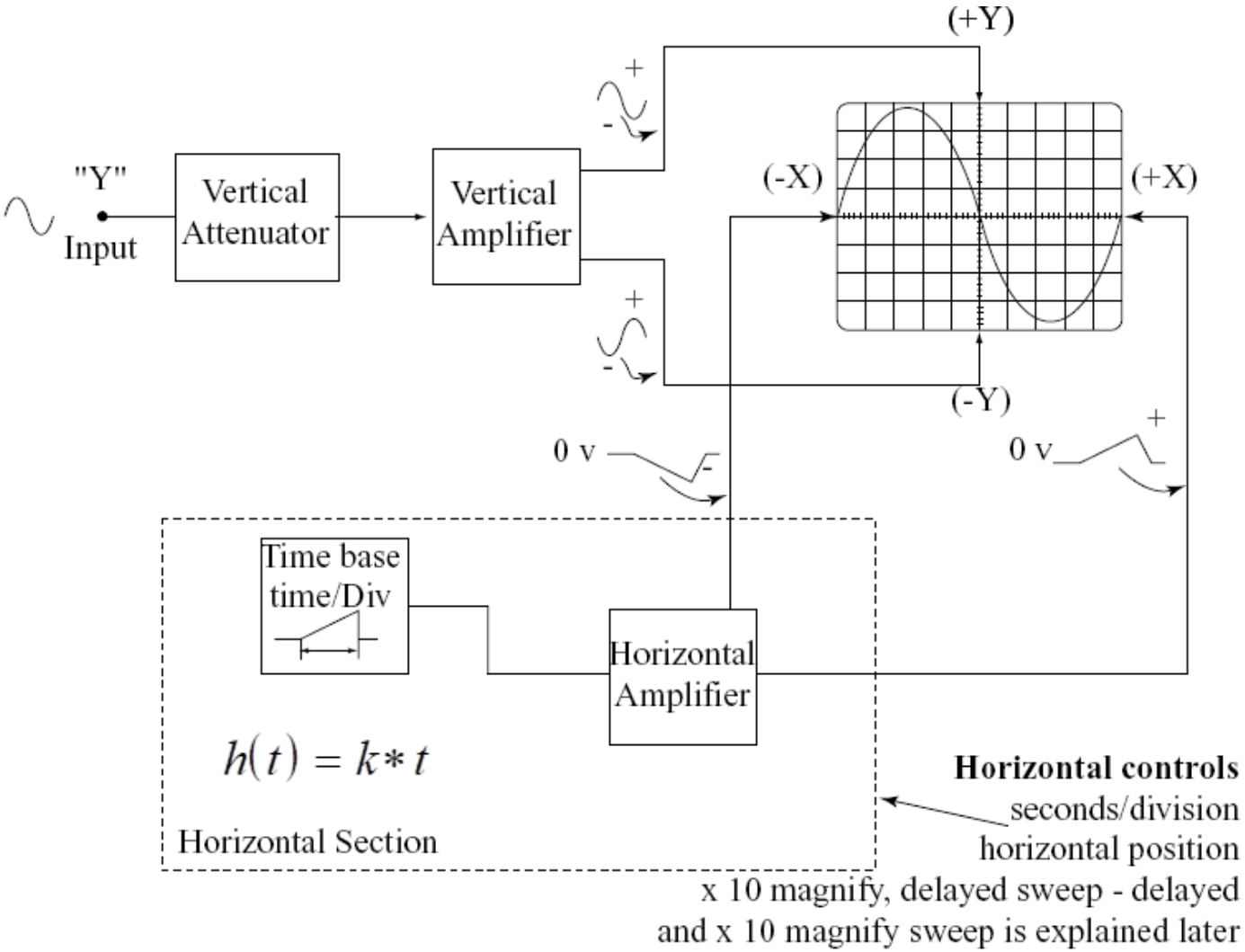
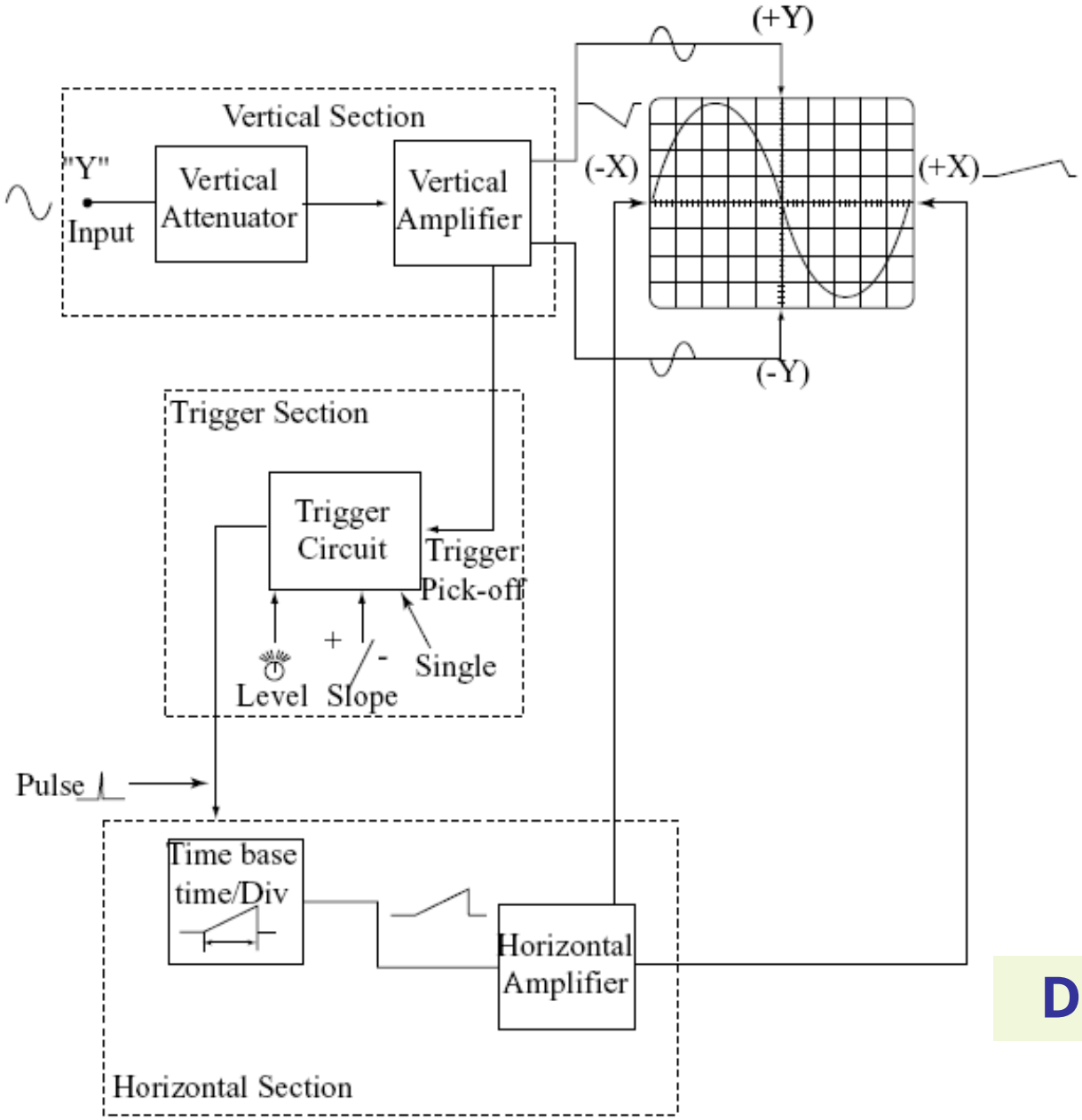
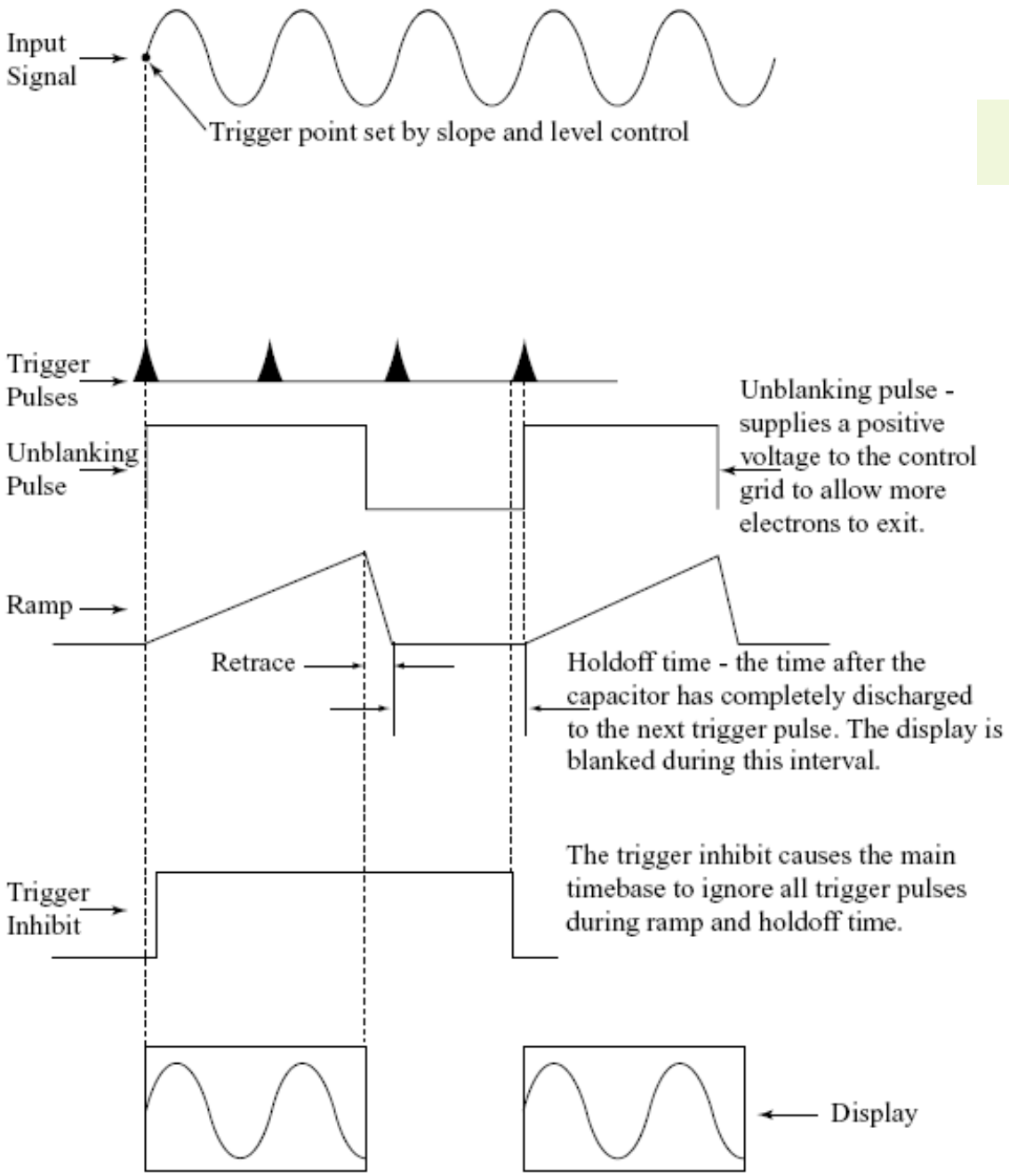
Sistema Horizontal



