TIMING PRO LIGHT GATES

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TIMING PRO LIGHT GATES

Timing Pro Light Gates consists of a set of Primary and Secondary Light Gates with Bluetooth connectivity to a smart device or PC. The Primary Light Gate has built in timer, solenoid attachment port and two channels(Primary & Secondary) on which unlimited Secondary Light Gates can be daisy changed. It has several advanced features over the conventional Timer by making use of dedicated software on PC and apps for Android/iOS which graphically displays the blocked pulse as a function of time for two channels. The Primary Light Gate contains Micro-controller having crystal controlled time base to accurately measure the time with least count time resolution of 0.1millisecond. Communication between Primary and Secondary Light Gates as well as Primary Light Gate and Solenoid is carried on via wire link and that between the Primary Light Gate and Computer is made through wireless Bluetooth link.

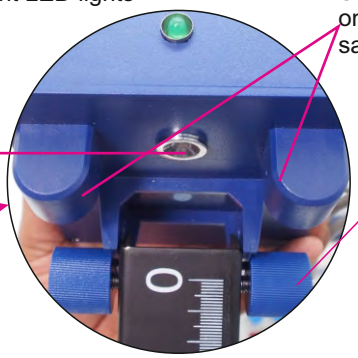
It can be used with Air track and Dynamic Trolleys to comprehensively study several experiments on kinematics and dynamics which requires light gate. An inbuilt rechargeable cell on Primary Light Gate provides power for the set-up. The Primary light gate also provides both power and trigger to an optional solenoid. Special circuits conserve battery power on the Light Gates and Solenoid. The solenoid has sensing circuits to detect object placed and then only energises the solenoid. The Solenoid winding has a resettable thermal fuse to prevent from overheating. The user-friendly software also contains templates for various experiments: Velocity, Acceleration, Collision, Picket Fence. 'g' by Free Fall and many more.

TIMING PRO LIGHT GATES

Attachment with *'g'* by Free Fall

Magnetic object like steel ball or dowel can be placed here. The solenoid circuit will sense it and hold it and the Object Present LED lights up.

Sensor detects object placed and then only energises the Solenoid thereby saving battery.



Knob to tighten solenoid box with *'g'* by Free Fall stand.

Solenoid

Object Present

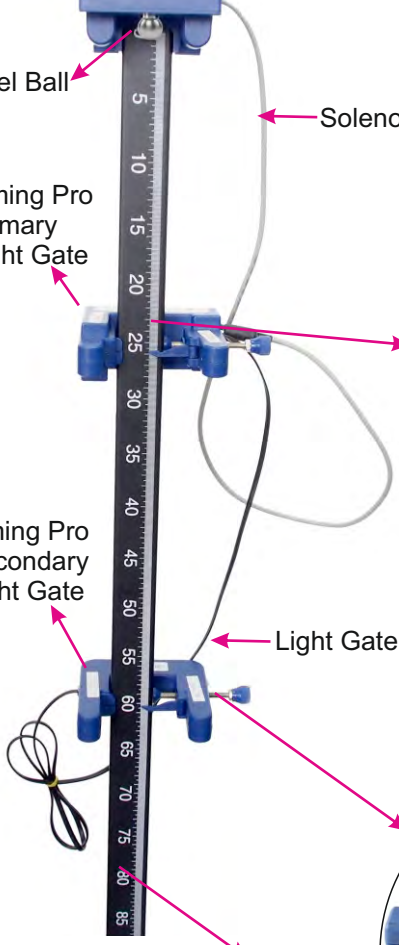
Steel Ball

Solenoid Cable

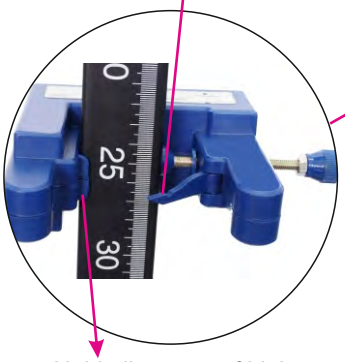
Timing Pro Primary Light Gate

Timing Pro Secondary Light Gate

Light Gate Cable

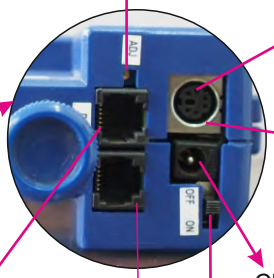


Pointer to read scale.



Hold alignment of Light Gate with *'g'* by Free Fall stand.

