

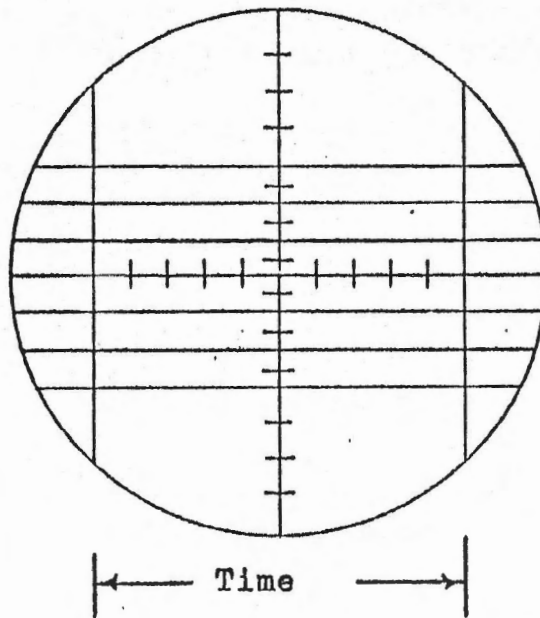
TEKTRONIX, INC.

Lecture notes on:

FUNDAMENTAL ELECTRONIC CONCEPTS
FOR
OSCILLOSCOPE USE & MAINTENANCE

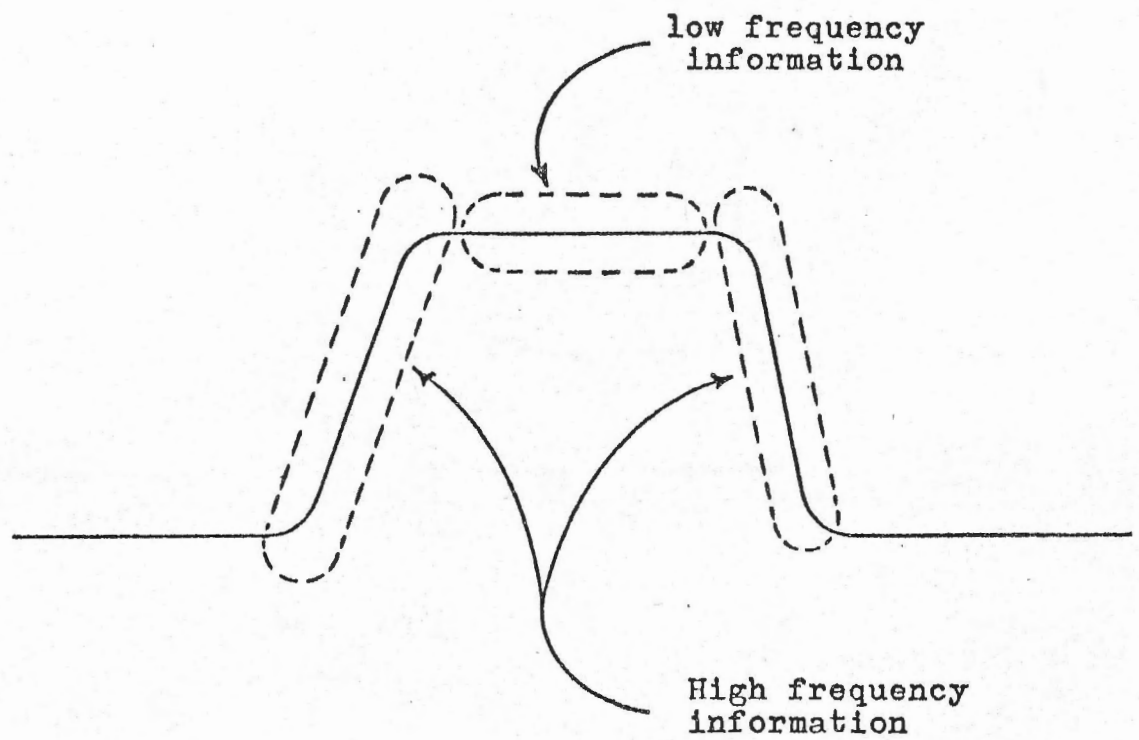
February 10, 1956/cs
Revised April 20, 1956/cs