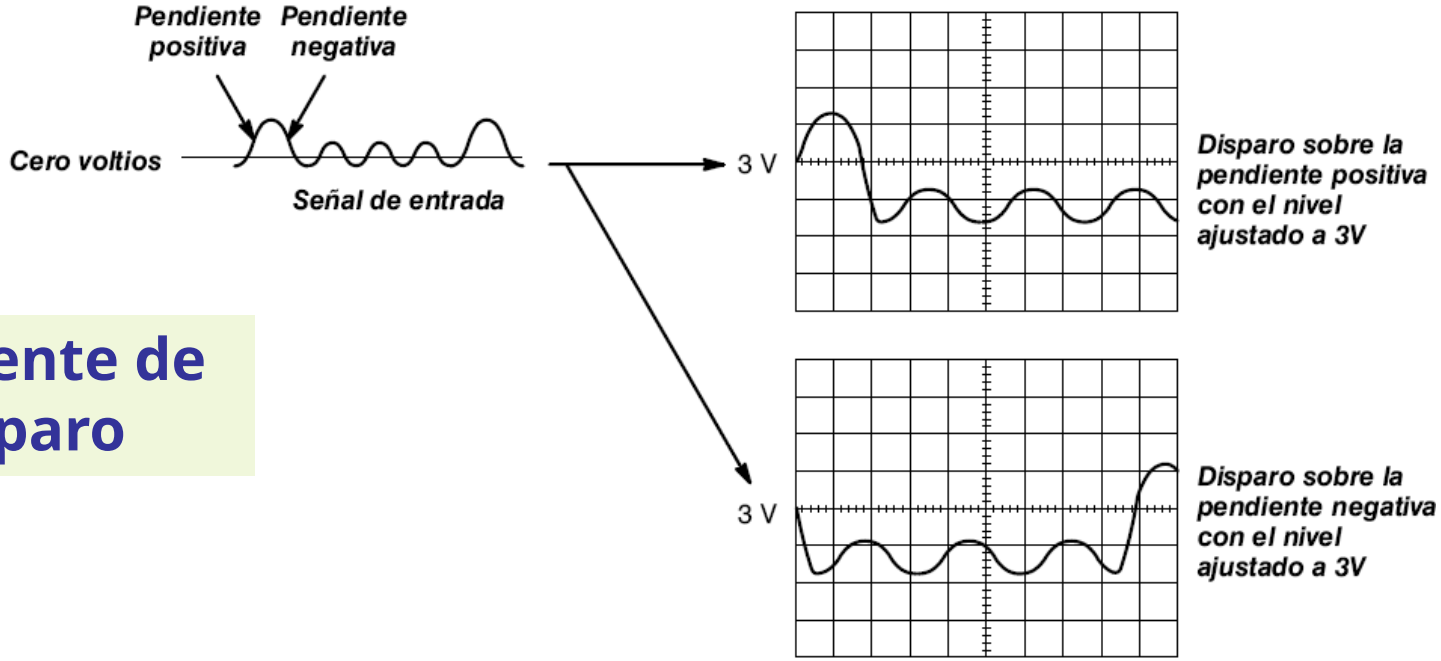

(+Y)
Vertical Section
"Y"
Input
Vertical
Attenuator
Vertical
Amplifier
(-X)
(+X)
(-Y)
Trigger Section
Trigger
Circuit
Trigger
Pick-off
+
-
Level
Slope
Single
Pulse
Time base
time/Div
Horizontal
Amplifier
Horizontal Section

Disparo

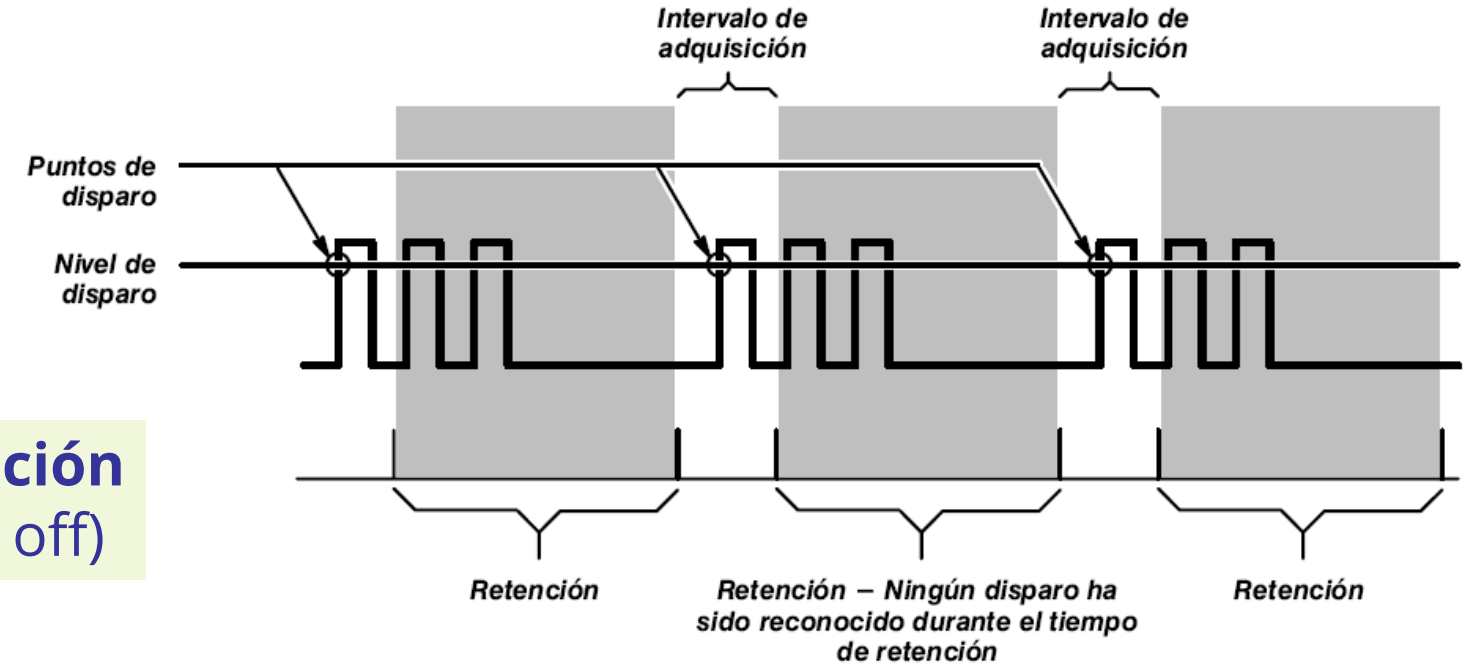
Disparo

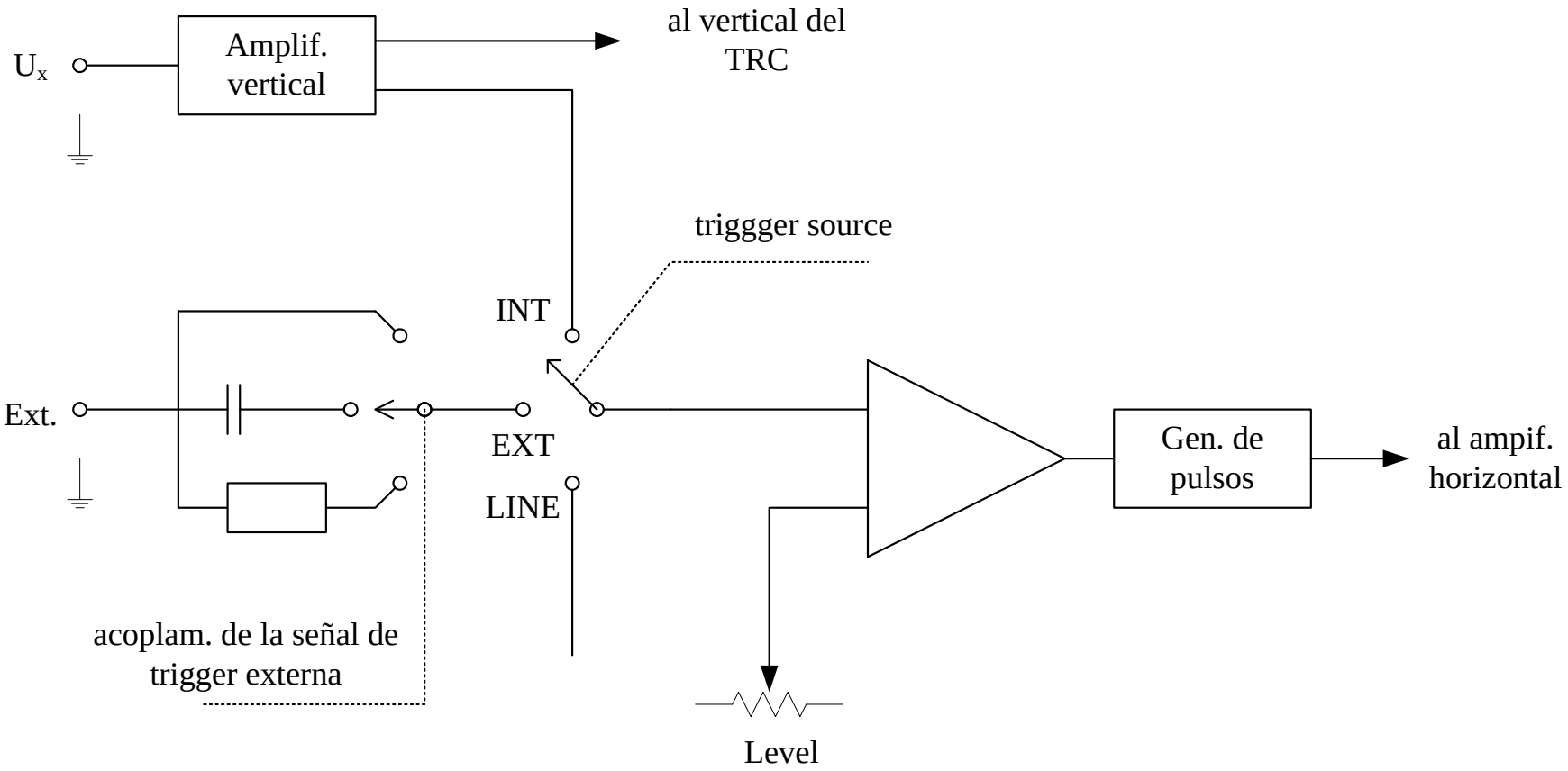

Input Signal
Trigger point set by slope and level control
Trigger Pulses
Unblanking Pulse
Unblanking pulse - supplies a positive voltage to the control grid to allow more electrons to exit.
Ramp
Retrace
Holdoff time - the time after the capacitor has completely discharged to the next trigger pulse. The display is blanked during this interval.
Trigger Inhibit
The trigger inhibit causes the main timebase to ignore all trigger pulses during ramp and holdoff time.
Display