Sensitivity Adjustment Pot



Solenoid attachment port

Charging Port

Primary Light Gate port for attachment for additional Light Gates

ON/OFF switch

Primary Light Gate port for attachment for additional Light Gates

Align cable and insert

Sensitivity Adjustment Pot

Knob Screw to tighten Light Gate with *'g'* by Free Fall stand

Pointer to read scale

Hold alignment of Light Gate with *'g'* by Free Fall stand

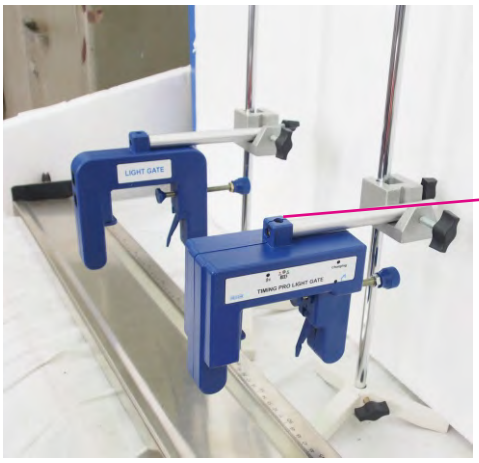
'g' by Free Fall Stand

Dual light gate connection ports allow daisy chaining

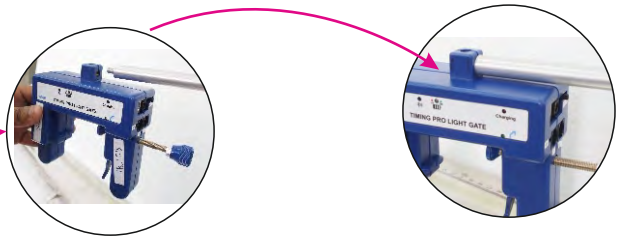
TIMING PRO LIGHT GATES

Easy fit attachments

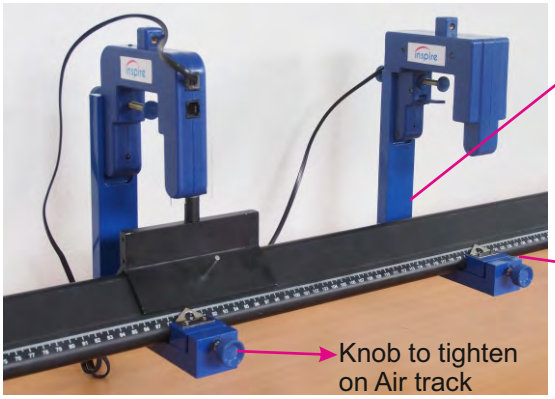
Timing Pro Light Gate with Rod attachment can be screwed in five orthogonal positions.



Rod can be screwed here

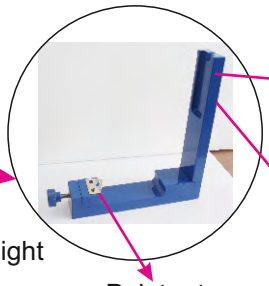


Timing Pro Light Gate with Inspire Air Track attachment maintain perfect alignment for experiments.



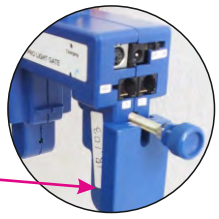
Knob to tighten on Air track

Accessories can be pressed attached and tightened with knob at desired location on Air Track



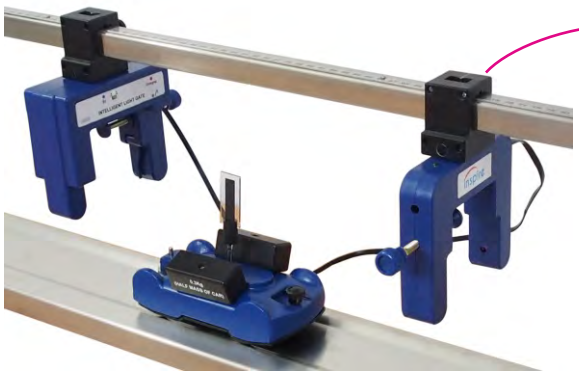
Air Track attachment for Light Gate

Pointer to read scale

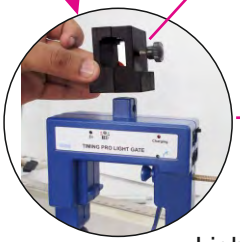


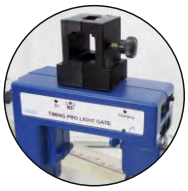
Slot on attachment to slide the Light Gates in position

Timing Pro Light Gate with Inspire Law of Motion Kit maintain perfect alignment for experiments.



Knob to tighten on track at desired location





Light Gate can be pressed and attached

FIRST TIME BLUETOOTH PAIRING

Please follow the steps below to pair the Light Gate(Primary) with the Smart device App.

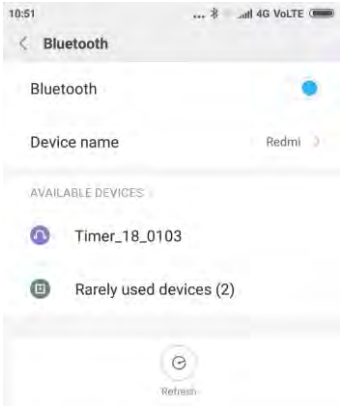
Power on the Timing Pro Light Gate. The LED on Light Gate starts blinking.

Go to Settings -> Bluetooth -> Turn Bluetooth On.

1. Tap Pair new device.

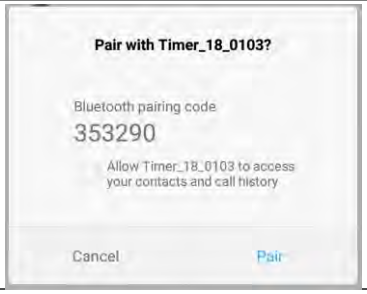
Note: If you don't see "Pair new device," you're running a different Android version. Look under "Available devices." If needed, tap More-> More and then Refresh.

2. Tap the name of the Timer device you want to pair with your phone or tablet. The name should appear in the following format : Timer_yy_srno.
3. Follow any on-screen steps.



A Bluetooth pairing request will appear with a pairing code. Tap on PAIR.

