

# DEC-101

## 5 Decade Counter Timer

### Helpful Hints

The frequency of the internal 1K Hz timer circuit of the DEC-101 may be set by turning the variable capacitor through the hole marked "ADJUST" turning the capacitor clockwise decreases the frequency, turning the capacitor counter clockwise increases the frequency.

An accurate method is to use a stop clock timer for a period of 100 seconds or more. A switch closure between the white -6 volt binding post on the APS-101 series Amplifier Power Supply and the white "Electronic Hold" jack on the DEC-101 will gate the counter off and on.

1. Plug in the DEC-101 to APS-100 (101)
2. Set count input switch to 1K Hz.
3. Set HOLD MODE switch to PULSE.
4. CONNECT TIMER BETWEEN white electronic hold jack and white -6V DC binding post.
5. Turn on APS-100 (101)
6. RESET counter.
7. BEGIN TIME CLOCK (which will start DEC-101)
8. Time for interval of about 100 seconds - stop time clock.

DEC-101 should have counted 1000 times the number of seconds on the time clock.

If DEC-101 has more counts than 1000 x time clock, turn capacitor at ADJUST hole clockwise.

If DEC-101 has less counts than 1000 x time clock, turn capacitor counter clockwise.

### RETEST STEPS 6-8

If a DEC-100 is available the  $\div 100$  output is an accurate gate signal to turn the counter off and on.

Set the DEC-100 to count at 120 Hz. Connect the  $\div 100$  output of the DEC-100 to the Electronic Hold of the DEC-101. Since the  $\div 100$  output starts and stops the DEC-101 every (1/1.2) seconds the DEC-101 should read 833 counts on a single on-off period. Multiple on-off periods of calibration allow more accurate timing.





## Introduction

The DEC-101 was designed to operate with the APS-101 Amplifier Power Supply. This all electronic five decade counter can act as a pulse counter, a timer or a scaler. As a counter it can count pulses at rates to 5MHz. The DEC-101 has an internal 1KHz count input for millisecond timing. An external adjustment allows calibration of this signal to better than within 1%. Once adjusted a 10°C temperature change affects the frequency by less than 1/2%. The counter has two control (hold) modes. The "pulse" mode allows the counter to act as an electric timer, switching the count on or off whenever the control signal is present. In the "gate" position a continuous count is available except when the manual hold button is depressed. The control signal can be applied either mechanically by depressing the manual hold or electronically by grounding the electronic hold. The DEC-101 provides a 450 volt pin jack output for the Geiger Tube (GET-100) making the unit a Geiger counter-scaler. A 24 VAC banana jack pair (or 12 volts from one pin to ground) operates the Light Source (LIS-100) or other accessories. The Light Source (LIS-100), with the Photocell (PHC-100) operating from the -6 volt binding post on the APS-101, provides a light timing gate to control the counter. The counter Reset switch resets the electronic decades to a zero count position. A divide by 10<sup>5</sup> jack provides an output voltage to trigger other counters. The count input switch allows for an internal timing of 1KHz or in the output position will count external pulses through the APS-101.

## Counting with the DEC-101 Counter/Timer

As a counter the DEC-101 will count pulses fed to and amplified by the APS-101 at rates up to 5 MHz. For all counting experiments the counter is set in the APS-OUTPUT position to record the pulses applied to the APS-101 input. When an external signal is applied to the APS-101 input it is amplified and appears at the APS-OUTPUT. The amplified signal is then fed through the connector to the counter and the counter will trigger for any input at the APS-101 (or change in DC offset) which causes the output to go lower than +.25 volts and above +1.05 volts. In effect then the counter is triggered on the "negative going" pulse. For example, if you have a maximum gain setting of 100 on the APS-101 and the DC offset at +.65 an output signal of  $\pm .40$  is required to initiate counting. Thus, the minimum input is  $\pm .40/100$  or  $\pm .004$  volts at the gain setting of 100.