Pendiente de Disparo



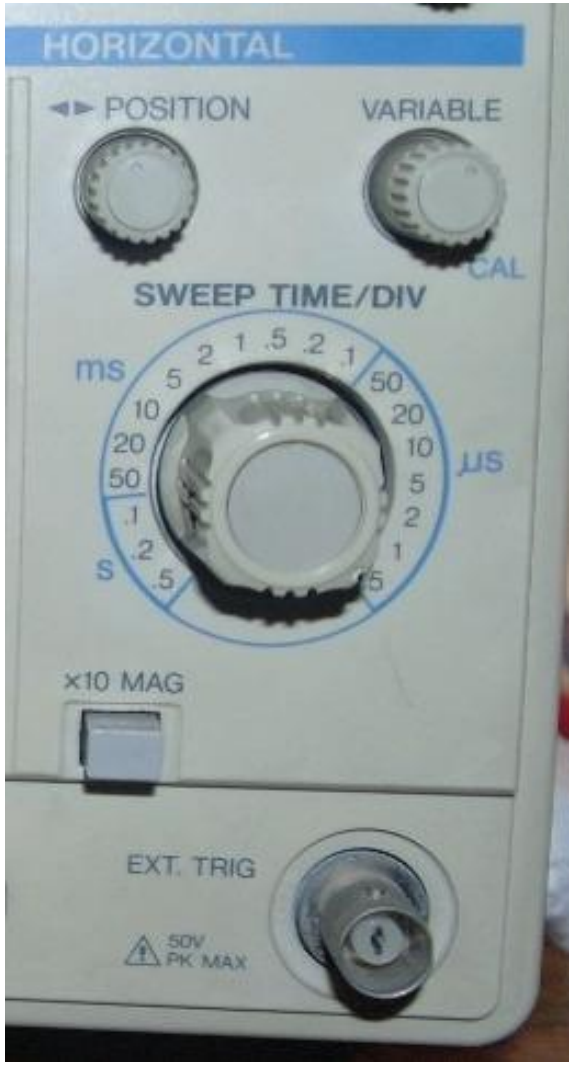
Retención (Hold off)