Timer will be paired.

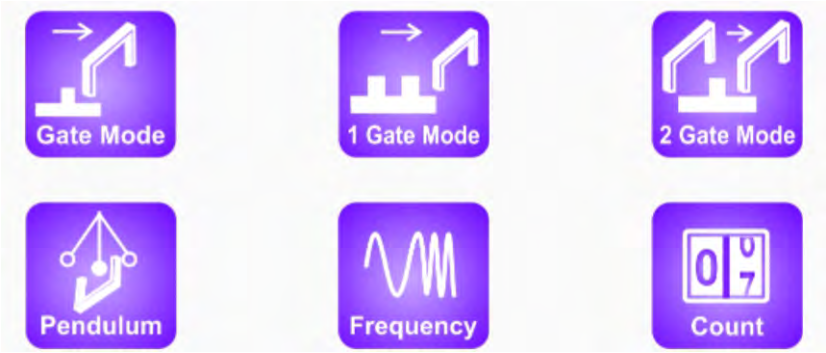


HOW TO START

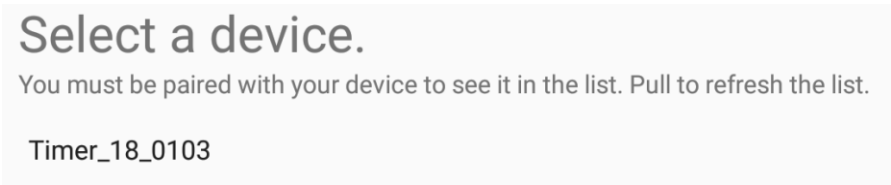
Please follow the steps below to pair the Light Gate(Primary) with the Smart device App.

Launch the Timing Pro Light Gate app. and select Basic version.

Tap any of the modes (say Gate Mode)



Tap the timer



The first screen will appear which shows an empty Data Table.

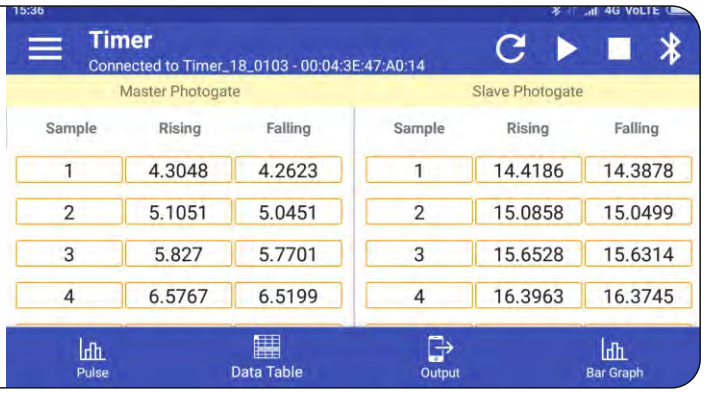
Click on ▶ **Start button** for data collection.

INPUT & OUTPUT DATA

Data Table Button:

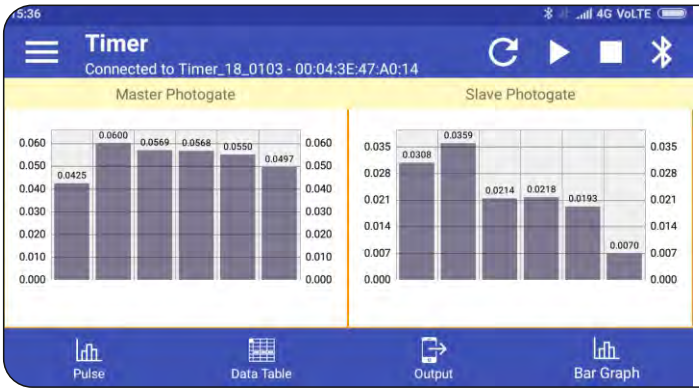
Interrupt both primary and secondary light gates for a few times.

Time data (time instant) of rising edges and falling edges of different interruptions at Primary and Secondary Gates will be displayed. Due to some bug, rising and falling data getting interchanged, which will be rectified later.



