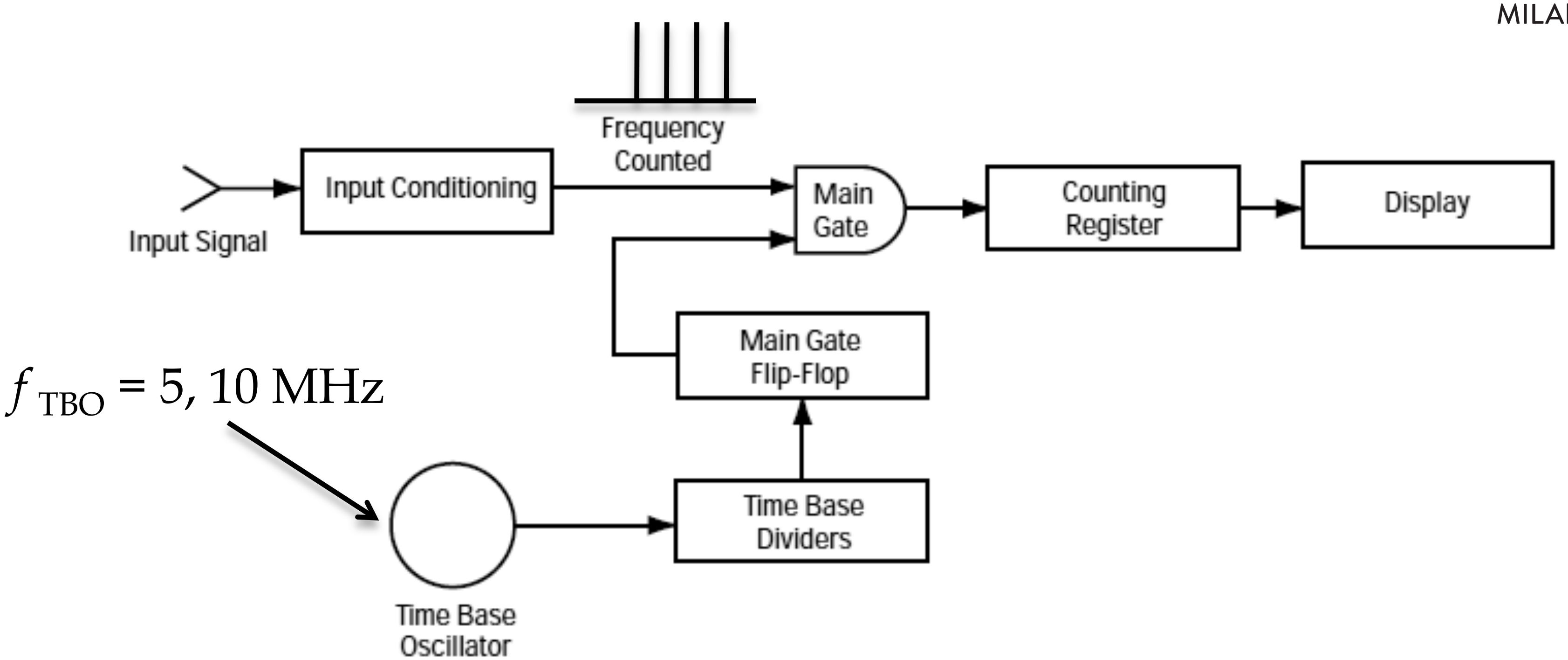
Electronic Counters

- Frequency measurement
- Period measurement
- Frequency ratio measurement
- Time interval measurement
- Total measurements between two signals

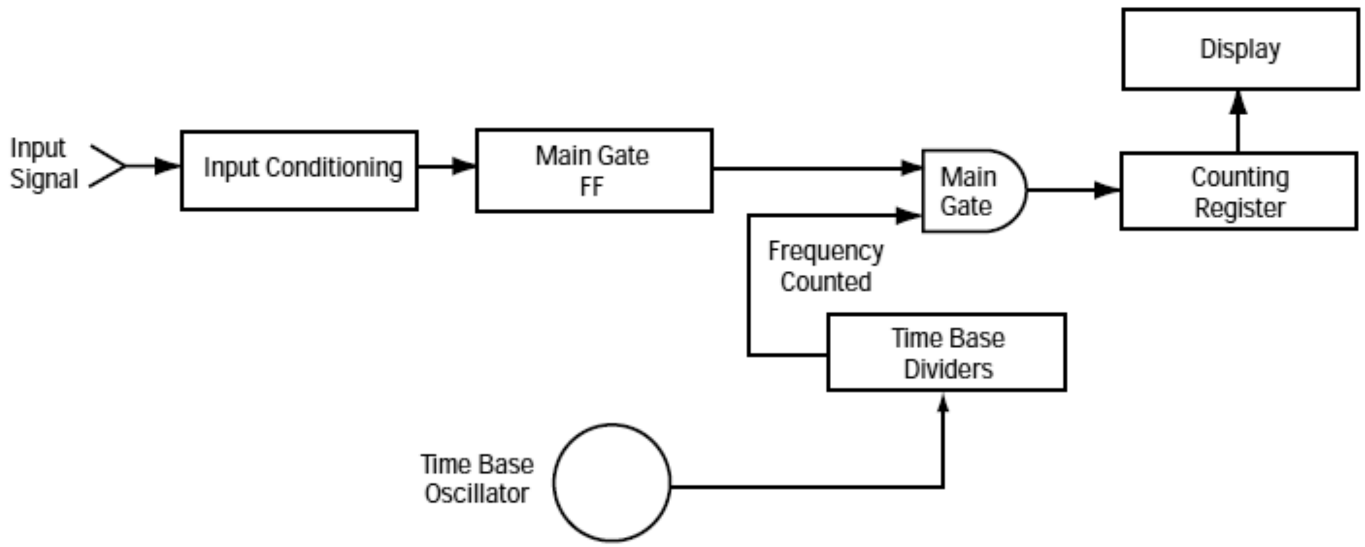


The frequency of a repetitive signal may be defined as the number of cycles in the time unit:

