 5: Press the [Memory] button after all data has been collected. The timer will display the number of each event followed by the duration of that event, starting with the first event (C1) and incrementing up to display all stored data to a maximum of 20 events. After data for the last event is displayed, the process starts again at C1. Press the [Memory] button to pause; press [Memory] again to resume.
- Step 6: Press the [Clear] button to clear the memory, reset the display, and re-initialize the function.

5.4 Oscillation Period (T)

This function is used to measure the elapsed time between every second passage (such as by a single flag) through one photogate, with two passages constituting one cycle. Cycle number is displayed as measurement proceeds, with cycle number updating with every other photogate passing (as with a pendulum). Either photogate P1 or P2 may be used, but both must be connected. Data for the first 255 cycles are displayed as they occur, with

the first 20 periods stored in memory.

5.4.1 Count-up timing

- Step 1: Connect both photogates. Position either one on the apparatus as appropriate.
- Step 2: Put the apparatus in its initial state.
- Step 3: Press the [Function] button repeatedly until the "T" function LED is illuminated.
- Step 4: Set the apparatus into motion. As the cycles progress, the timer will display the number of each cycle as it occurs, counting up, to a maximum of 255 cycles.
- Step 5: Press the [Memory] button after all data has been collected. The timer will display the number of each cycle followed by the duration of that cycle, starting with the first cycle (C1) and incrementing up to display all stored data to a maximum of 20 cycles. After data for the last cycle is displayed, the timer displays "n" and the total time for all cycles. The display starts again at C1.
- Step 6: Press the [Memory] button to pause; press [Memory] again to resume.
- Step 7: Press the [Clear] button to clear the memory, reset the display, and re-initialize the function.

5.4.2 Count-down timing

- Step 1: Connect both photogates. Position either one on the apparatus as appropriate.
- Step 2: Put the apparatus in its initial state.
- Step 3: Press the [Function] button repeatedly until the "T" function LED is illuminated.
- Step 4: To pre-select the desired number of cycles: Press and hold the [Memory] button. After two seconds, the display will start incrementing. Release the [Memory] button as the display reaches the desired number of cycles.
- Step 5: Set the apparatus into motion. As the cycles progress, the timer will display the number of each cycle as it occurs, counting down from the value set in Step 4. After the preset number of cycles is completed, the timer will immediately display from memory the number of each cycle followed by the duration of that cycle, starting with the first cycle (C1) and incrementing up to display all stored data to a maximum of 20 cycles. After data for the last cycle is displayed, the timer displays "n" and the total time for all cycles. The display starts again at C1.
- Step 6: Press the [Memory] button to pause; press [Memory] again to resume.
- Step 7: Press the [Clear] button to clear the memory, reset the display, and re-initialize the function.

5.5 Acceleration (a)

This function is used to determine the acceleration of a test body. Two photogates are mounted at fixed positions along the acceleration track. The test body is fitted with a double flag of known distance between leading edges. As the test body accelerates, it passes the first photogate at low velocity, continues along the test track, and passes the second photogate at higher velocity. The timer measures the interval times at the photogates, and the interval time between the two photogates. The velocity at either photogate may be calculated by the formula $v_n = d_{flag} / t_n$. The acceleration of the body may then be calculated by the formula $a = (v_2 - v_1) / t_{1-2}$.

- Step 1: Connect both photogates. Position them on the apparatus as appropriate.
- Step 2: Put the apparatus in its initial state.

- Step 3: Press the [Function] button repeatedly until the "a" function LED is illuminated.
- Step 4: Set the apparatus into motion. After the test body passes the second photogate, the data will be displayed sequentially as follows:
- 1 (photogate 1)
 - xxx (time interval for first photogate)
 - 1 - 2 (between photogates 1 and 2)
 - xxx (time interval between the two photogates)
 - 2 (photogate 2)
 - xxx (time interval for second photogate)
- The display then will return to 1 and continue cycling. Note: pressing [Memory] does *not* pause the display in this mode.
- Step 5: Press the [Clear] button to reset the display and re-initialize the function.

5.6 Gravitational Free-Fall (g)

This function is used to determine the acceleration of a free-falling steel ball using a vertical drop apparatus equipped with an electromagnetic ball release. The timer is equipped to supply power to, and control, the electromagnetic release. Two photogates are mounted at fixed positions on the apparatus such that the falling ball will pass through them. The timer begins timing when the ball is released, then measures the elapsed time from release to photogate pass-through for each photogate. The acceleration from release to either photogate passage may then be calculated by the formula $a = 2s/t^2$, where s is the distance from the ball release to the photogate. It should be noted that the ball release time (from button release to ball release) is not insignificant, and should be measured prior to test and subtracted from raw times, with these corrected times entered into calculations.

- Step 1: Connect the plug from the apparatus to the 5-pin DIN plug on the rear panel. Position the photogates on the apparatus as appropriate.
- Step 2: Press the [Function] button repeatedly until the "g" function LED is illuminated.
- Step 3: Press the [Electromagnet] button. Note that the "Electromagnet" LED illuminates. Hang the ball from the electromagnetic release.
- Step 4: Press the [Electromagnet] button again. As the button is *released*, the ball will drop from the electromagnet and pass through the photogates. After the ball passes the second photogate, the data will be displayed sequentially as follows:
- C1 (photogate 1)
 - xxx (time interval for first photogate)
 - C2 (photogate 2)
 - xxx (time interval for second photogate)
- The display then will return to C1 and continue cycling. Note: pressing [Memory] does *not* pause the display in this mode.
- Step 5: Press the [Clear] button to reset the display and re-initialize the function.

5.7 Collision (Col)

This function is used to determine the momentum of two test masses before and after impact. Two photogates are mounted at fixed positions along the test track. The test masses are fitted with double flags of known distance between leading edges. The test masses are then placed on the track, outside the photogates, and put in motion toward

each other so that they collide between the two photogates. Interval time is measured at each photogate passing. The velocity at either photogate may be calculated by the formula $v_n = d_{flag} / t_n$. Both elastic and inelastic collision can be investigated. In the case of elastic collision, the masses rebound off each other at impact, exchanging momentum according to $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$. In the case of inelastic collision, the masses remain coupled at impact and combine momentum according to $m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$.

Step 1: Connect both photogates. Position them on the track as appropriate.
Step 2: Put the test masses, fitted with double flags, at their initial positions on the track.
Step 3: Press the [Function] button repeatedly until the "Col" function LED is illuminated.
Step 4: Set both masses into motion toward each other. The masses pass their respective photogates, collide, and make final photogate passes. The data will be displayed sequentially as follows:

- 1.1 (initial pass of test mass past photogate P1)
- xxx (initial time interval for photogate P1)
- 1.2 (final pass of test mass(s) past photogate P1)
- xxx (final time interval for photogate P1)
- 2.1 (initial pass of test mass past photogate P2)
- xxx (initial time interval for photogate P2)
- 2.2 (final pass of test mass(s) past photogate P2)
- xxx (final time interval for photogate P2)

If the test masses pass P1 three times and P2 one time, interval time 1.3 will be displayed in place of 2.2.

If the test masses pass P1 one time and P2 three times, interval time 2.3 will be displayed in place of 1.2.

The display then will return to 1.1 and continue cycling. Note: pressing [Memory] does *not* pause the display in this mode.

Step 5: Press the [Clear] button to reset the display and re-initialize the function.