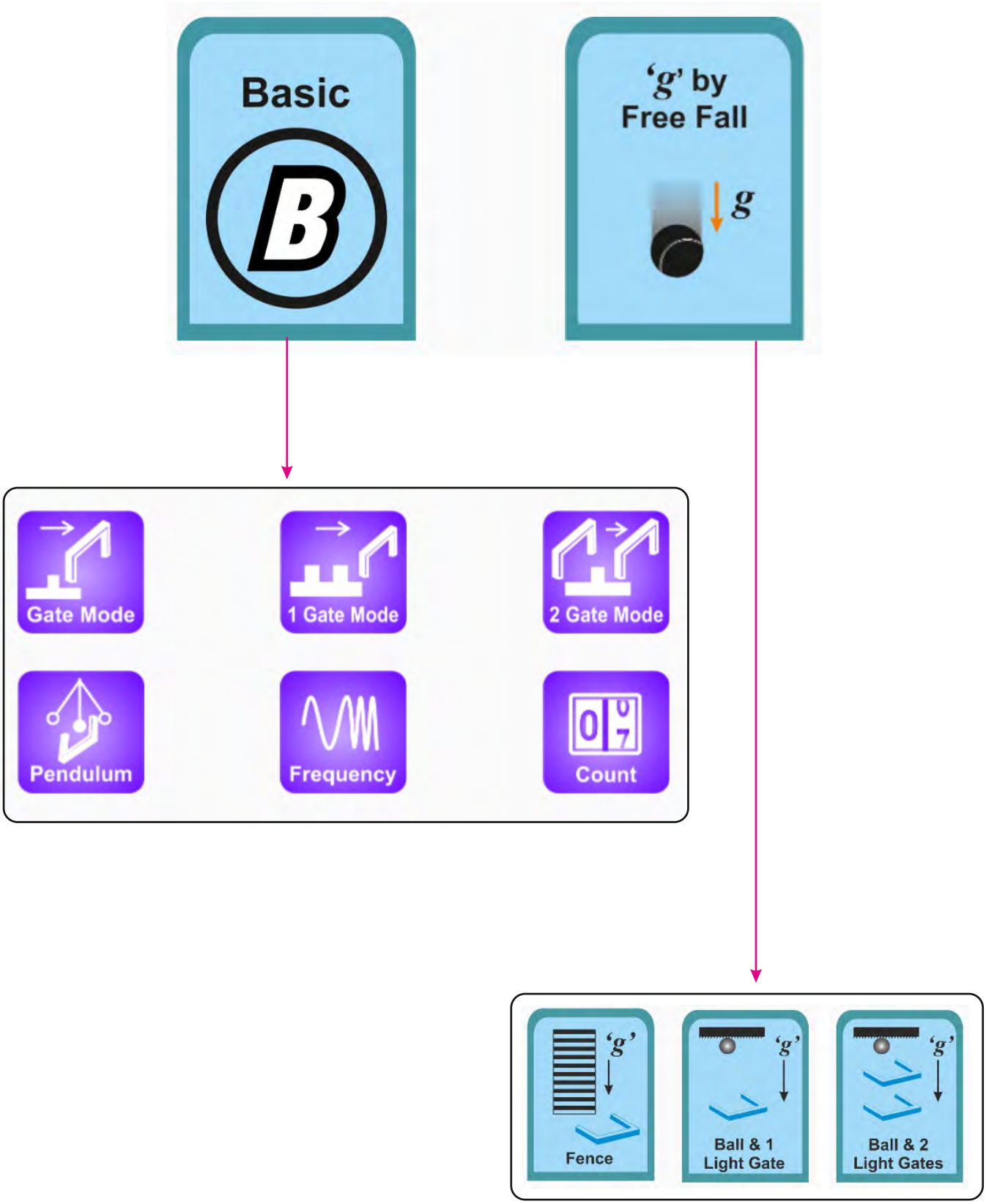
Tap on Pulse Button: It displays pulses at Primary and Secondary Light Gates corresponding to their blocking and unblocking states.

Tap on Output Button: It displays the output parameter value (in tabular form) as per the chosen mode.



Tap on Bar Graph Button: It displays the bar graph of output data.

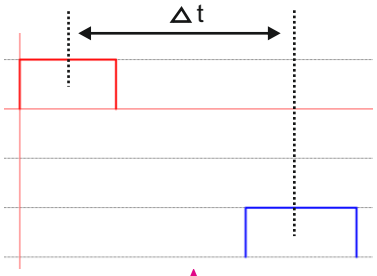
OPERATIONAL MODES



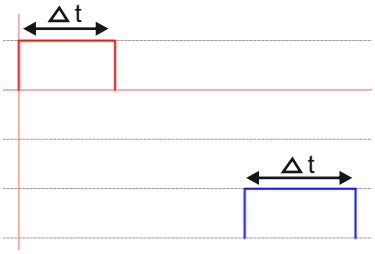
BASIC MODE

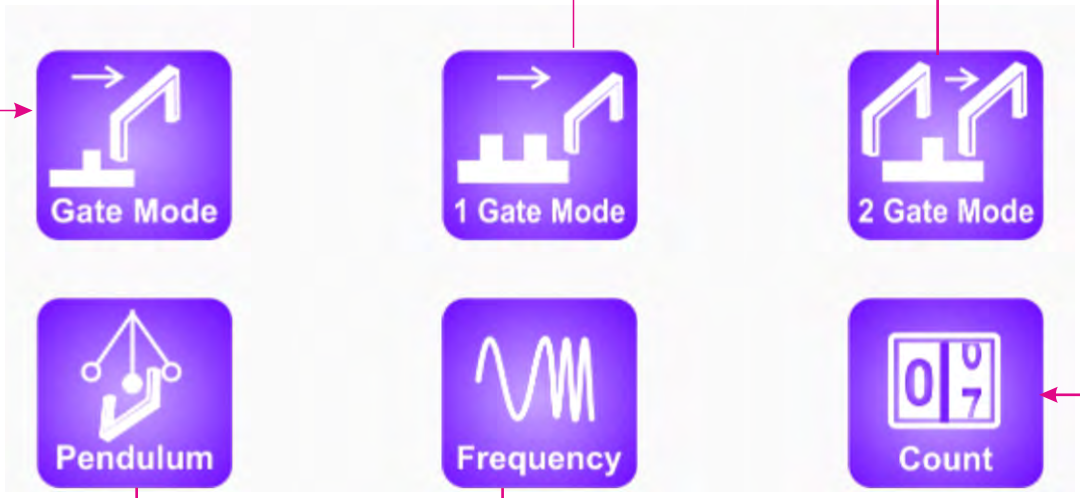
1-Gate mode: Time difference is measured from **Center** time (of rising edge and falling edge) of first interruption to the **Center** time (of rising edge and falling edge) of second interruption. Hence, the timer actually measures the **Centre** time between two successive blockings of the beam.