$$f = n \,/\, t$$

If t is equal to 1 s, the frequency is expressed as n cycles per second or Hz

Electronic counters – Period measurement

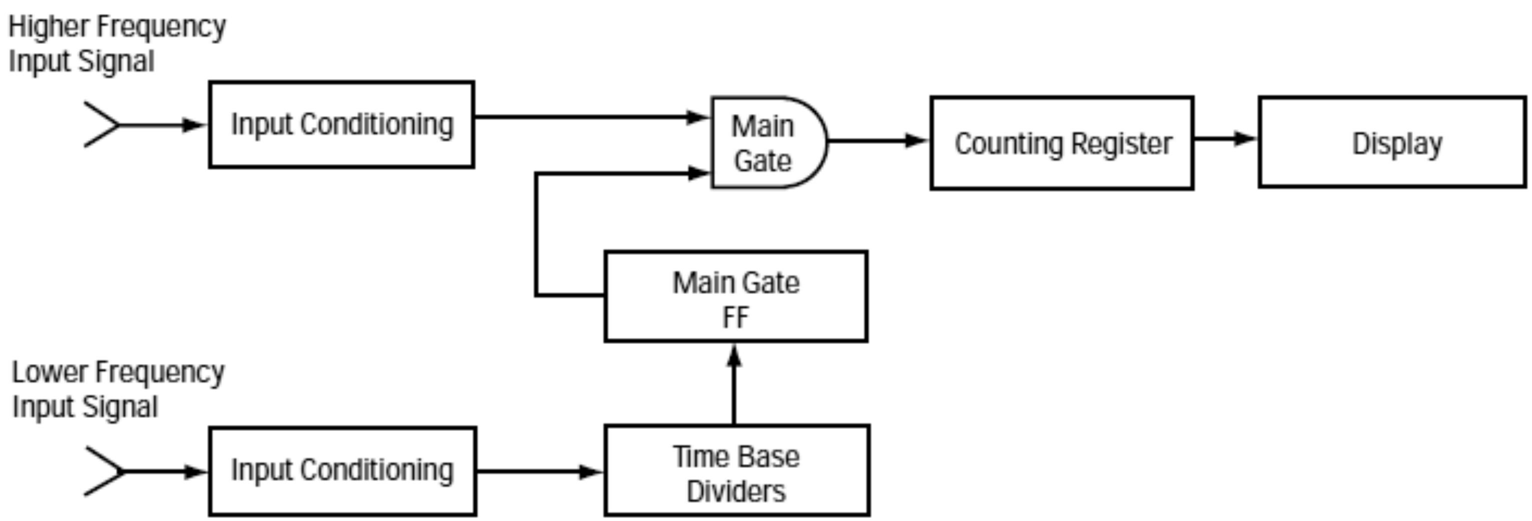


The period *P* of a signal is the inverse of its frequency:

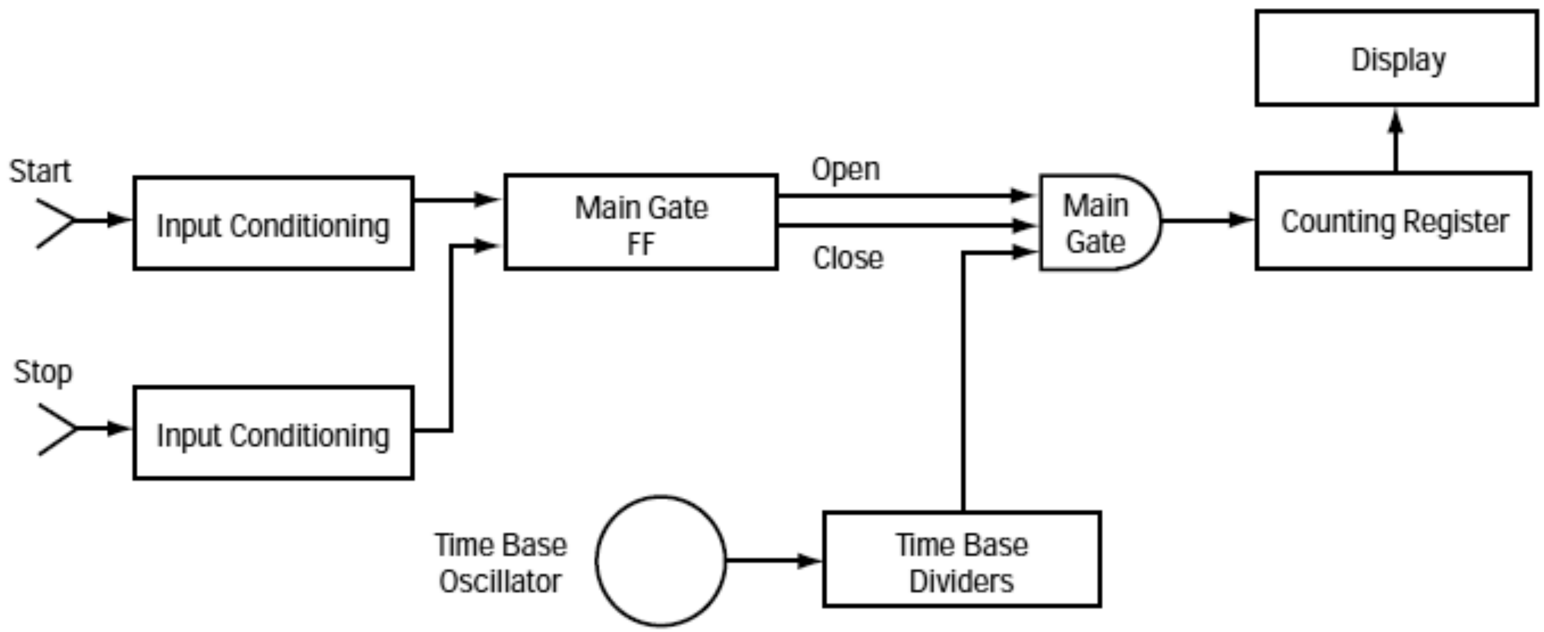
$$P = 1 / f = t / n$$

The period is the time it takes a signal to complete an oscillation. If the time of oscillation is calculated on many periods → **average over multiple periods**. The period measurements allow to obtain more accurate measurements at low frequency: Frequency measurement to 100 Hz on an 8-digit display and 1 second Opening time: 00000,100 kHz. Measurement of the period on the same signal with oscillator at 10 MHz: 0010000.0 us ➔ Resolution increased by a factor of 1000.

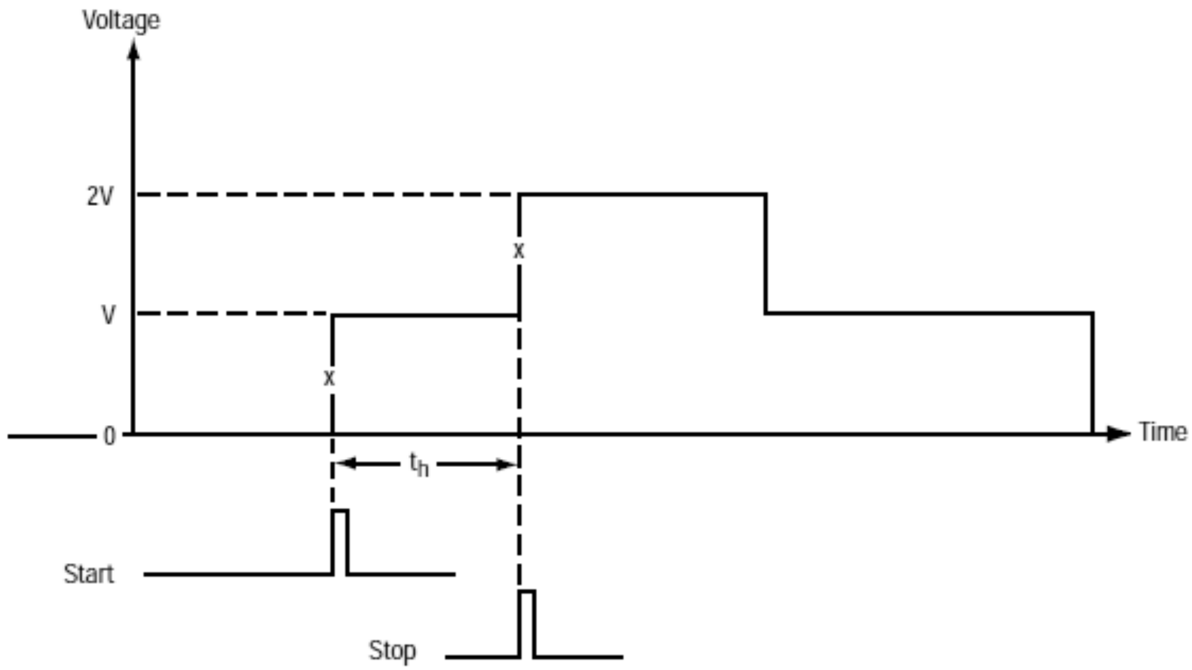
Electronic counters – Frequency ratio measurement



The ratio of two frequencies is determined using the lower frequency as a control signal the opening of the door of the counter. The higher frequency signal is counted by the counter register.
The accuracy of the measurement can be increased by using the multi-average technique.