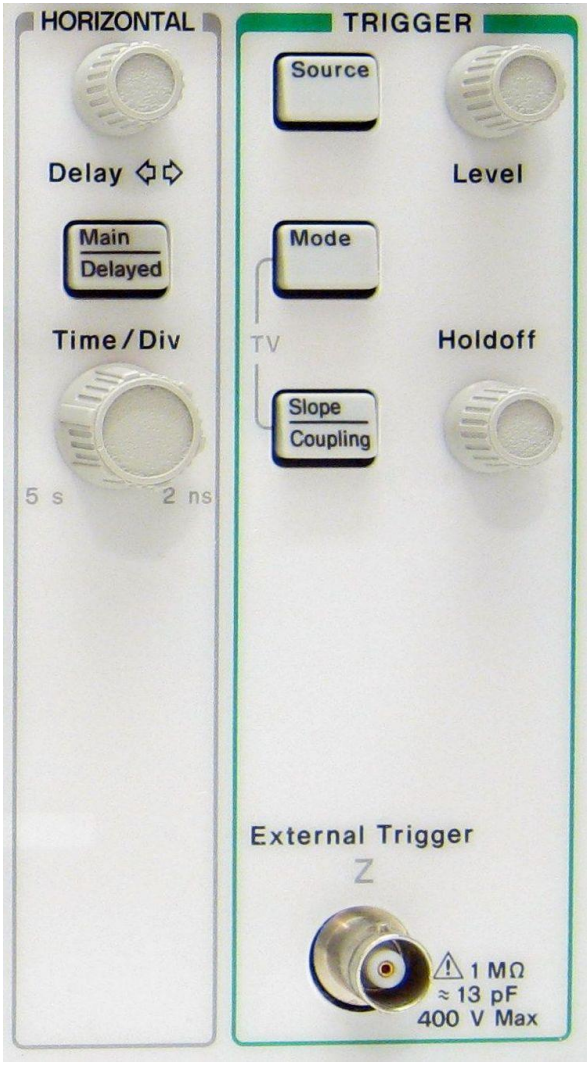




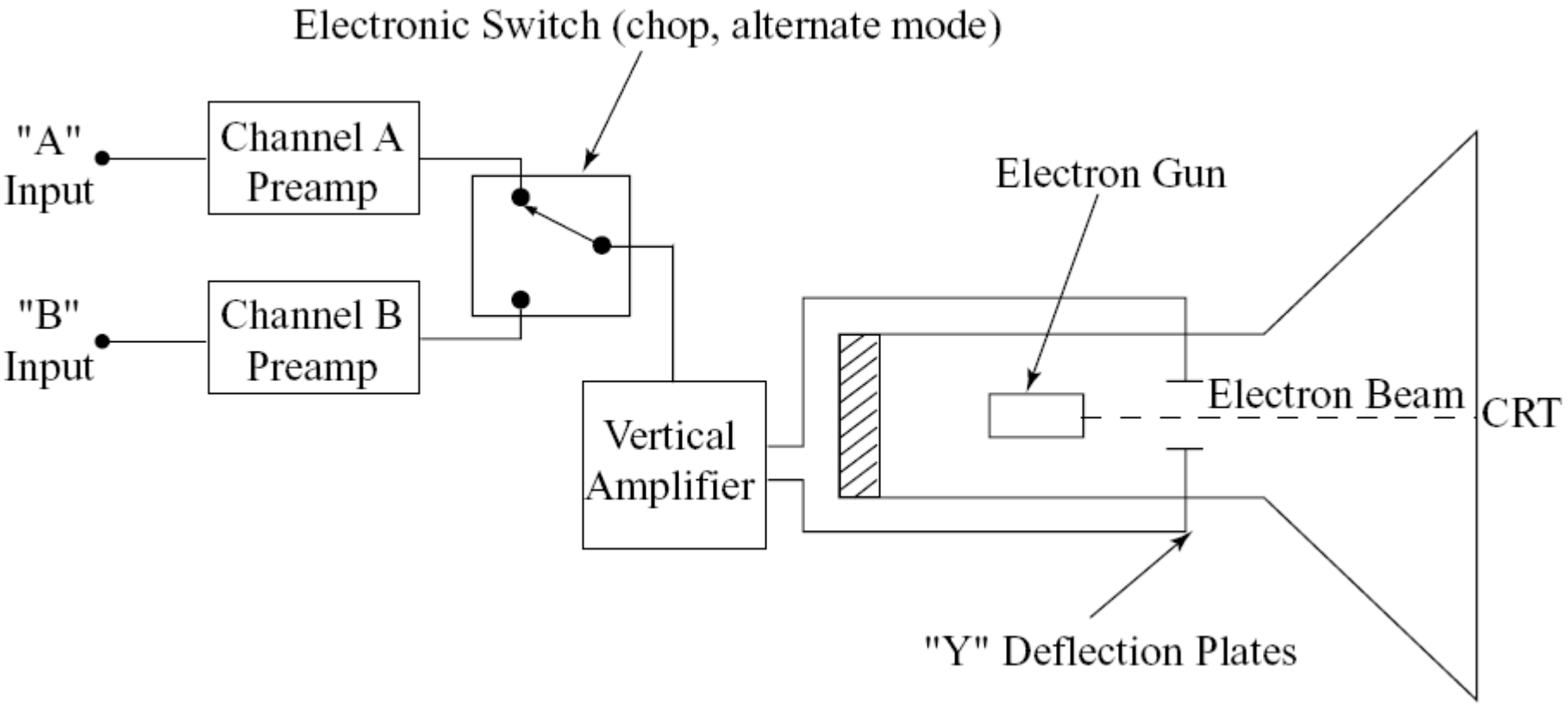
Disparo: fuente y acoplamiento

Controles Horizontales



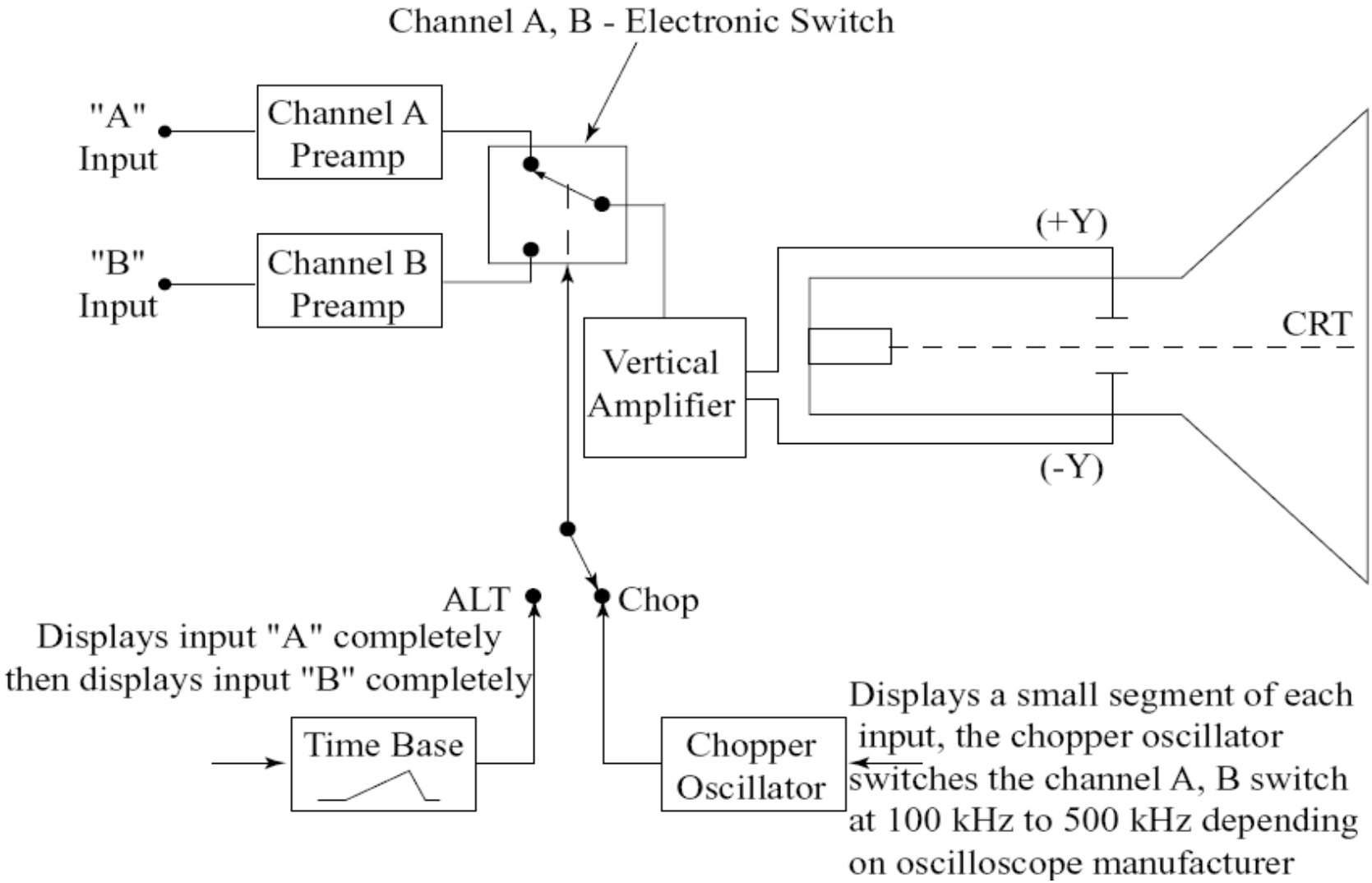


Osciloscopios de Doble Trazo



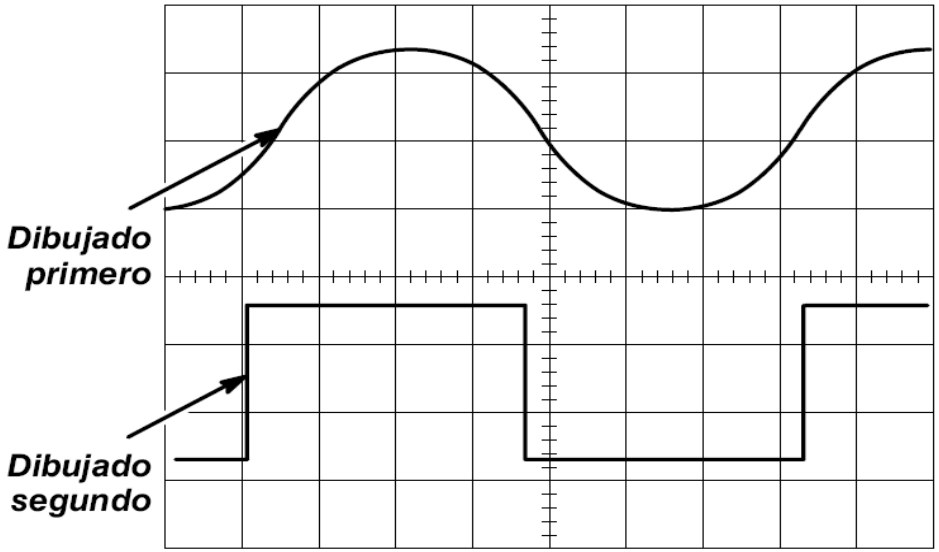
Osciloscopios de Doble Trazo

Modos de funcionamiento

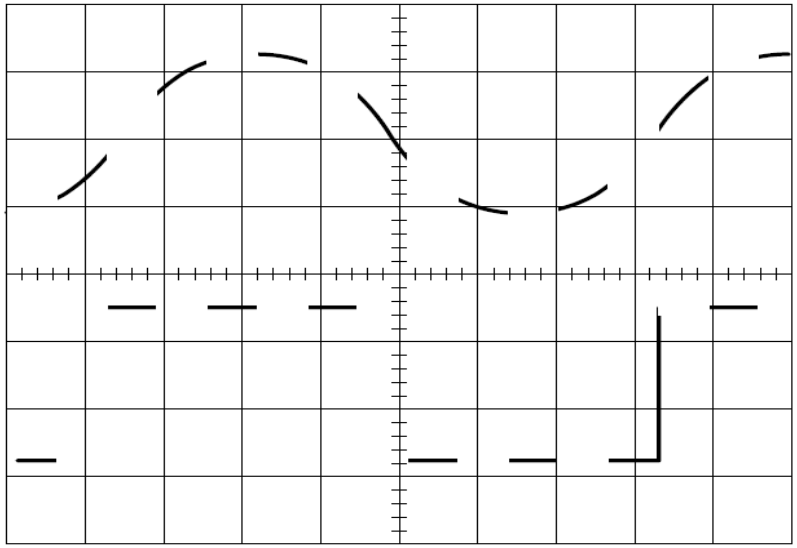


Modo Alternado

El Canal 1 y el canal 2 son dibujados alternativamente



Segmentos del canal 1 y del canal 2 dibujados alternativamente



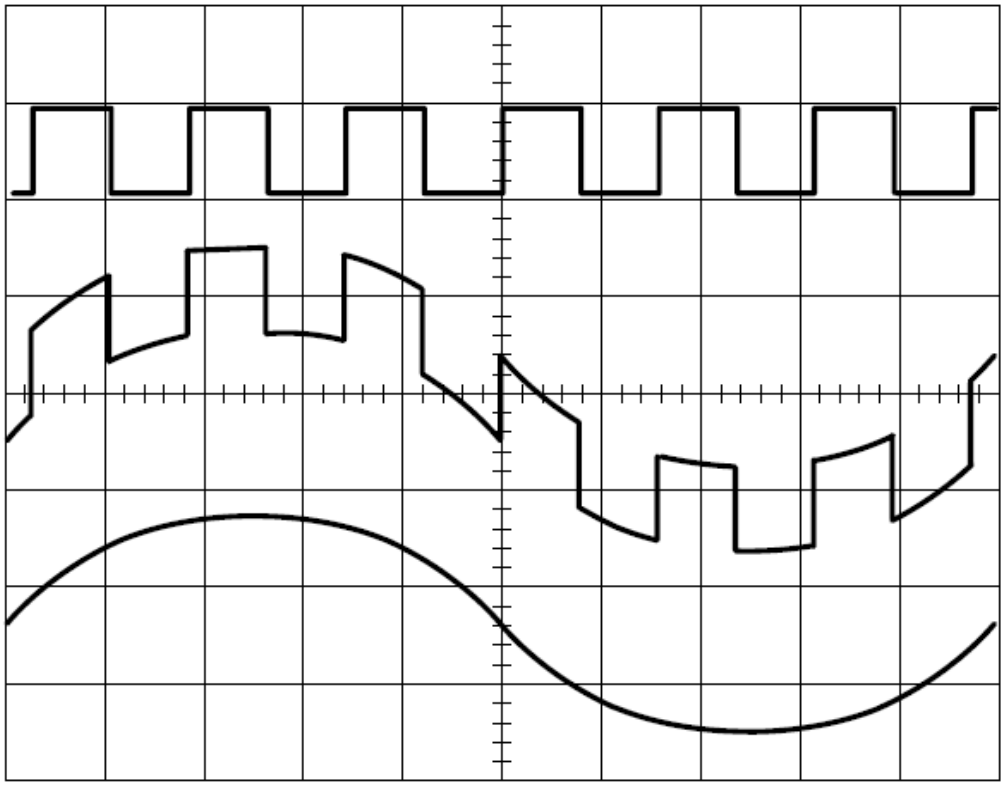
Modo Troceado

(Chopped)

Imagen del canal 1

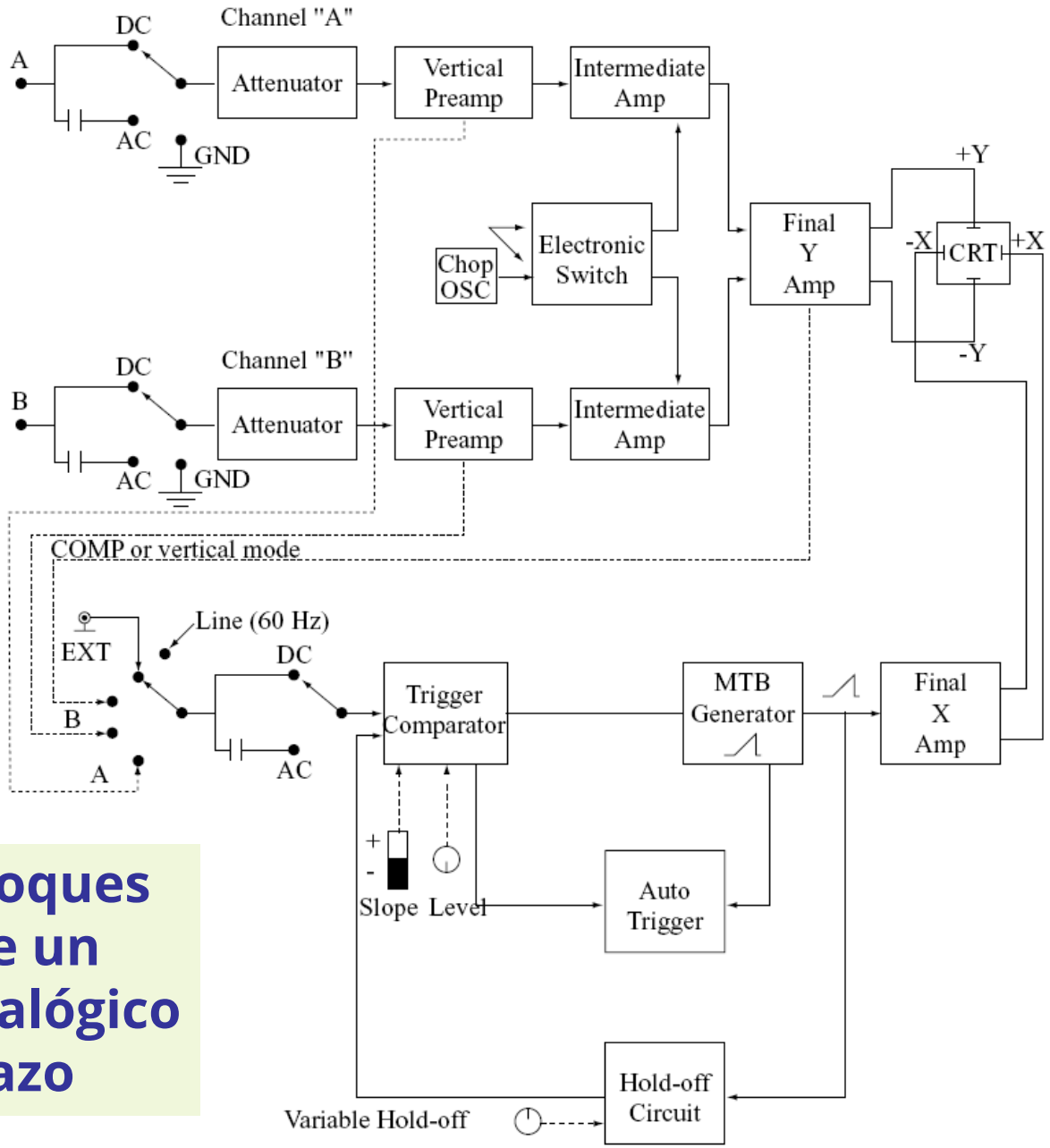
Modo ADD: Combinación del canal 1 y el canal 2