2-Gate mode: Time difference is measured from **Center** time (of rising edge and falling edge) of first interruption at one light gates to the **Center** time (of rising edge and falling edge) of second interruption at Second Light Gate. Hence, the timer actually measures the average time between two successive blockings of the beam at two different Light Gates.

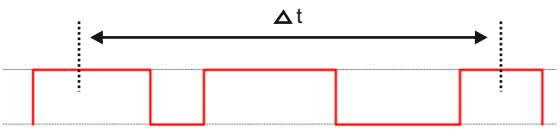


Gate mode: Time difference is measured from rising edge to falling edge.





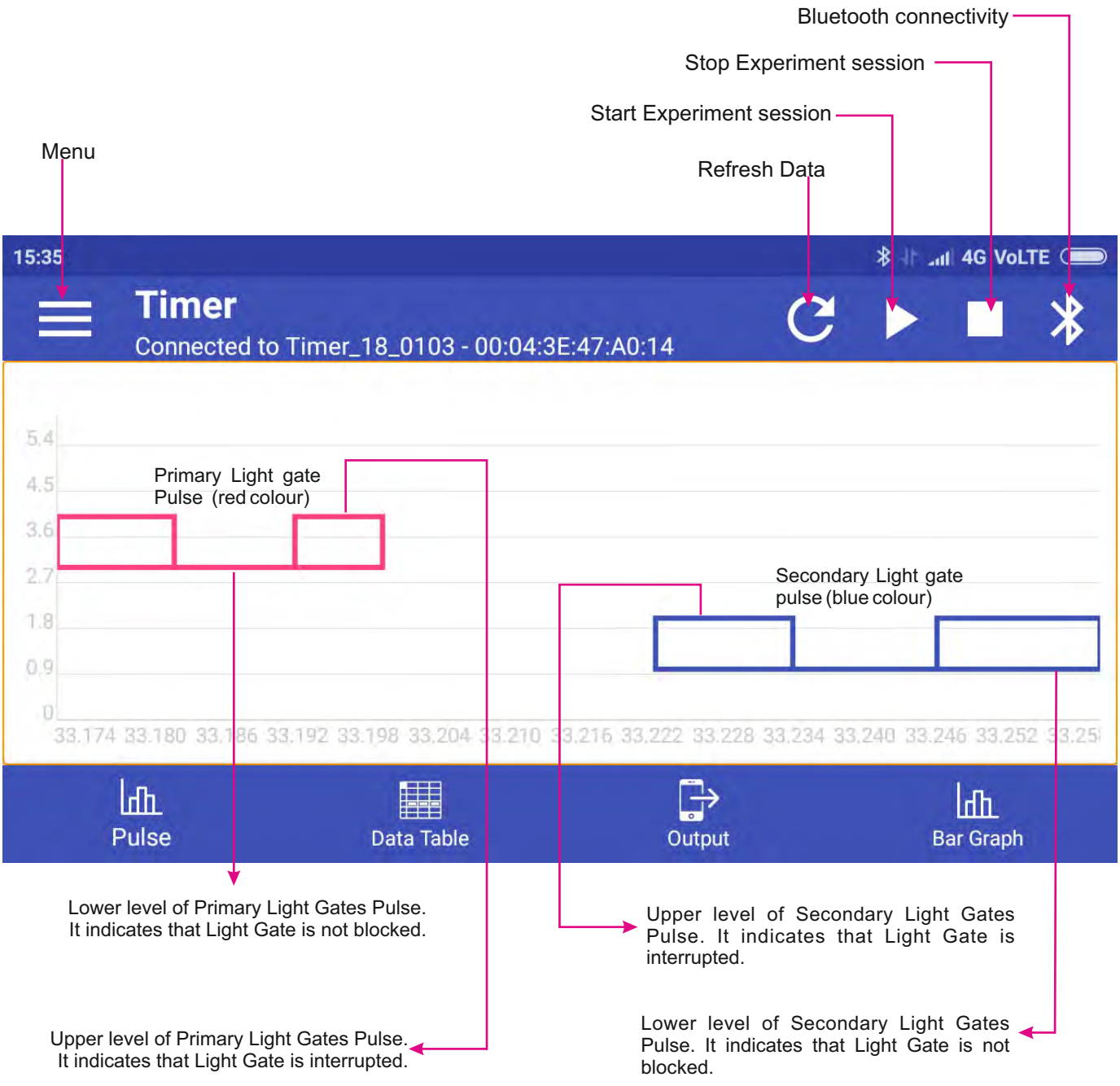
Pendulum: Pendulum Mode measures time between 1st and 3rd interruptions of the Light Gates beam i.e. from **Center** time (of rising edge and falling edge) of first interruption to the **Center** time (of rising edge and falling edge) of third interruption.



Frequency: Frequency Mode measures the number of interruptions per second of the Light Gate beam from leading edge of the first interruption to leading edge of the last interruption.