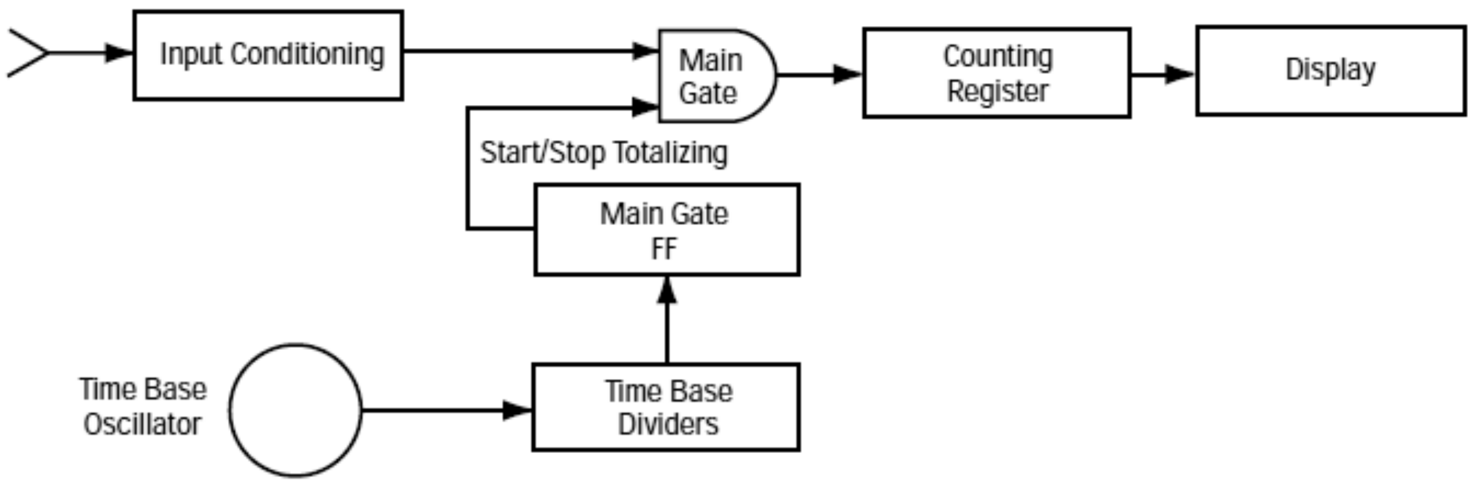


The *main gate* is now controlled by two independent inputs: the START input, which opens the door of the counter and the STOP input that closes it. The clock pulses are accumulated while the door of the counter remains open. Their count shows the time elapsed between the START and STOP event.



The circuit must be able to trigger (synchronize) events that have different amplitude characteristics.

Electronic counters – Total measurements between two signals



Functionality similar to the frequency mode measurement. It is used to count the total number of a specific group of pulses. I can accumulate the counts of two channels and make the sum or the difference (A + B) or (A-B) simply through manual control on the front control panel of the instrument, by setting the instant of START and STOP of the measure.

Three other functions are implemented in conventional contracts:

- Normalized counters;
- Programmed counters;
- Prescaled counters.

Normalized counters

The normalized counters show the frequency of the measured signal multiplied by a numeric constant:

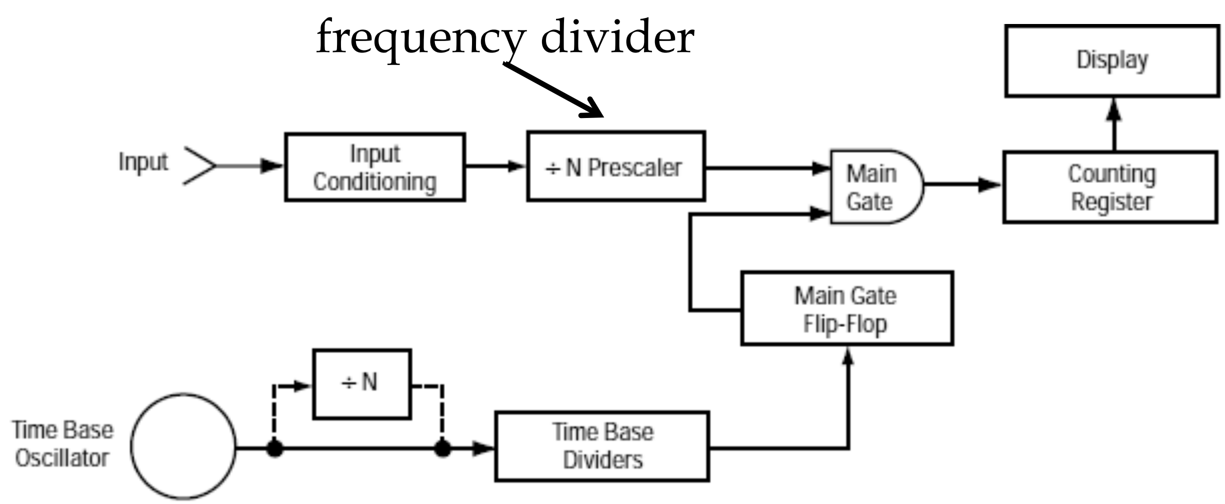
$$y = a \bullet f$$

This technique is commonly used for the measurement of rounds per minute or the flow in industrial applications.

Programmed counters

Programmed counters send an electrical signal when the display exceeds the value set by the user within the electronic counter. The electrical signal is usually used for the control of devices in industrial applications. For example for measures of groups and to measure the rpm of the inside of engines.

Prescaled counters



To increase the maximum conversion rate without exceeding the physical capacity of the main door and the counter you can insert a divider (prescaler). The prescaler divides the frequency of a factor of N input signal before entering the main door. To make the measurement it is therefore necessary that the main door remains open a time N times longer to accumulate the same number of counts in the counter. The prescaler therefore requires a compromise between the use of a counter and a main door with less stringent performance and the cost of an additional divider to insert within the system, maintaining the same resolution.

Defects:

- resolution less accurate in the same measurement time N;
- rates of measurement of less than 1 ms not usable.