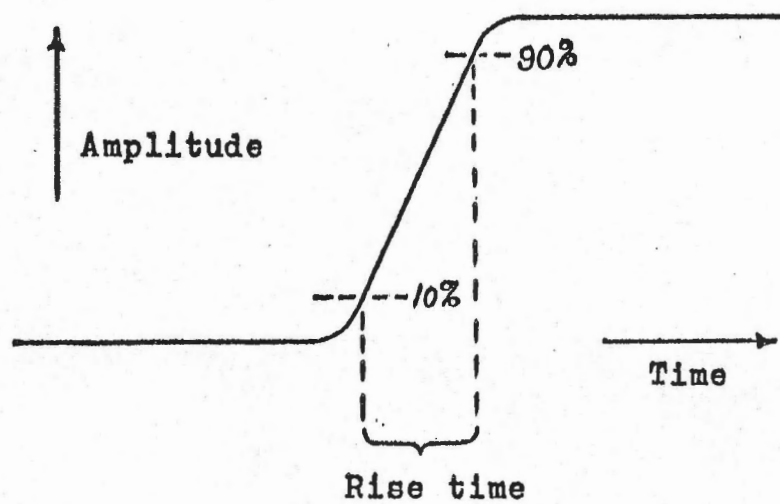
Information obtained from a
Cathode-ray Oscilloscope:

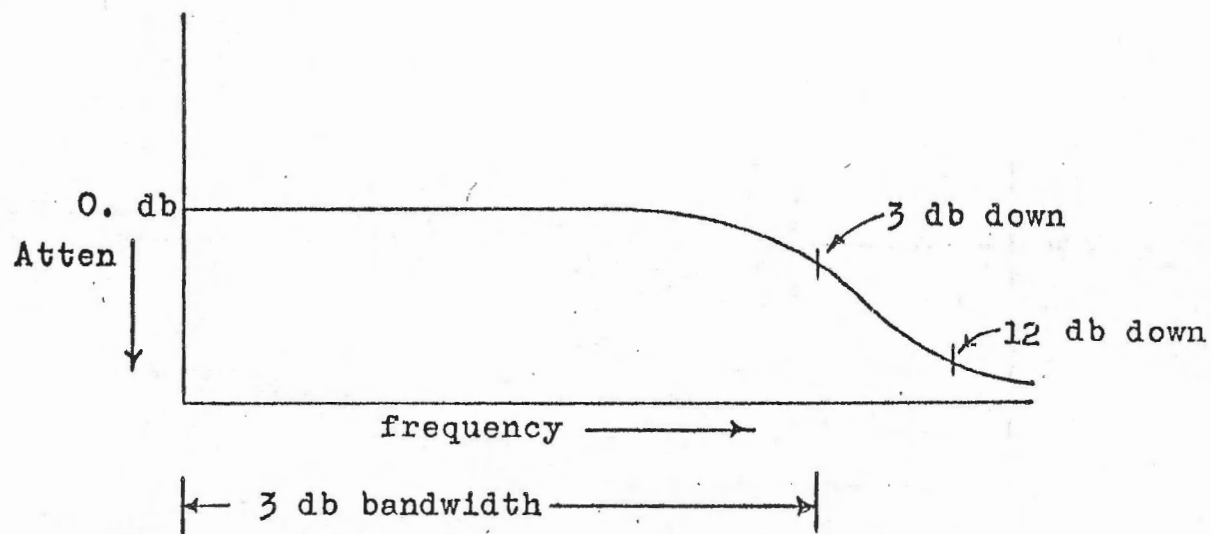


Amplitude =
(Divisions of display)
 \times
(volts/div)

Time = (Divisions of display)(Time/div)