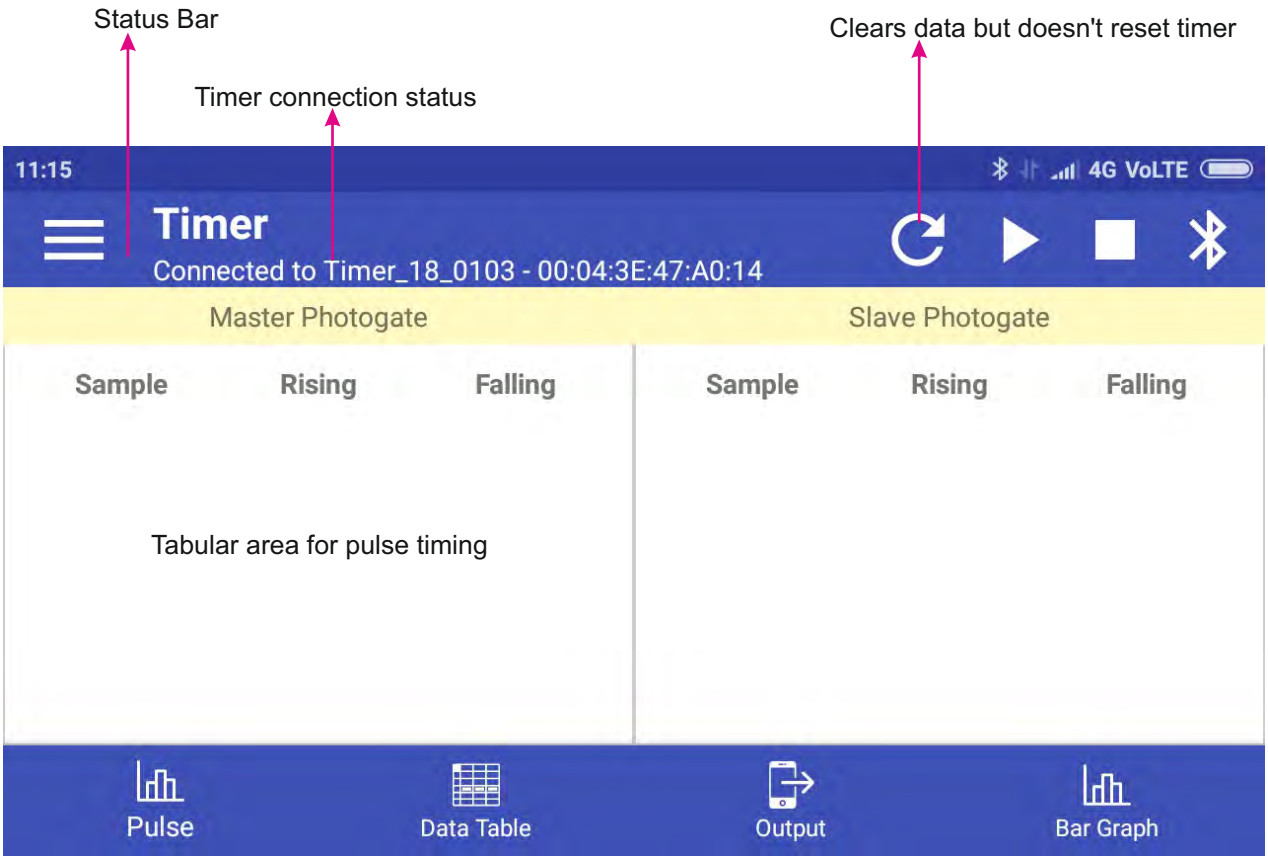
Count: This mode simply counts the blocking of photogates at regular intervals of time as specified by the user.

SCREENSHOT


Bluetooth connectivity
Stop Experiment session
Start Experiment session
Refresh Data
Menu
15:35
4G VoLTE
Timer
Connected to Timer_18_0103 - 00:04:3E:47:A0:14
Primary Light gate Pulse (red colour)
Secondary Light gate pulse (blue colour)
5.4
4.5
3.6
2.7
1.8
0.9
0
33.174 33.180 33.186 33.192 33.198 33.204 33.210 33.216 33.222 33.228 33.234 33.240 33.246 33.252
Pulse
Data Table
Output
Bar Graph
Lower level of Primary Light Gates Pulse. It indicates that Light Gate is not blocked.
Upper level of Secondary Light Gates Pulse. It indicates that Light Gate is interrupted.
Upper level of Primary Light Gates Pulse. It indicates that Light Gate is interrupted.
Lower level of Secondary Light Gates Pulse. It indicates that Light Gate is not blocked.

SCREENSHOT

Once timer is successfully connected with the app, it shows the connection status in the status bar. The bluetooth LED will remain in blinking state. To conduct experiment and observe readings, tap on the start button which restarts and activates the timer and the bluetooth LED on Timer glows in stable state. Interruptions on Primary and Secondary gates are recorded in the tabular area. After completion, you can stop by clicking on Stop button. The buetooth LED on light gate goes back to blinking state. However, timer remains connected to the app for current experiment session. Timer is disconnected when the bluetooth is turned off in the android device.