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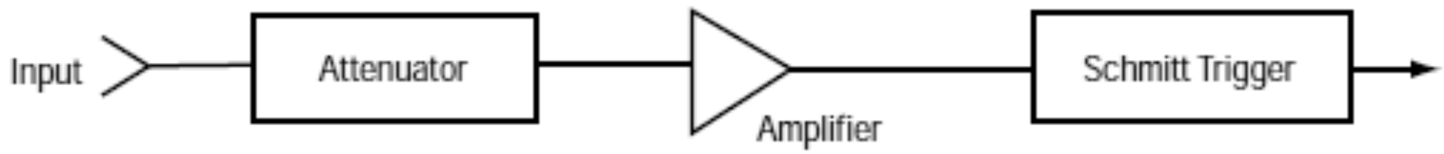
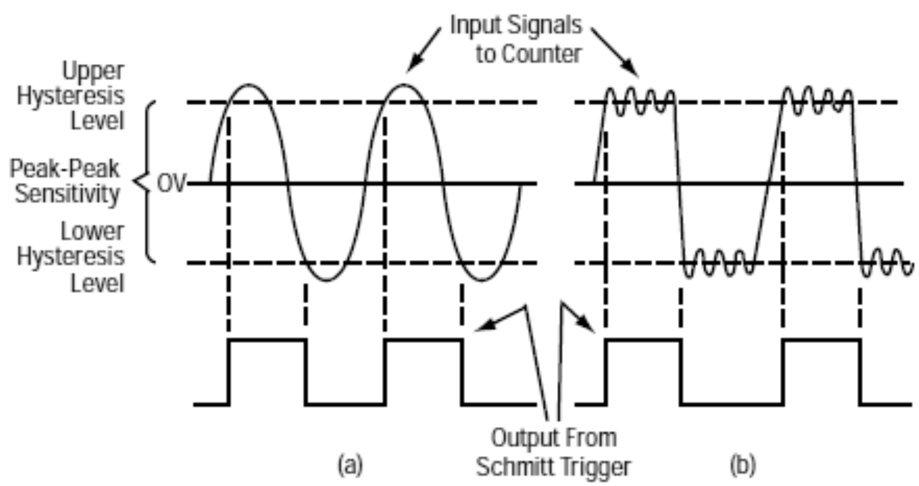
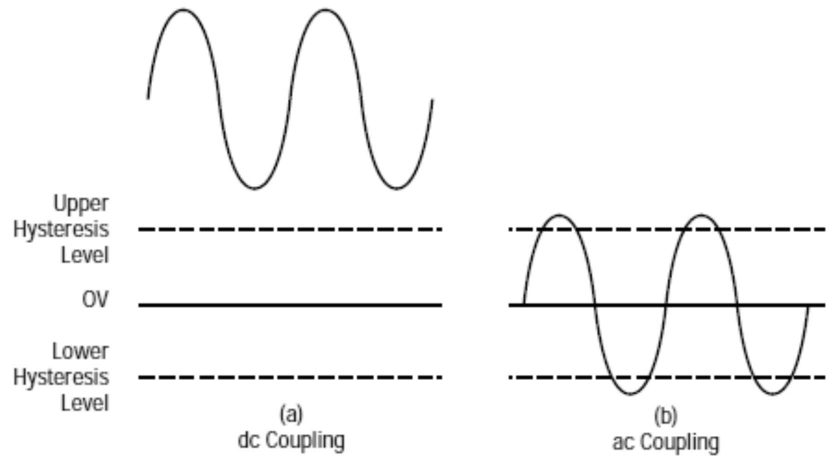


1- Sensibility

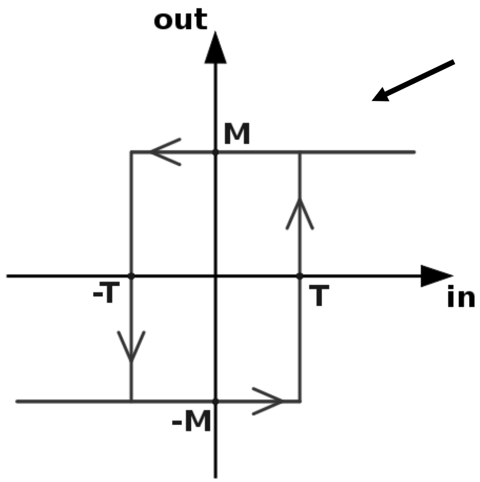
The smallest signal countable by a counter. You can improve it by using the amplifier before the Schmitt Trigger. Too much sensitivity may cause false triggering events.



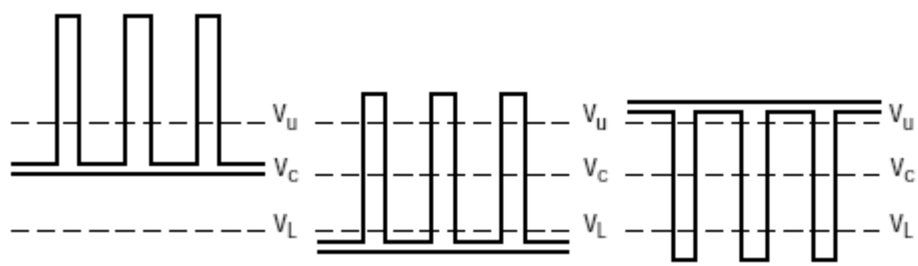
2-AC- DC coupling



3-Trigger level



Schmitt trigger



4-Slope control

It is used to decide whether the Schmitt trigger should generate a pulse on the rising or falling edge of the signal.

5-Dynamic range

Linear range for the operational amplifier usage.