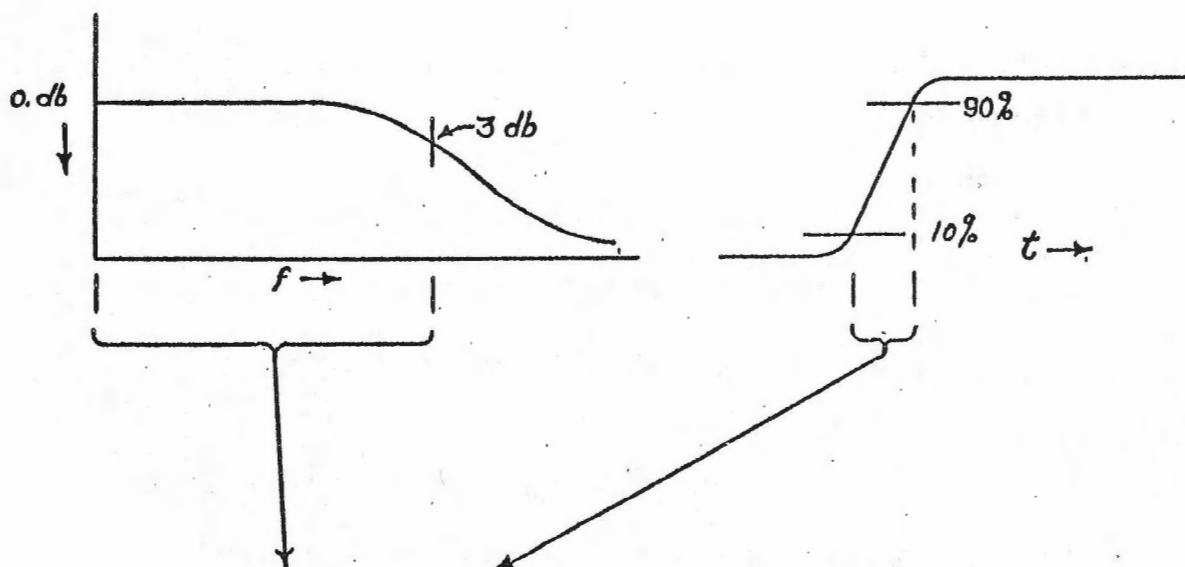






Amplitude-frequency response curve

Note that frequency plotted is logarithmic --- for a "rule of thumb", if the 3 db down point occurs at 10 mc, then the 12 db down point will fall approximately at 20 mc



$$(\text{BW}_{\text{cps}}) (\text{RT}_{\text{sec}}) = k ; \quad \begin{array}{l} k \text{ is a value between} \\ .33 \text{ and } .5 \text{ depending} \\ \text{upon amount of high-} \\ \text{frequency compensation.} \end{array}$$