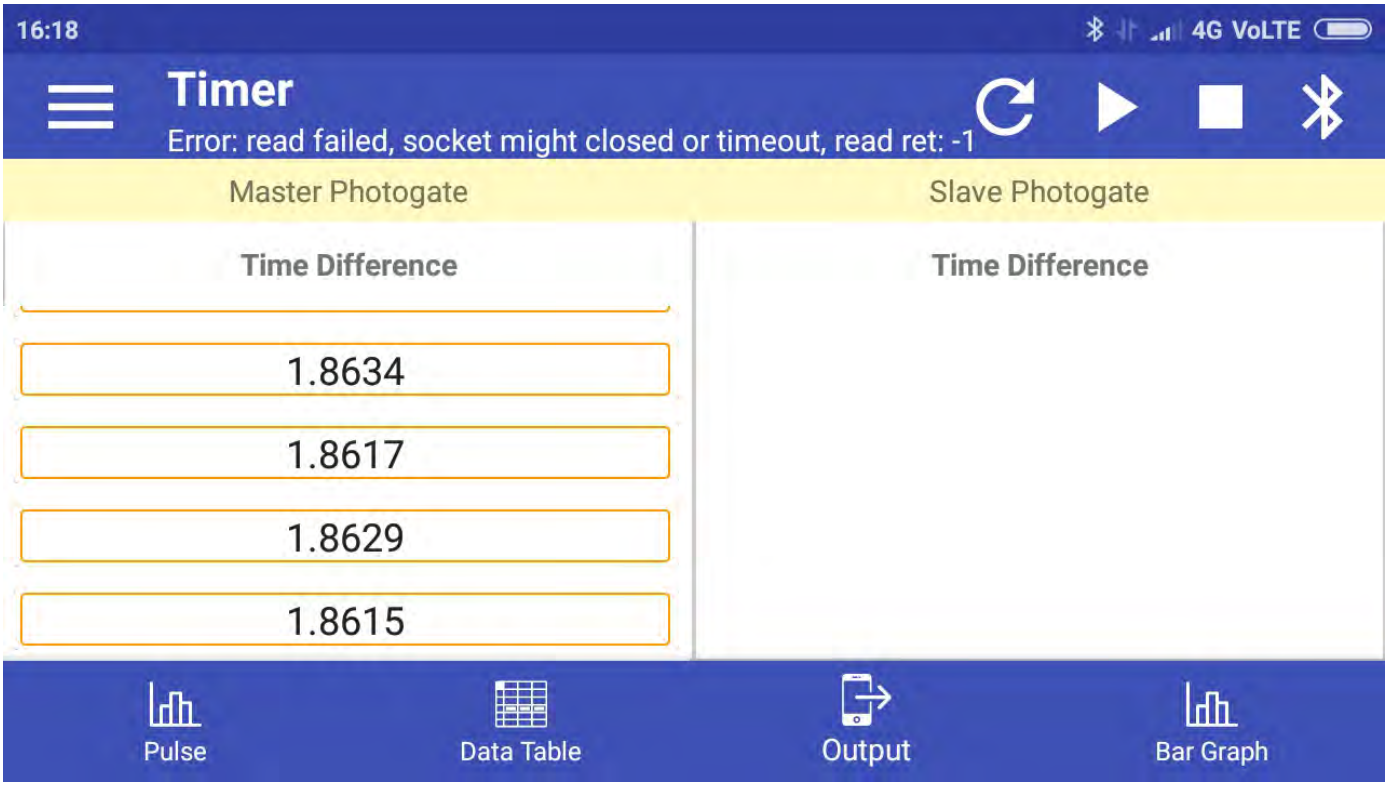


BASIC MODE: PENDULUM

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Or, $$g = 4\pi^2\frac{l}{T^2}$$

Substituting l = 0.858 m and T (Time period) = 1.86s in the above equation, we obtain g = 9.79 m/s^2



'g' USING FENCE

Follow these steps to find the 'g', acceleration due to the gravity using 10-b Picket Fence.

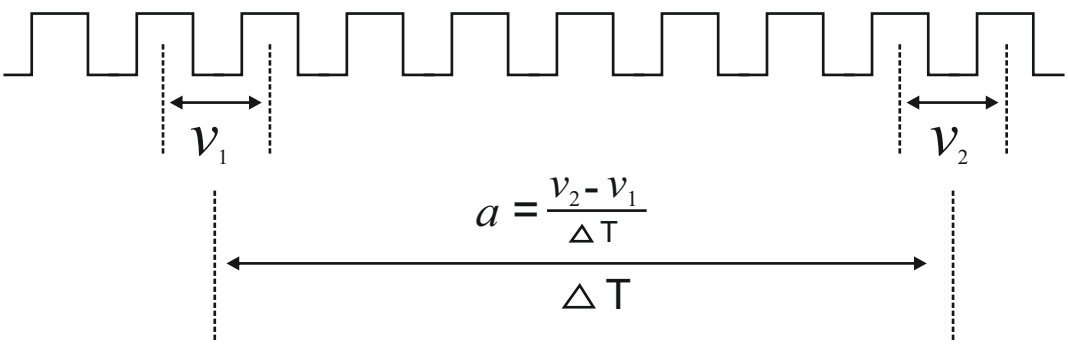
1. Switch on the primary light gate.
2. Go to **Basic** ⟶ **Gate Mode.**