In the gate position a continuous count is available except when the manual hold button is depressed. In the pulse position the count may be stopped and restarted by depressing and releasing the manual hold switch. The electronic hold allows an external signal to control the counting. In effect it provides access to the electronics of the counter by some outside source such as a photocell (PHC-100) or some remote switching device. For some counting experiments the photocell may be plugged into the electronic hold and the -6V binding post of the APS-101 or into the amplifier input and -6V binding post of the APS-101.

For most counting experiments the DC offset should be set at 0 or slightly negative. The gain control will have an effect on the counting rate. An excessive amount of gain will result in spurious counting due to the noise picked up by the counter. In general after the pulse source is applied to the APS-101 the counter may be set to the gate position. Increase the gain starting at zero until a continuous count is observed. The counter may then be used in either the gate or pulse position.

For further information see film loop FIL-100D Measuring Frequency.

The following diagrams show some common experiments using the DEC-101 as a counter.

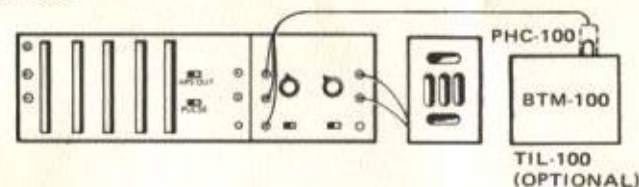


Diagram 1 Measuring the Frequency of Blinky

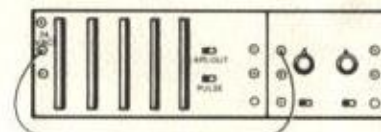
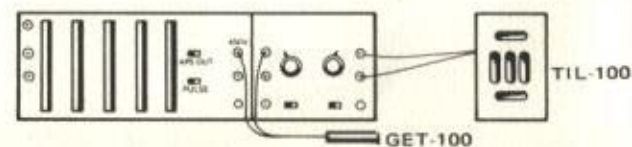


Diagram 2 Measuring Line Frequency



Note: Keep gain low and offset slightly positive. Suspend the Geiger Tube on a ring stand. Handling may introduce noise into the counter.

Other Suggestions:

Calibrating a Stroboscope

Diagram 3 Radiation Counting



## Timing with the DEC-101 Counter/Timer

The DEC-101 module with its 1 KHz internal time base, (or the DEC-100 with a 120 Hz Timebase) becomes an extremely useful tool whenever accurate time measurements are required. The 1 KHz counting signal allows a display of time in milliseconds. The timer may be controlled manually by depressing and releasing the manual hold switch. With the timer set in the pulse and 1 KHz positions a depression and release of the manual hold switch starts the timer and the next depression and release stops the timer. The timing may also be controlled electronically by inserting a photo-gating technique into the system. A photocell (PHC-100) is plugged into the electronic hold and the -6V binding post on the APS-101. A light source (LIS-100) is then plugged into the 24 volt jacks on the DEC-101. Now with the timer set in the pulse and 1 KHz positions an interruption through the photogate starts the timer and the second interruption stops it. In the gate position the timer will become activated as long as there is an interruption of the photo-gate. This mode can be particularly useful when used at the beginning of a timing experiment to determine exactly at what point the gate is interrupted. After this has been determined the pulse mode may be used to determine the elapsed time.

For all practical purposes when the DEC-101 is used as a timer the Gain control, the DC offset and the AC-DC switch are of little significance.

For further information see film loop FIL-100A Measuring Acceleration in Freefall and FIL-100C Measuring the Speed of Sound.

The following diagrams show some common experiments using the DEC-101 as a timer.