Imagen del canal 2

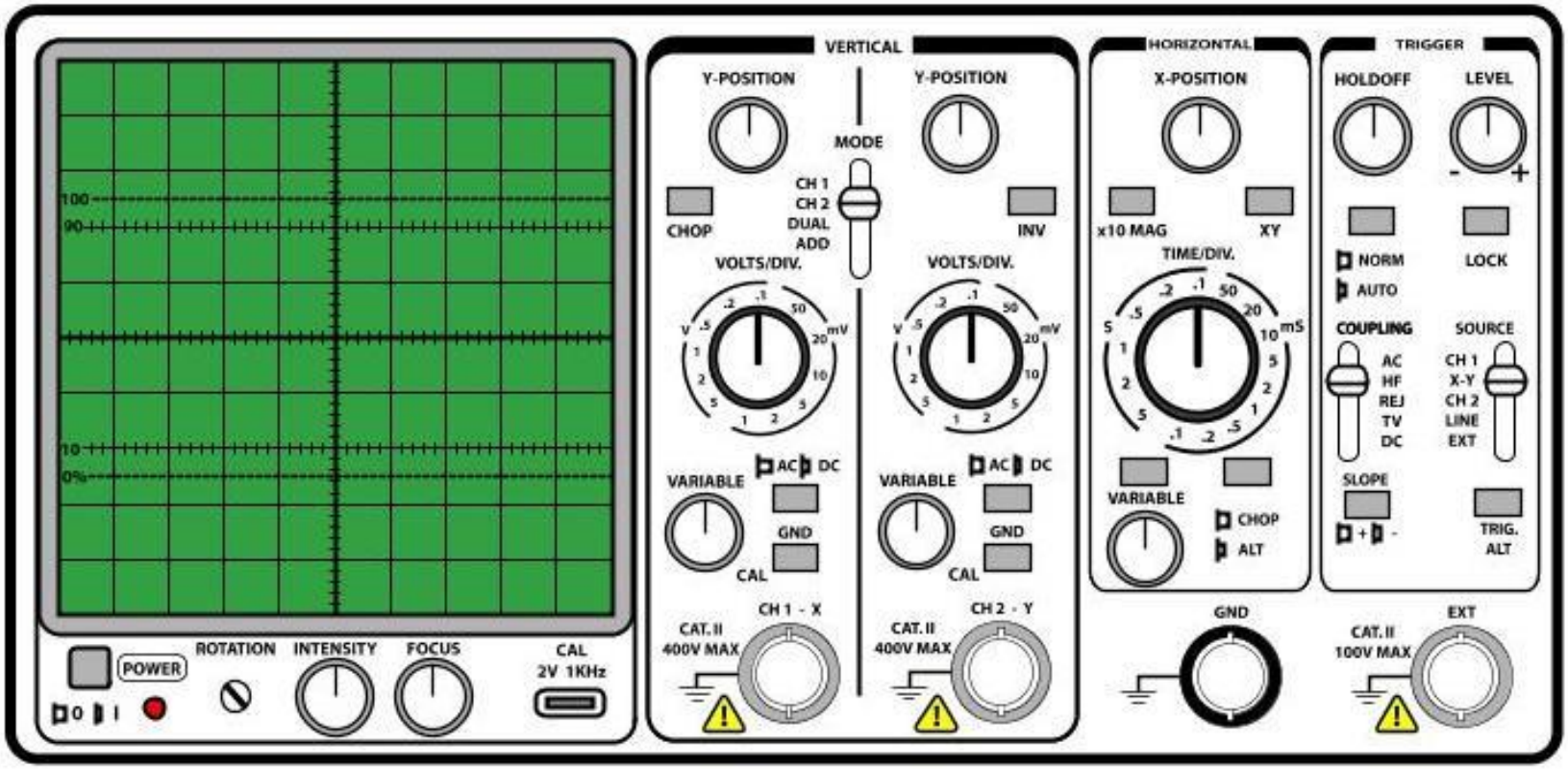


Modo Sumado (Add)

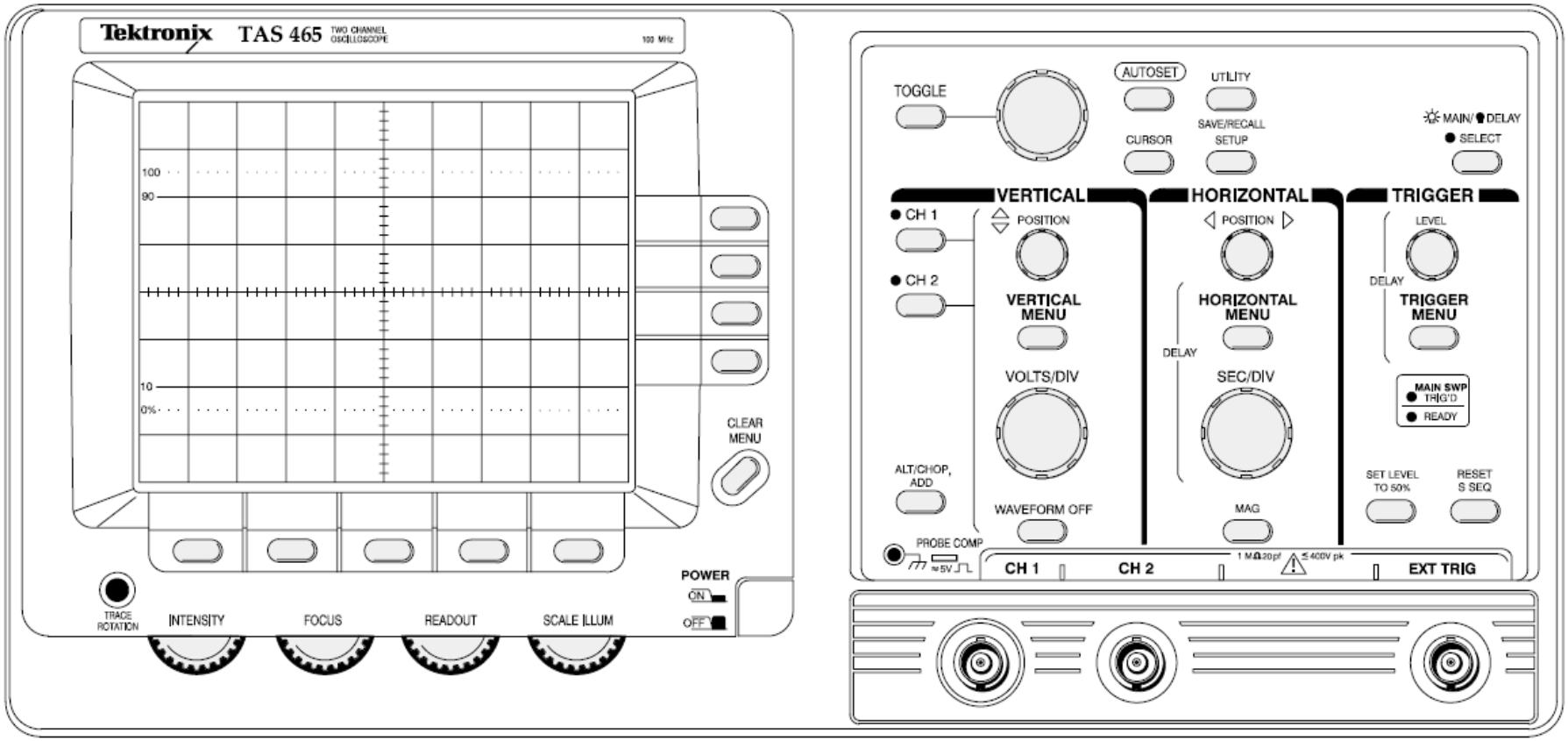
Esquema de bloques expandido de un Osciloscopio Analógico de Doble Trazo



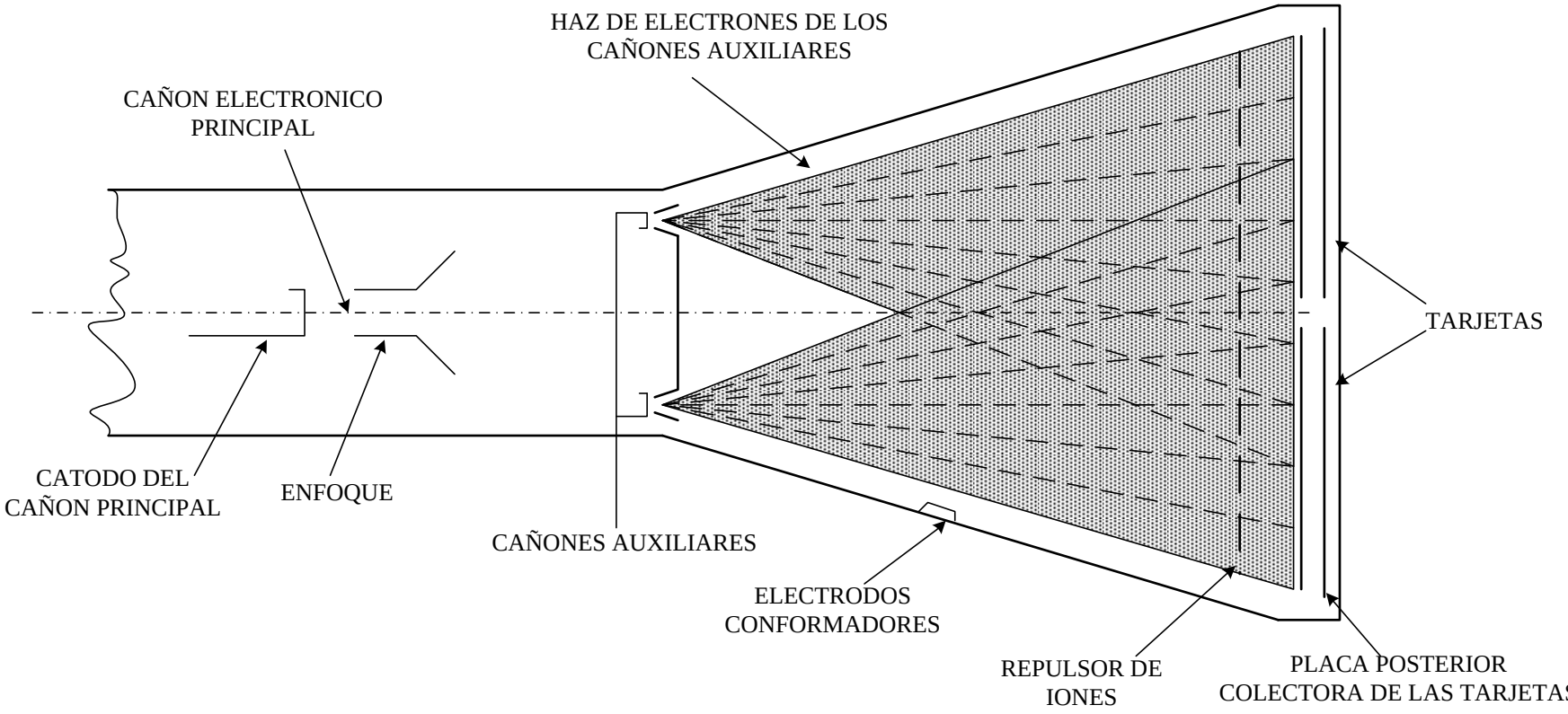
Panel Frontal típico de un Osciloscopio Analógico



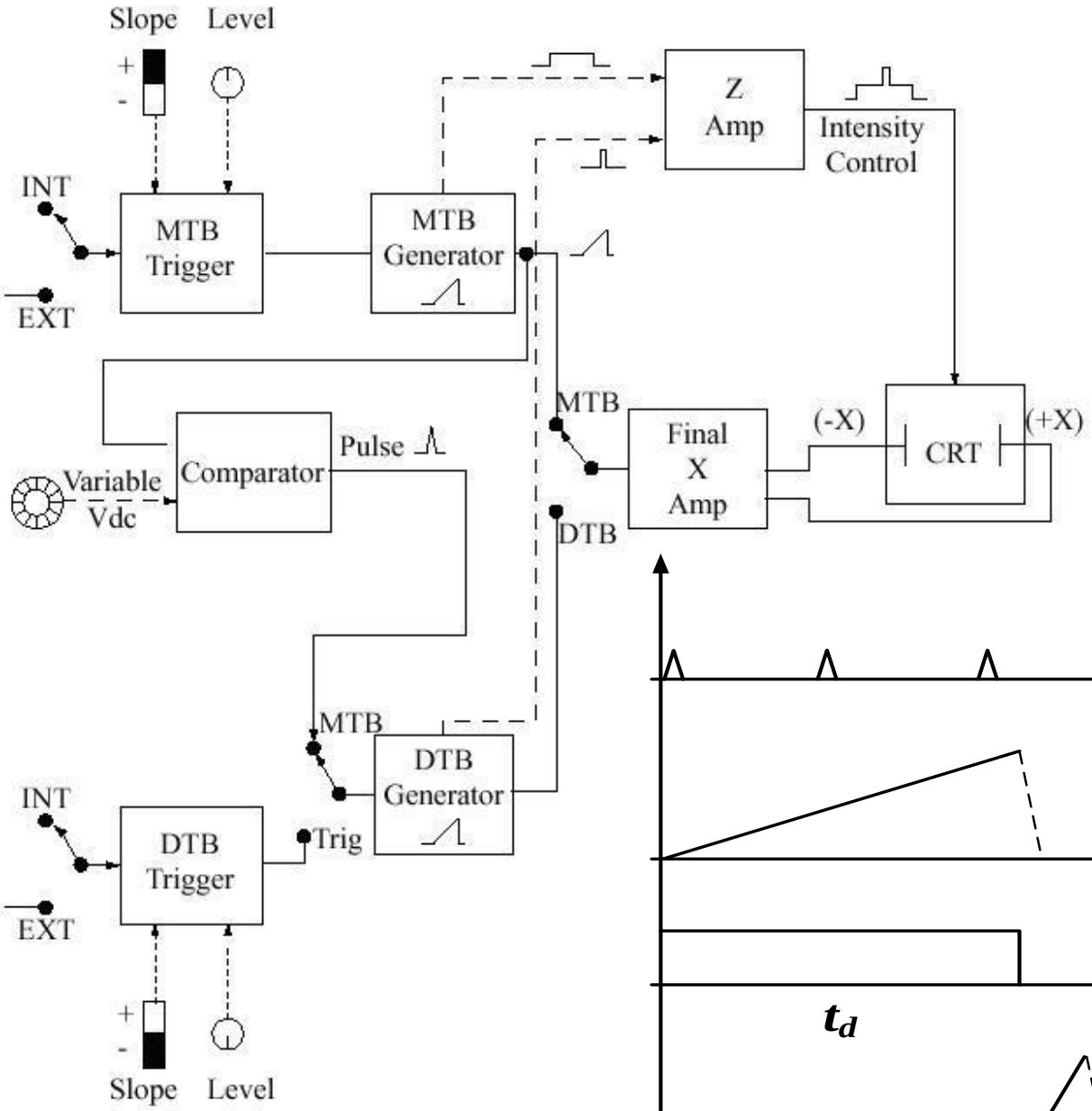
Panel Frontal del Osciloscopio Analógico TAS 465