6-Attenuator

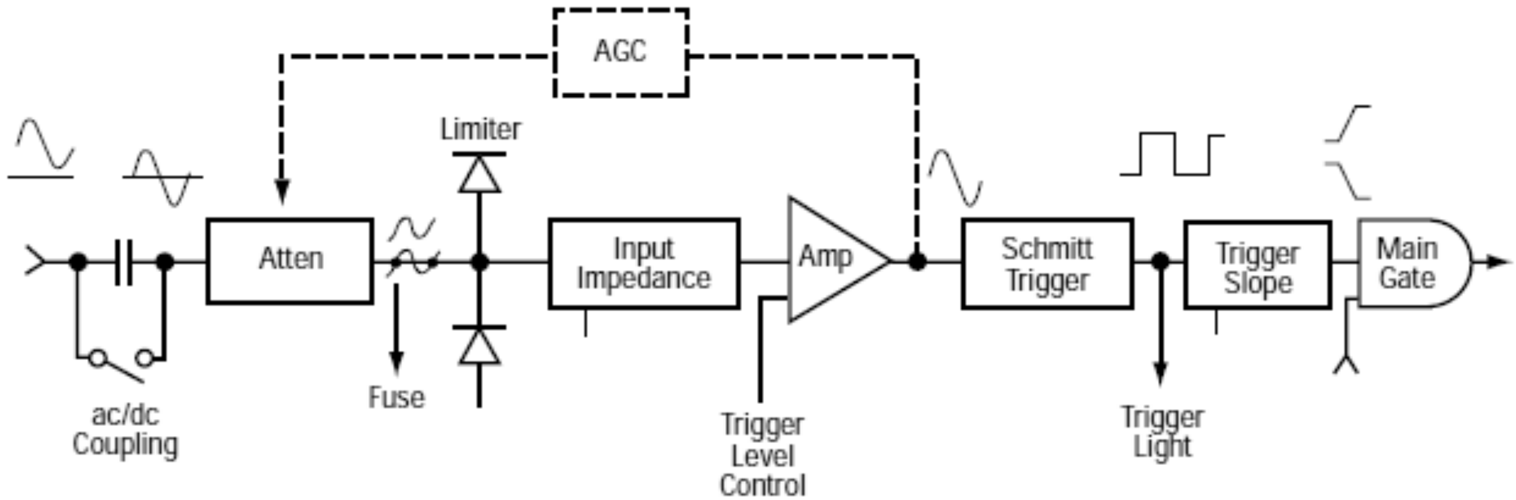
Adapt the range of the input signal to the one measured by the counter.

7-Input impedance

1 MΩ for frequency up than 10 MHz and 50 Ω for higher frequency.

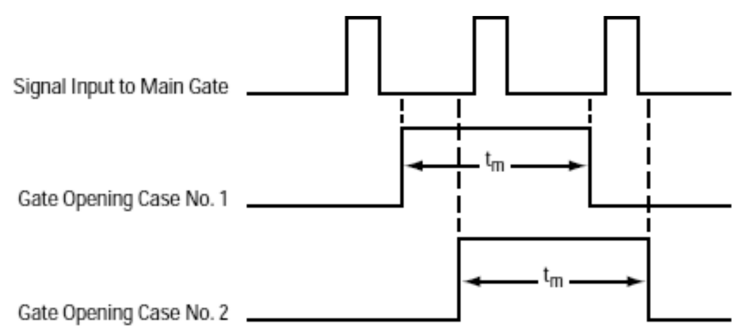
8-Automatic gain control

It serves to automatically control the sensitivity of the measuring system.



Counter input summary

- Counting errors ±1;
- Errors of the time base;
- Trigger errors;
- Systematic errors.



Terms:

- The counting ±1 and trigger (random errors) errors significantly degrade the resolution of time intervals measurements.
- The time interval is repetitive.

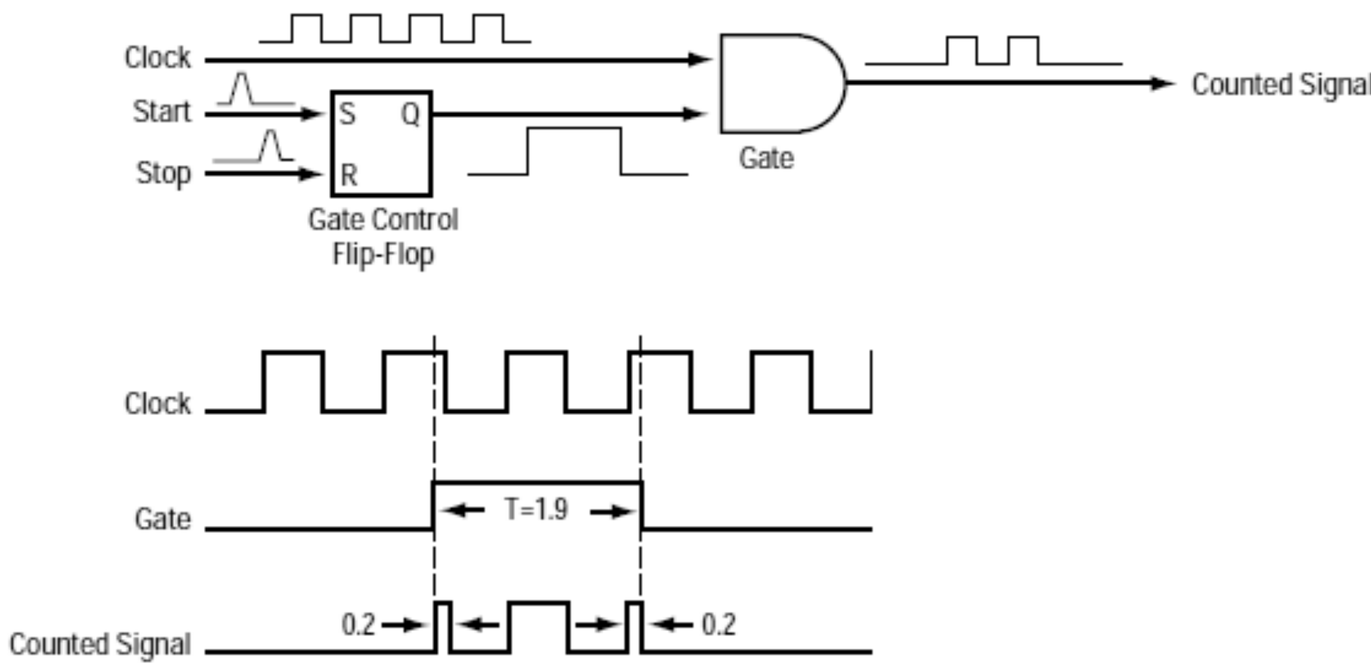
Measurement accuracy in averaged intervals