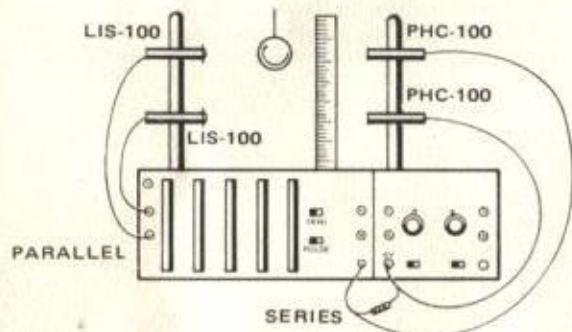
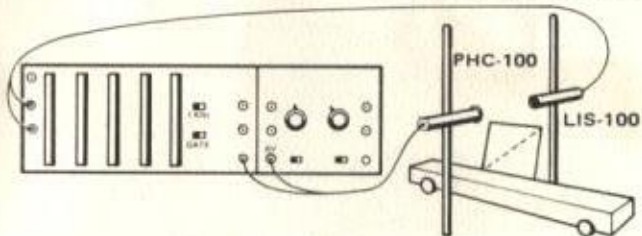


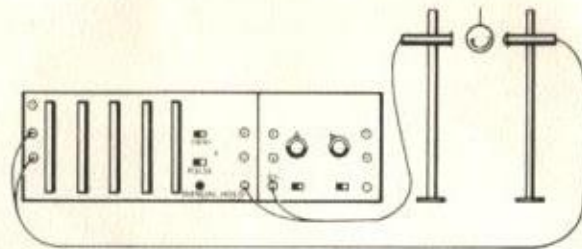
Diagram 1 Measuring Acceleration in Free Fall  $d = \frac{1}{2} at^2$

PAPER SAIL (20 cm. square) MAY BE CUT DIAGONALLY FOR SHORTER TIME INTERVALS.



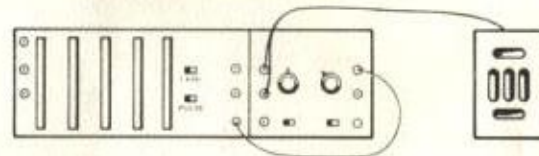
GLIDER WITH AIR TRACK  
PUCK WITH AIR TABLE  
CART WITH LOW FRICTION WHEELS

Diagram 2 Measuring Uniform Motion  $speed = distance/time$



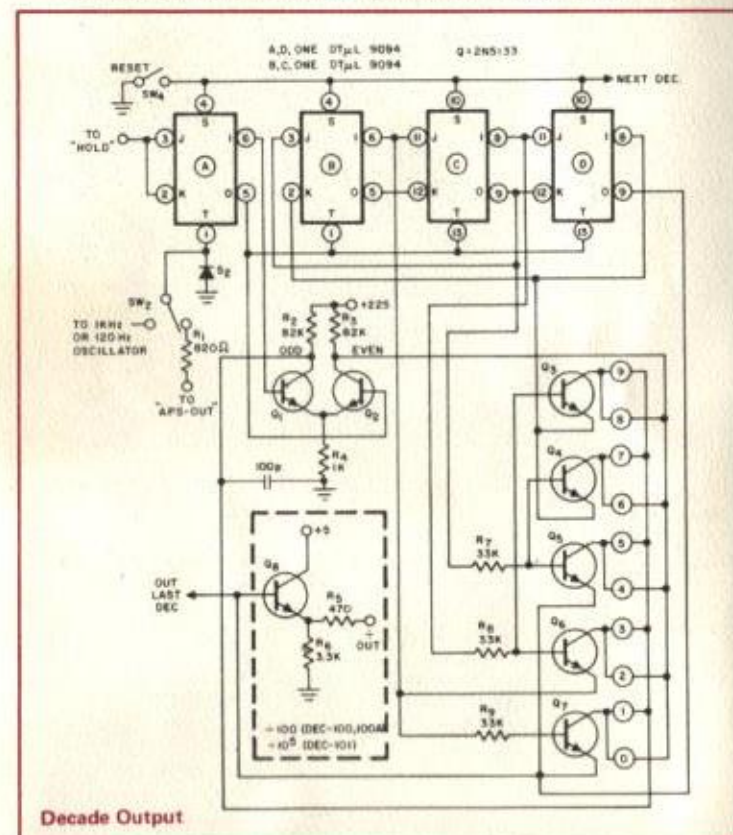
Note: After the pendulum has first interrupted the photo-gate and pulsed the counter on depress the manual hold switch overriding the photo-gate so that the counter will not pulse off as the pendulum swings back through the gate. Release the manual hold switch and let the pendulum pulse the counter off after one complete oscillation. You may depress the manual hold switch after one oscillation to keep the counter in an off position for easy reading.