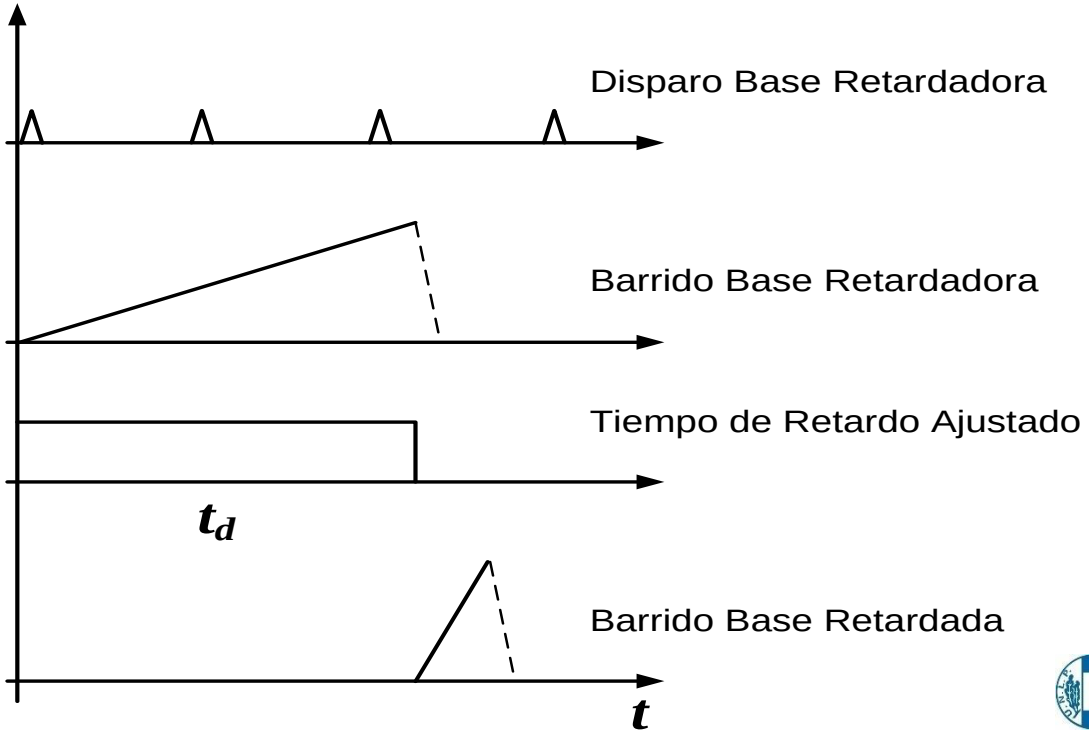


Osciloscopios con Almacenamiento en el TRC

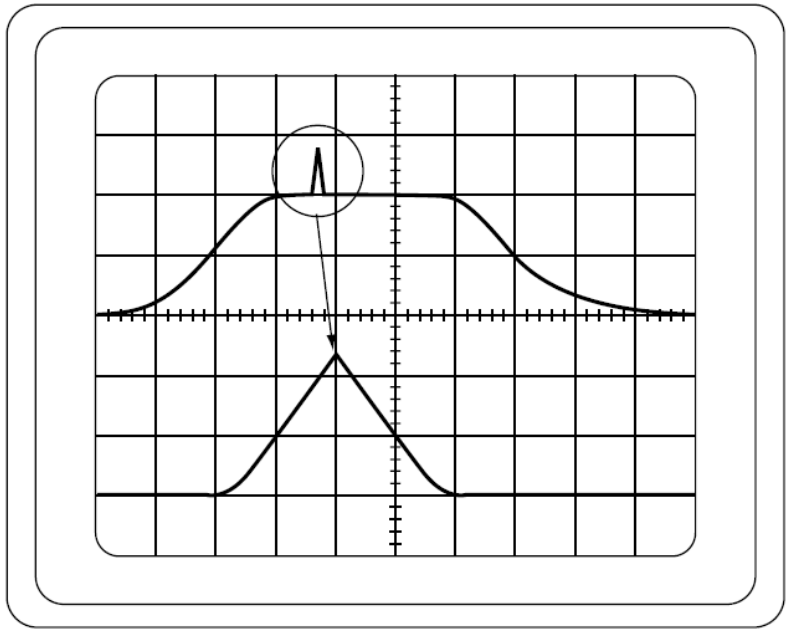


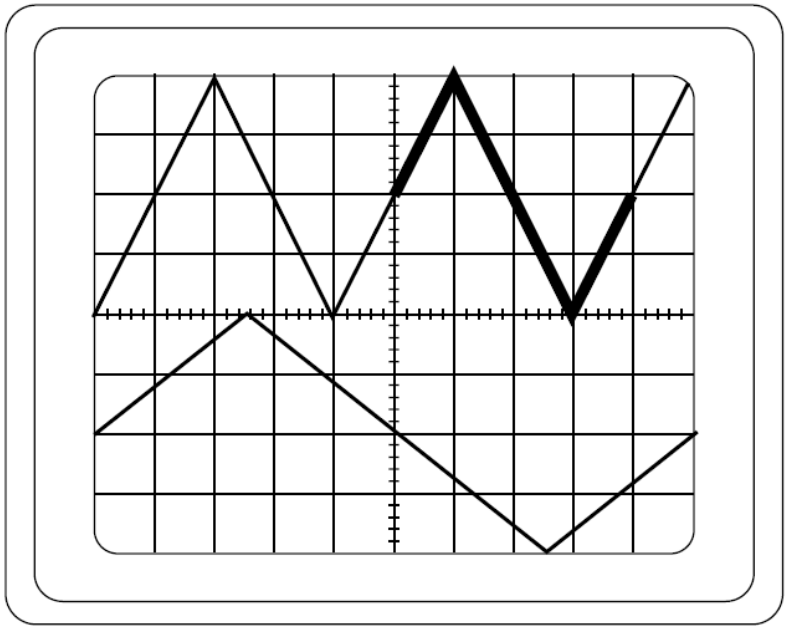
Osciloscopios con Barrido Retardado





Ejemplos de presentación de un Osciloscopio con Barrido Retardado





Especificaciones de un Osciloscopio Analógico típico, con Almacenamiento

Textronix T912

A. DISPLAY

Probe Adjust Output	
Voltage (0° C to +40° C)	Approximately 0.5 V.
Repetition Rate	Approximately 1 kHz.
Z-Axis Input	
Sensitivity	5 volt signal causes a noticeable decrease in intensity.
Signal Polarity	Positive going from ground.
Usable Frequency Range	Dc to 5 MHz.
Maximum Input Voltage	30 V (dc + peak ac) 30 V p-p at 1 kHz or less.
Input Impedance	Approximately 10 kΩ.
Power Source	
Line Voltage Ranges (ac, rms)	
120 V Range	HI—108 to 132 V. LO—90 to 110 V.
240 V Range	HI—216 to 250 V. LO—198 to 242 V.

Line Frequency	50 to 60 Hz.
Maximum Power Consumption	80 watts, 100 VA, at 60 Hz.
CRT Display	
Display Area	8 X 10 cm.
Trace Rotation Range	Adequate to align trace with horizontal center line.
Standard Phosphor	P1
Nominal Accel-erating Potential	2,760 V.
Storage Display	
Writing Rate	At least 25 cm/ms.
Enhanced Writing Rate	At least 250 cm/ms.
Storage Viewing Time	One hour or less. (Storage time longer than 1 hour will make erasure difficult.)

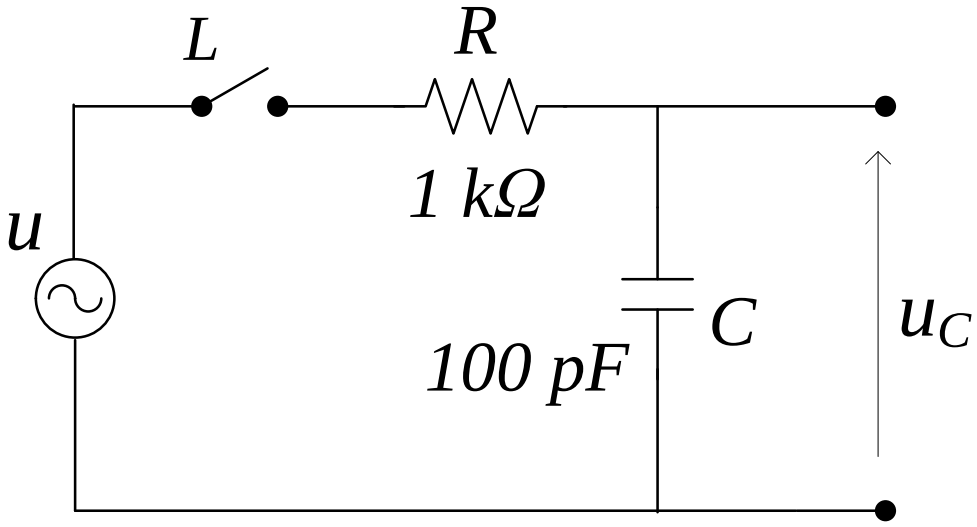
B. VERTICAL AMPLIFIER

Deflection Factor	
Range	2 mV/div to 10 V/div; 12 steps in a 1-2-5 sequence.
Accuracy	
+20° C to +30° C	Within 3%
0° C to +45° C	Within 4%.
Uncalibrated (VAR) Range	Continuously variable between settings. Extends deflection factor to at least 25 V/div (at least 2.5:1).
Frequency Response	
Bandwidth	Dc to at least 10 MHz (5 division reference signal centered vertically from a 25 Ω source with VOLTS/DIV VAR control in calibrated detent).
Risetime	35 ns or less.
Chopped Mode Repetition Rate	Approximately 250 kHz.
Input Resistance	Approximately 1 MΩ.
Input Capacitance	Approximately 30 pF.
Maximum Input Voltage	
DC Coupled	400 V (dc + peak ac). 800 V (p-p ac) at 1 kHz or less.
AC Coupled	400 V (dc + peak ac). 800 V (p-p ac) at 1 kHz or less.