= ± 1n (1 count + trigger error)

± error of the timebase

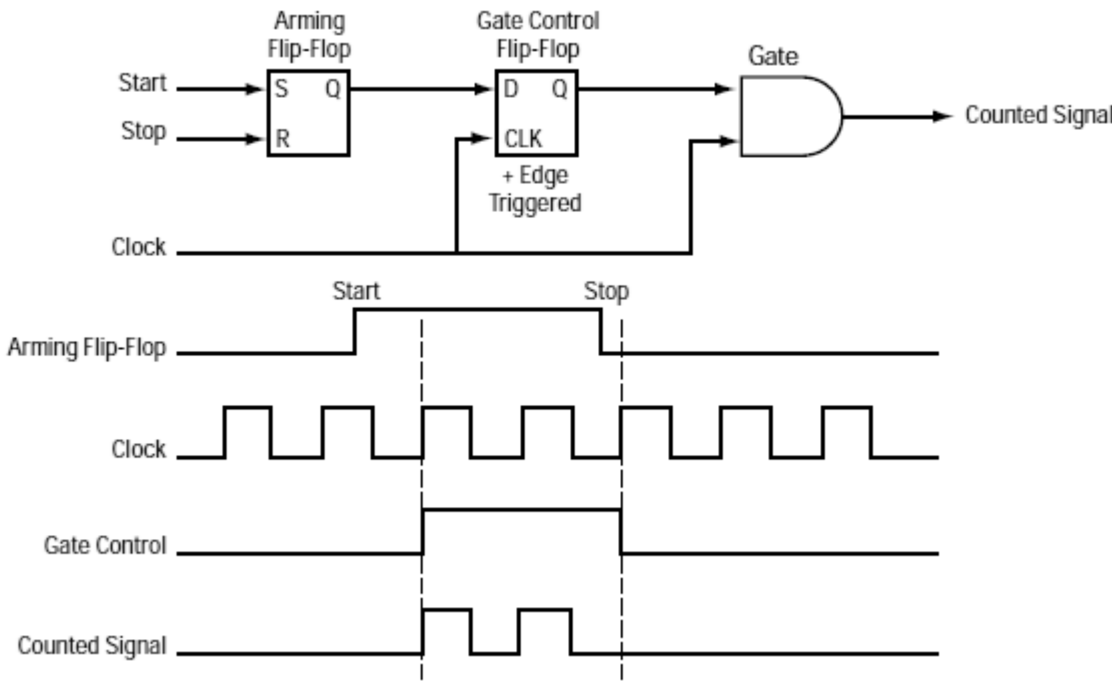
± systematic error

Electronic counters – Time interval measurement: Direct Gating



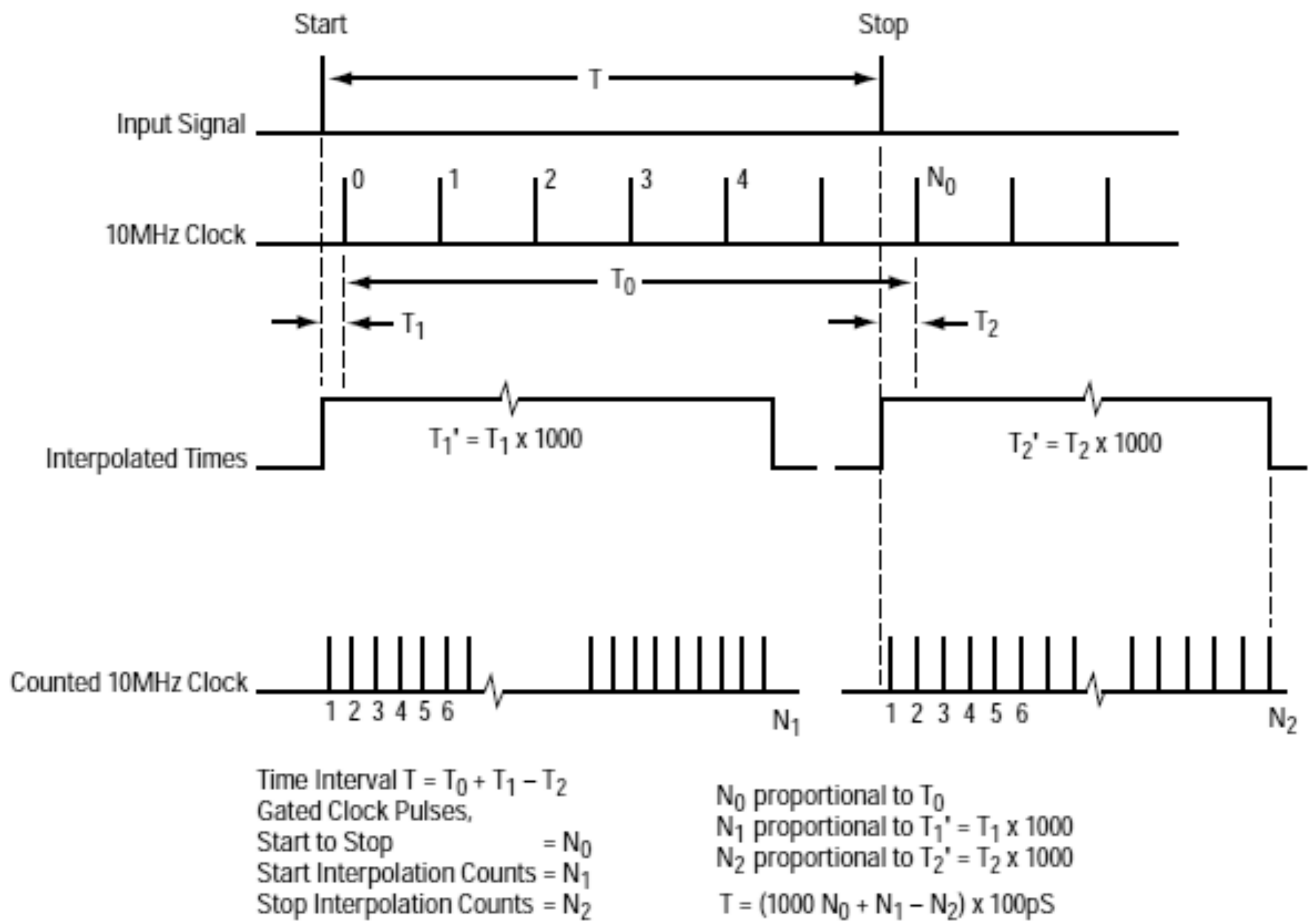
- Truncate the clock pulses can cause errors of more than 1 count;
- The time measurements will be affected by errors not estimable;
- The counter does not measure time intervals less than those of the minimum measurable pulse width.