Diagram 3 Measuring the Period of a Pendulum



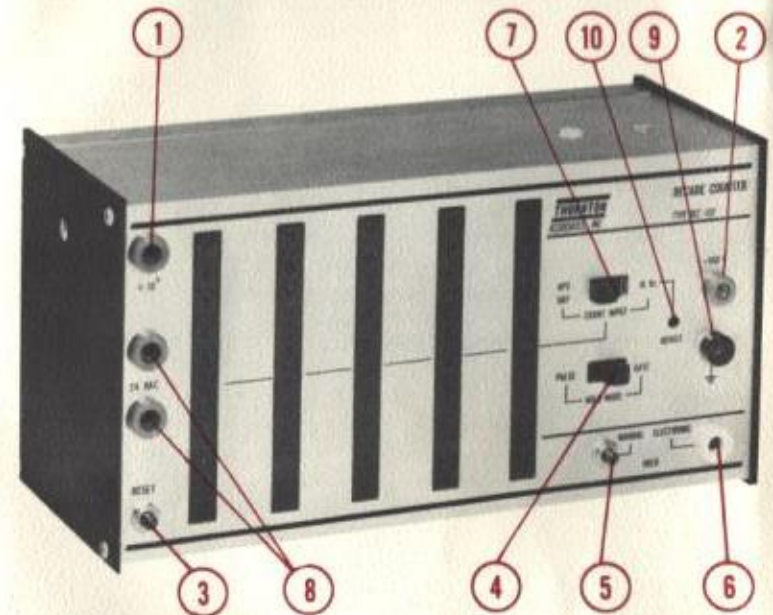
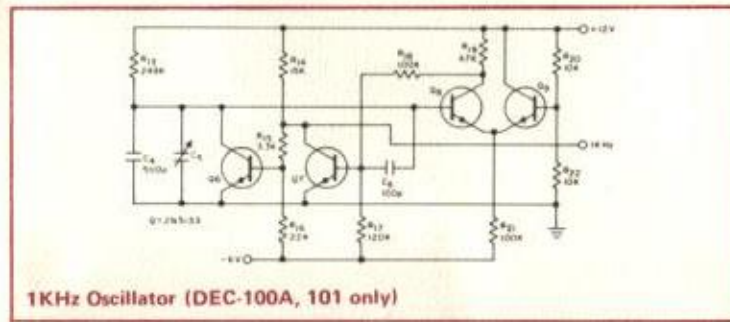
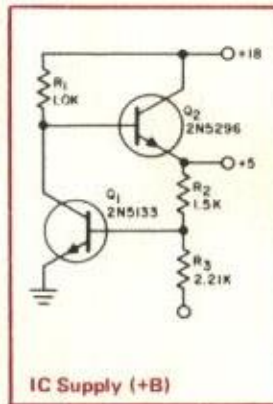
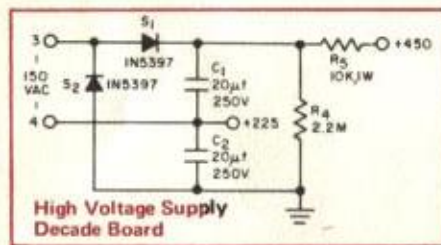
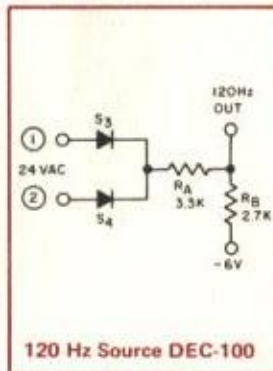
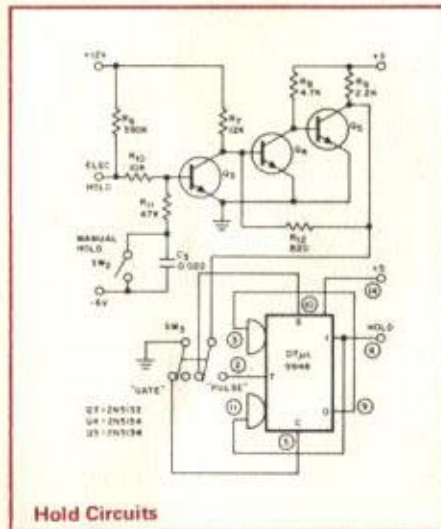
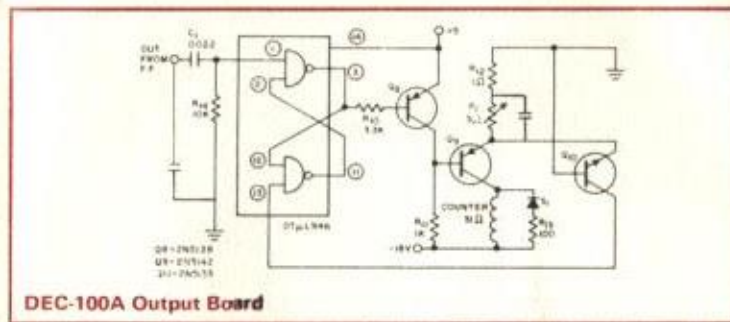
Note: Activate the timer by clapping, snapping fingers, speaking, etc. Determine the time between two successive sounds.