C. TIME BASE

Sweep Rate	
Calibrated Range	0.5 s/div to 0.5 μs/div; 19 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 50 ns/div.
Accuracy	Accuracy specification applies over center 8 divisions. Exclude first 50 ns of sweep for both magnified and unmagnified sweep rates and anything beyond the 100th magnified division.
+20°C to +30°C	
Unmagnified	Within 3%.
Magnified	Within 5%.
0°C to +45°C	
Unmagnified	Within 4%.
Magnified	Within 6%.
Variable Magnifier	10:1.
X-Y Operation	
Deflection Factor	
Variable Magnifier	
X10	Approximately 100 mV/div.
X1	Approximately 1 V/div.
X-Axis Bandwidth	Dc to at least 1 MHz with 10 div reference signal.
Input Resistance	Approximately 1 MΩ.
Input Capacitance	Approximately 30 pF.
Phase Difference Between X- and Y-Axis Amplifiers	5° or less from dc to 50 kHz.
Triggering	
Sensitivity	0.5 div internal or 100 mV external from 2 Hz to 1 MHz, increasing to 1.5 div internal or 150 mV external at 10 MHz.
External Trigger Input	
Maximum Input Voltage	400 V (dc + peak ac). 800 V (p-p ac) (1 kHz or less).
Input Resistance	Approximately 1 MΩ.
Input Capacitance	Approximately 30 pF.
Level Range	
EXT	+0.5 V to −0.5 V.
$\frac{\text{EXT}}{10}$	+5 V to −5 V.

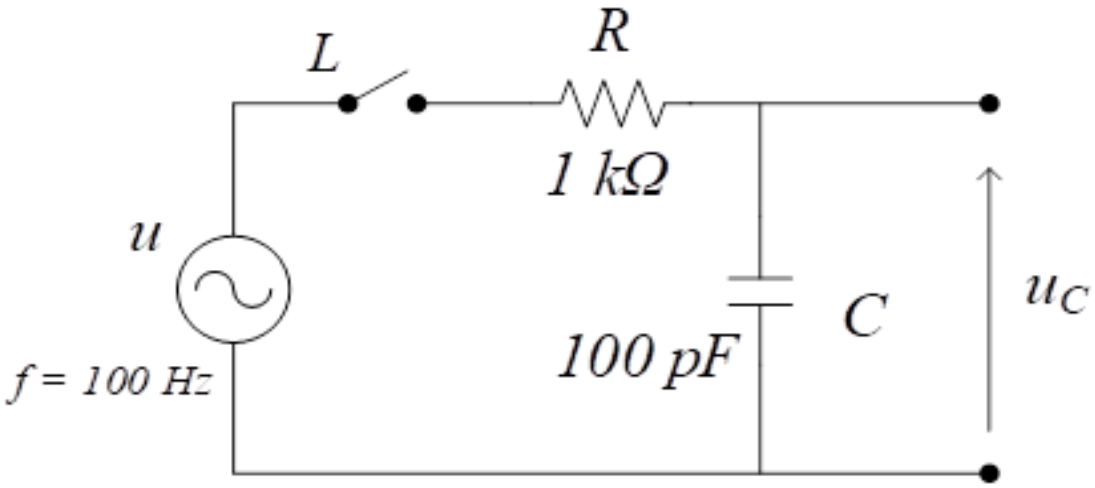
Ejemplo: es necesario visualizar la forma de onda de tensión en el capacitor, cuando se cierra la llave L. Se pretenden observar los primeros 5 ciclos, y medir su valor cresta y frecuencia.



$$u\,[V] = 100\ sen\ 628t$$

Se dispone de un osciloscopio Tektronix T912, y puntas pasivas de tensión 10X y 100X, con cable coaxial de longitud adecuada (≈1m), y capacidad entre el conductor central y la malla de 100 pF.

Detallar: cómo conectar el osciloscopio al circuito, cómo ajustar sus principales controles, qué punta utilizar, y cuáles son los errores de medición que pueden aparecer.



$$u\,[V\,] = 100\ sen\ 628t$$

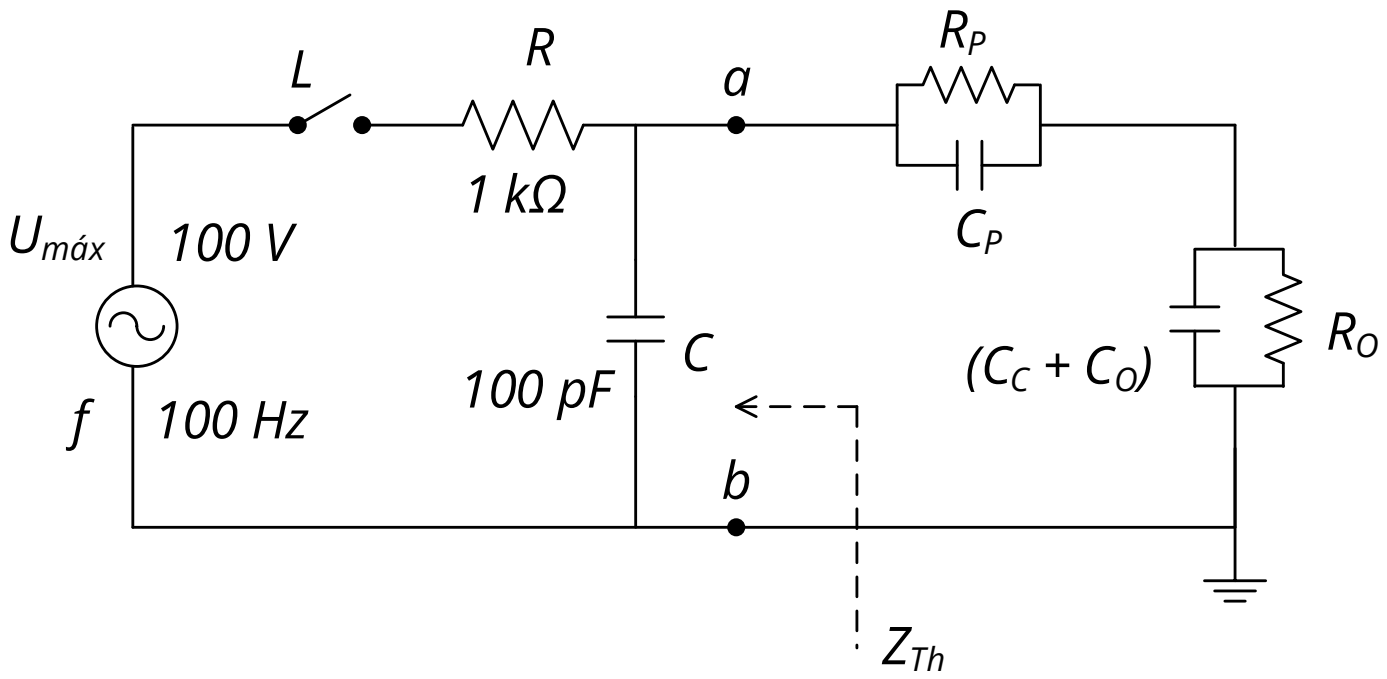
$\tau_s = R * C$ = 100 ns

$t_{s_s} = 2{,}2 * \tau_s = 0{,}22\ \mu s$ << 10 ms (BW$_s$ ≈ 1,6 MHz)

BW$_{osciloscopio}$ = 10 MHz $\Rightarrow$ $t_{s_o} = 35$ ns

$t_{s_s} = \sqrt{t_{s_o}^2 + t_{s_s}^2} \approx t_{s_s}$ ($e \approx 1\ \%$; que no es relevante para este caso.)

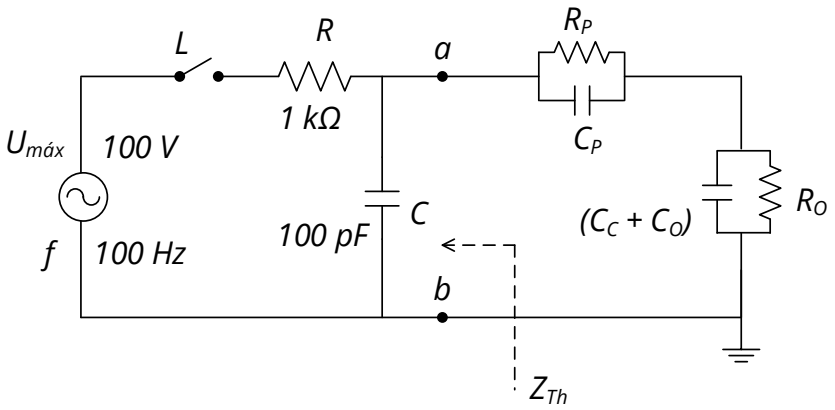
Circuito equivalente con punta 10X o 100X:



Para la frecuencia de interés, 100 Hz:

$$X_C \approx 15{,}9\ M\Omega \Rightarrow Z_{Th} \approx 1\ \text{k}\Omega$$

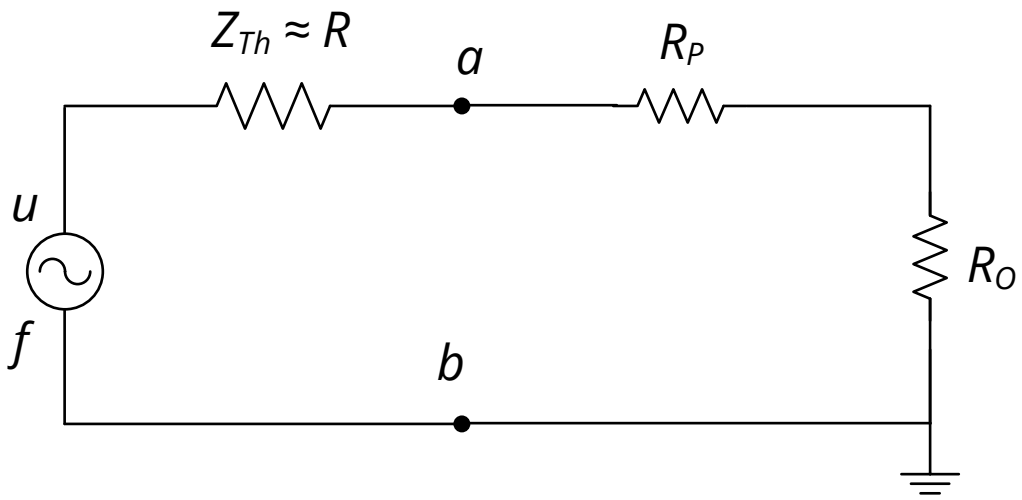
$$X_{(C_C + C_O)} \approx 12{,}2\ M\Omega$$