Electronic counters – Time interval measurement: Synchronized Gating

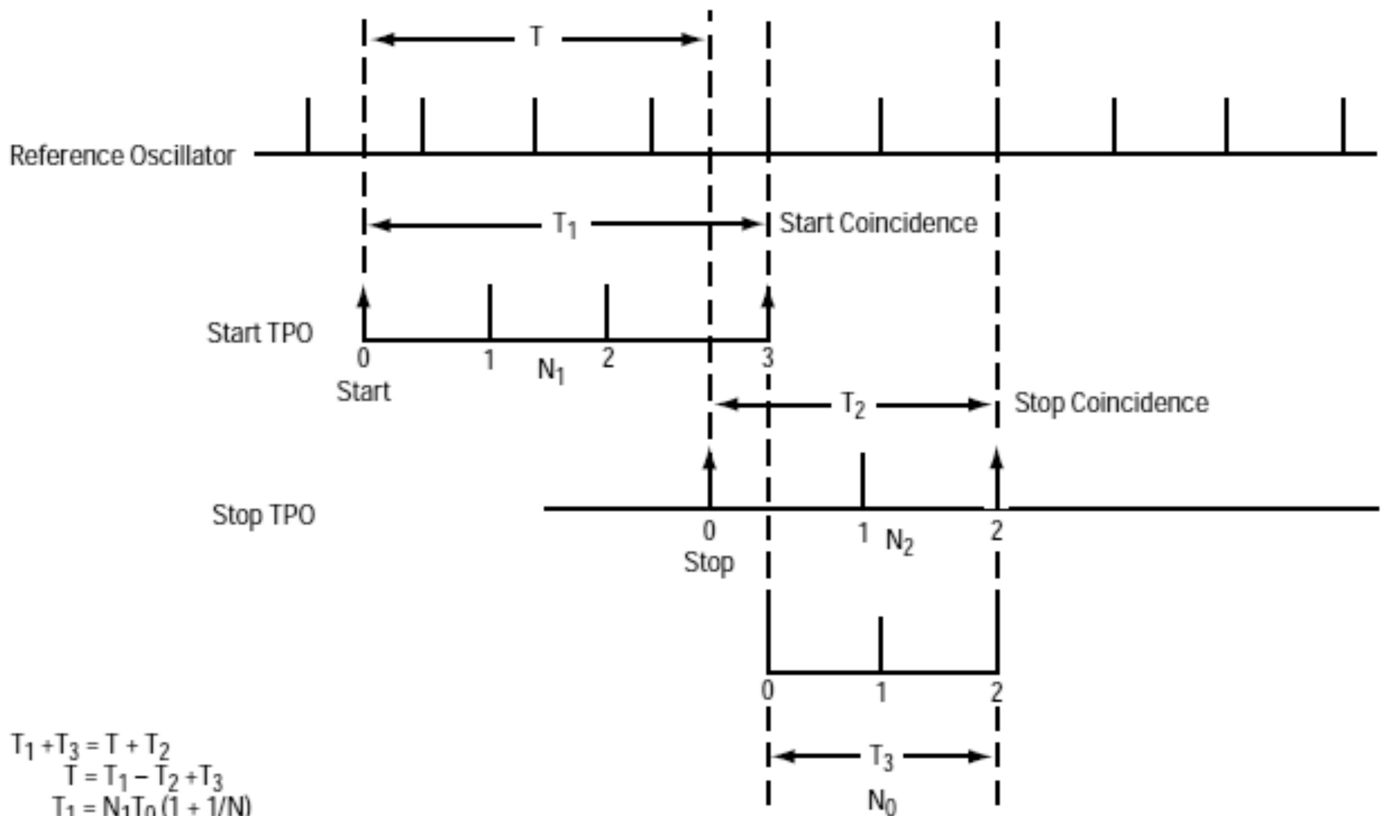


- Clock pulses are not truncated;
- The measurements show distortion errors that can not be estimated;
- It allows measurements of time intervals less than the minimum measurable pulse width from the counter.

Electronic counters – Analogic interpolation method



Electronic counters – Dual Vernier Method of Interpolation



$T_1 + T_3 = T + T_2$

$T = T_1 - T_2 + T_3$

$T_1 = N_1 T_0 (1 + 1/N)$

$T_2 = N_2 \cdot T_0 (1 + 1/N)$

$T_3 = N_0 \cdot T_0 \cdot$

Time Interval Measured, $T = T_0 [N_0 + (1 + 1/N)(N_1 - N_2)]$