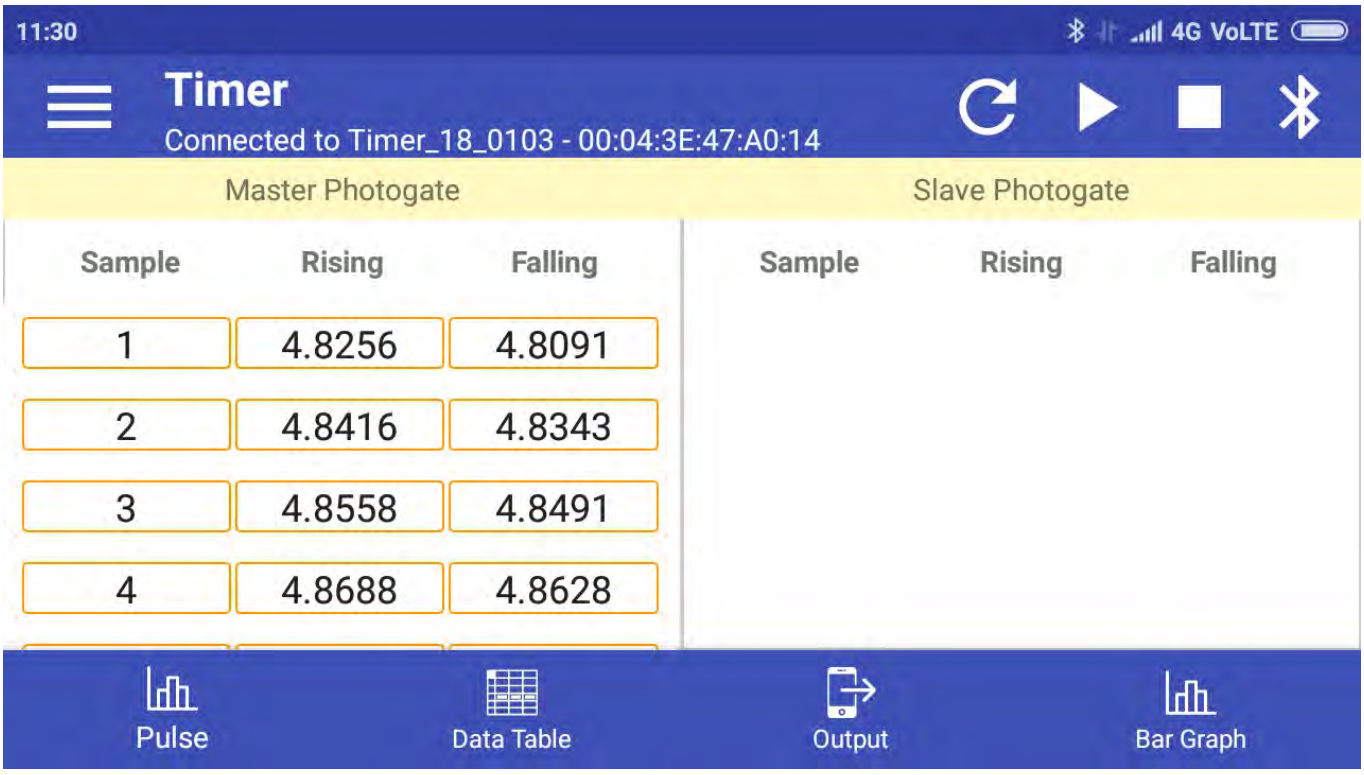
3. Click on Start.

4. Drop the Fence through the Light Gate.
   (a) You may drop the fence using hand as shown.
   (b) Alternatively, you may drop the fence using the solenoid mounted on 'g' by Free Fall Stand.
   Place the light gate at 40 cm mark in this case.

5. Data for different interruptions will be recorded in the data table. Scroll up/down along the screen to see all the data points.

6. Determine the acceleration by using the data in data table as demonstrated in the figure. For more clarity, see the sample data and sample calculation in the next page.





'g' USING FENCE

Sample No	Rising Time	Falling Time
1	4.8091	4.8256
2	4.8343	4.8416
3	4.8491	4.8558
4	4.8628	4.8688
5	4.8752	4.8809
6	4.8869	4.8921
7	4.8978	4.9027
8	4.9081	4.9128
9	4.9179	4.9224
10	4.9271	4.9316
11	4.9364	4.9458

Average time of 2nd pulse, $t_2 = \frac{(4.8343 + 4.8416)}{2} = 4.8380$ s.

Average time of 3rd pulse, $t_3 = \frac{(4.8491 + 4.8588)}{2} = 4.8525$ s.

Average time of 9th pulse, $t_9 = \frac{(4.9179 + 4.9224)}{2} = 4.9202$ s.

Average time of 10th pulse, $t_{10} = \frac{(4.9271 + 4.9316)}{2} = 4.9294$ s.

Initial velocity :

Average time of 2nd and 3rd pulse, $T' = \frac{(4.8380 + 4.8525)}{2} = 4.8453$ s.

Initial velocity, $v_1 = \frac{20\text{mm}}{(t_3 - t_2)s} = \frac{0.020}{(4.8525 - 4.8380)}$ m/s. = 1.379 m/s

Final velocity :

Average time of 9th and 10th pulse, $T'' = \frac{(4.9202 + 4.9294)}{2} = 4.9248$ s.

Final velocity $v_2 = \frac{20\text{mm}}{(t_{10} - t_9)s} = \frac{0.020\text{m}}{(4.9294 - 4.9202)s} = \frac{0.020}{0.092}$ m/s = 2.174 m/s

Acceleration $g = \frac{\Delta v}{\Delta T} = \frac{v_2 - v_1}{T'' - T'} = \frac{2.174 - 1.379}{4.9248 - 4.8453} = \frac{0.795}{0.0795} = 10$ m/s^2