Con: $R_P \,.\, C_P = R_O \,.\, (C_C + C_O)$

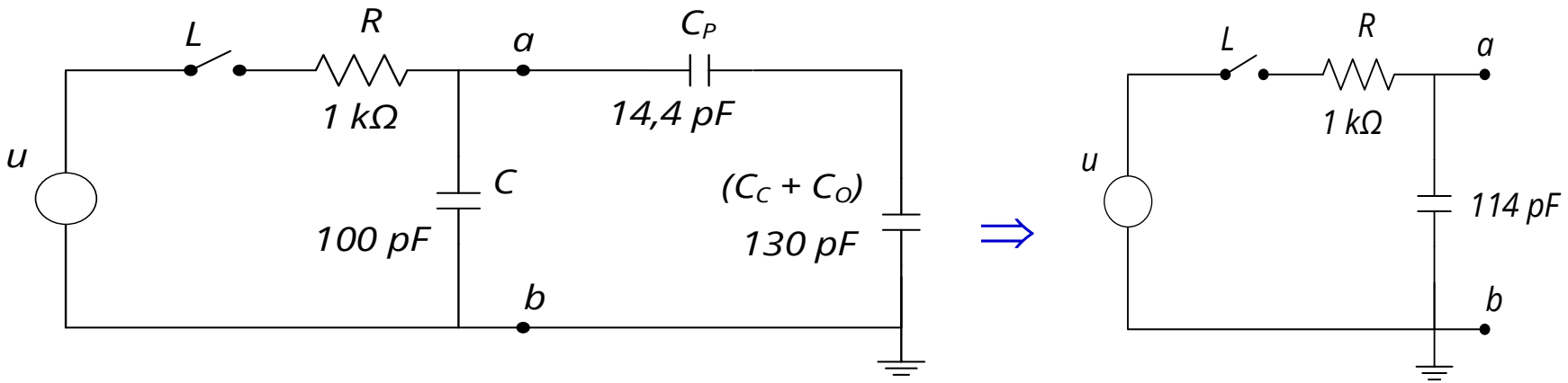
Punta	10X	100X
R_P	9 MΩ	99 MΩ
C_P	14,4 pF	1,31 pF
X_{C_P}	≈ 110 MΩ	≈ 1,2 GΩ

Punta 10X - Rta. forzada (100 Hz)



$$e_{inserción} \approx \frac{-R}{R_P + R_O} . 100 = \frac{-1\ k\Omega}{9\ M\Omega + 1\ M\Omega} . 100 = -0{,}01\ \%$$

Punta 10X - Rta. natural (transitorio inicial)

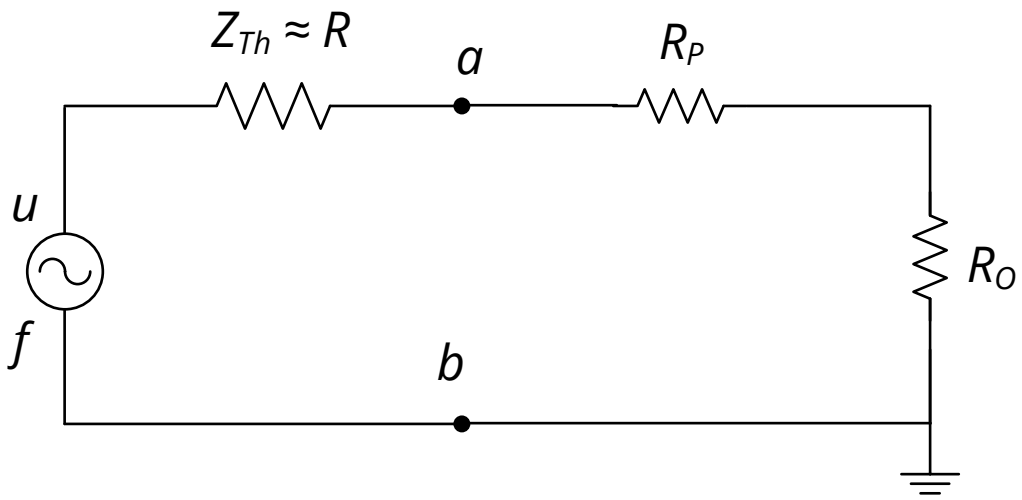


$$t_{s_m} \approx 2{,}2 * 1\ k\Omega\ *\ 114\ pF = 0{,}25\ \mu s$$

$$\Rightarrow e_{inserción_{t_{s_s}}} = \frac{t_{s_m} - t_{s_s}}{t_{s_s}} \approx 14\ \%$$

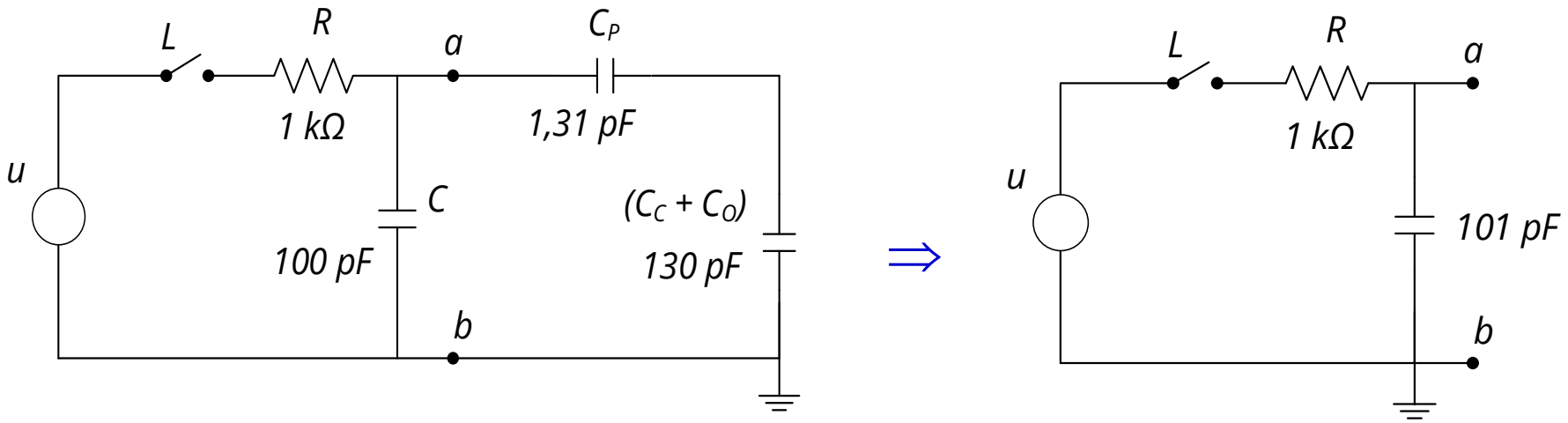
(no relevante para este caso)

Punta 100X - Rta. forzada (100 Hz)



$$e_{inserción} \approx \frac{-R}{R_P+R_O} \cdot 100 = \frac{-1\ k\Omega}{99\ M\Omega+1\ M\Omega} \cdot 100 = -0{,}001\ \%$$

Punta 100X - Rta. natural (transitorio inicial)



$$t_{s_m} \approx 2{,}2 * 1\ k\Omega * 101\ pF = 0{,}222\ \mu s$$

$$\Rightarrow\ e_{inserción_{t_{s_s}}} \approx 1\ \%$$

(no relevante para este caso)

Supongamos que se elige la **punta 100X** para visualizar los 5 ciclos:

$$U_{p-p\ osc}[V] = \frac{200\ V}{100} = 2\ V$$

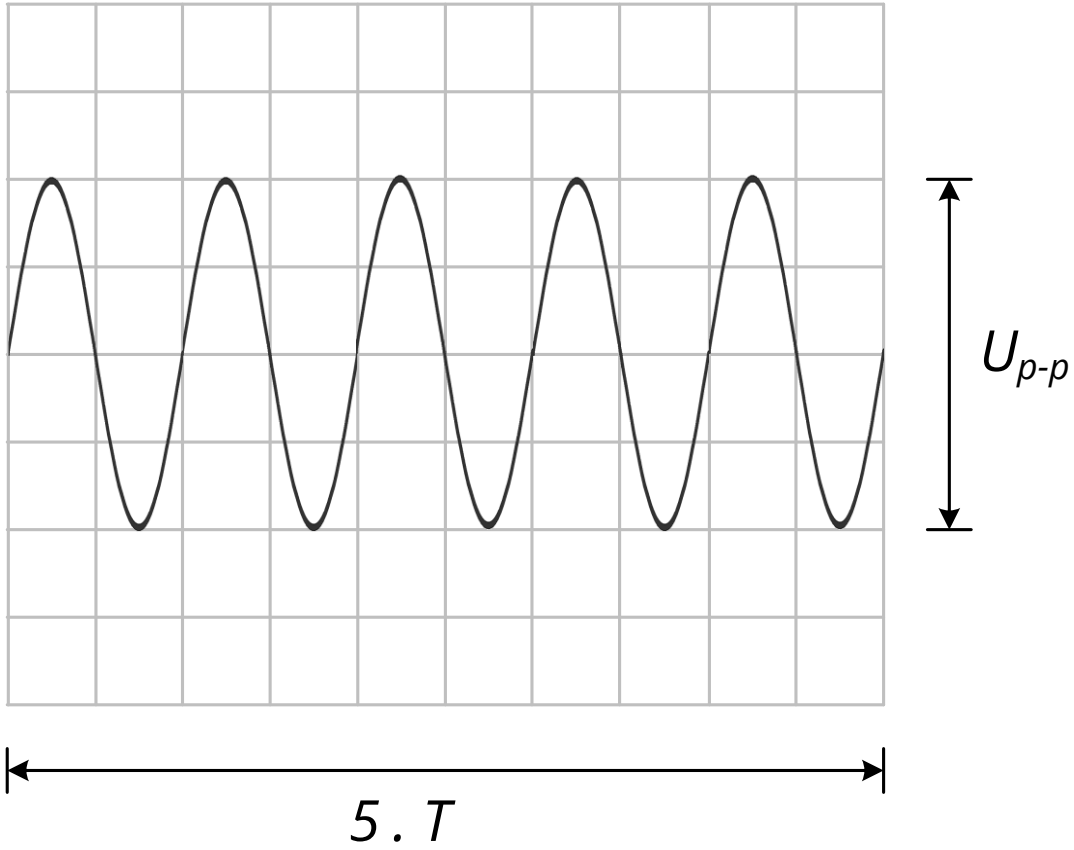
$$Atenuador\ \left[\frac{V}{div}\right] = \frac{2\ V}{8\ div} = 0{,}25\ \frac{V}{div}$$

$$\Rightarrow Atenuador\colon\ 0{,}5\ \frac{V}{div}$$

$$Base\ de\ Tiempo\ \left[\frac{ms}{div}\right] = \frac{5\ *\ 10\ ms}{10\ div} = 5\ \frac{ms}{div}$$

Ajustes del disparo:

- Disparo único (single sweep).
- Nivel de disparo ≈ 0 V, pendiente +.



Errores en Vertical:

$$U_{p-p\,m}[V] = 100 * 4\ div * 0{,}5\,\frac{V}{div} = 200\ V$$

$$\mathrm{e}_{U_{p-p_m}} = \pm\left(e_{punta} + e_{resolución_{U_{p-p_m}}} + e_{Atenuador}\right) =$$

$$= \pm\left(\approx 0 + \frac{{}^{1}\!/_{50}\ div}{4\ div} * 100 + 3\right) = \pm 3{,}5\ \%$$

Errores en Horizontal:

$$T_m[ms] = \frac{10\ div}{5} * \ 5\ \frac{ms}{div} = 10\ ms$$

$$\mathrm{e}_{T_m} \ = \ \pm \left(e_{resolución\ T_m} + \ e_{Base\ de\ Tiempo} \right) =$$

$$= \pm \left(\frac{{}^{1}/_{50}\ div}{10\ div} * 100 + 3 \right) = \ \pm 3{,}2\ \%$$