Diagram 4 Using a Speaker or Microphone to Activate the Timer



Decade Output





### Description of DEC-101 Controls

- $\div 10^5$  OUTPUT: When all five decades are full (counts of 99999) the next input signal returns the count to zero. At this time a 1-2 volt pulse is produced at the  $\div 10^5$  output. A Loudspeaker, or Voltmeter, or Oscilloscope connected between this output and ground can be used to detect the pulse.  
If you need to count at a higher rate you could –  
a. Feed the  $\div 10^5$  pulse into a second decade scaler  
b. Use the  $\div 10^5$  pulse with a relay to operate a mechanical register.
- 450V DC OUTPUT JACK: The 450 volt DC output (for Geiger Tube) has a 10K ohm series resistor to limit the current temporarily if the supply is shorted, but the supply must not be shorted indefinitely.
- RESET BUTTON: This returns the count to zero. Counter does not operate properly unless this is pressed when the unit is first turned on, or a new input is applied.
- HOLD MODE SWITCH: When set to GATE the counter stops counting while the MANUAL HOLD button is held depressed. When the HOLD MODE is set to PULSE the counter starts when the MANUAL HOLD button is depressed and released and stops when the button is depressed and released again.
- MANUAL HOLD
- ELECTRONIC HOLD JACK: Allows external (automatic) switching. Shorting the ELECTRONIC HOLD JACK to ground is equivalent to depressing the MANUAL HOLD button and can be used in either "gate" or "pulse" mode. A mechanical switch could be used. A useful alternative is the Photocell (PHC-100), (conducts better when illuminated than when dark).
- COUNT INPUT SWITCH: Set to the 1 KHz position for interval timing. The count changes by one unit every 1/1000 sec = 0.001 sec. Set to the APS-101 output position to count pulses from Geiger Tube or other source.
- 24V AC for Light Source LIS-100
- GROUND
- FREQUENCY ADJUSTOR (See Helpful Hints)