$$= .35 \quad (\text{typical value used by TEK})$$

LIMITS: Overshoot on leading edge less than 2-3%

$$(BW) (RT) = .35$$

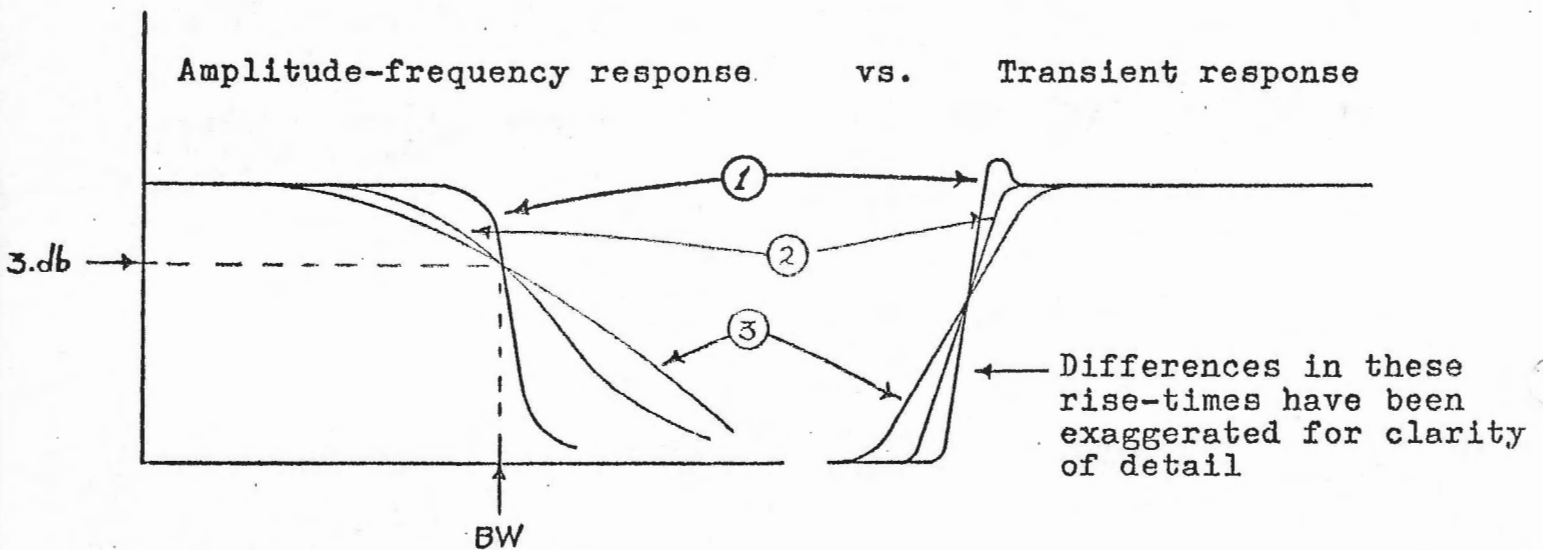
Limits: Overshoot less
than 2-3%

$$(RT) = \frac{.35}{(BW)}$$

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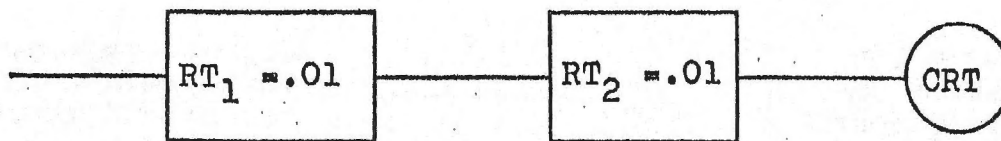
EXAMPLE: $RT_{\mu\text{sec}} = \frac{.35}{10_{\text{mc}}} = 0.035 \mu\text{sec}$

Amplitude-frequency response vs. Transient response



1. Amplitude-frequency response curve "falls off" too rapidly --- causes transient response to show overshoot & ringing;
2. Amplitude-frequency response curve "falls off" along a Gaussian curve and produces the optimum transient response --- the sharpest corner free from overshoot & ringing;
3. Amplitude-frequency response curve "falls off" too slowly --- causing undershoot

Effect of passing a signal through two identical stages:



$$RT_t = \sqrt{RT_1^2 + RT_2^2 + \dots + RT_n^2}$$

$$RT_1^2 = .0001$$

$$RT_2^2 = .0001$$

$$RT_t = \sqrt{.0002} = .014 \quad \text{(shows a 40\% increase in rise-time--just due to passing signal through two equal stages of a video system)}$$

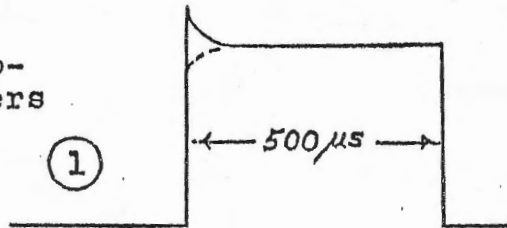
TYPES OF OVERSHOOT

Description & Cause

Display

Cure

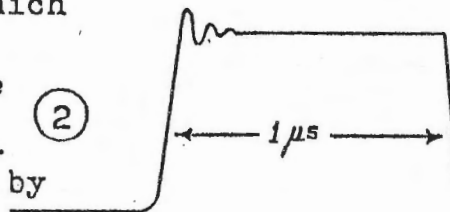
Typical overshoot (or undershoot) caused by mis-adjustment of compensated voltage-dividers



Adjust compensated voltage-divider trimmer capacitors as required.

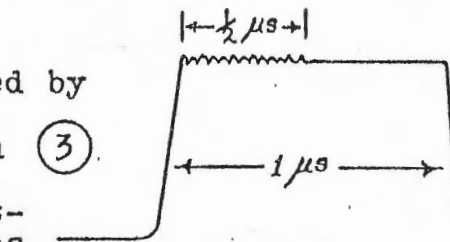
Overshoot followed by a high-frequency ring which decays exponentially;

typical of video stage or system with excess high frequency gain -- usually brought about by too much inductive or capacitive compensation



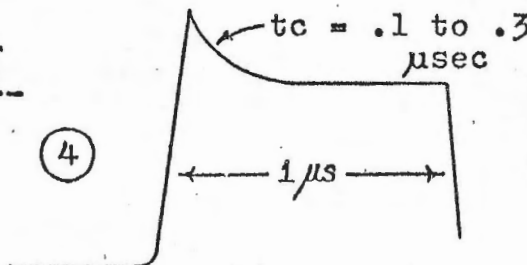
Adjust high-frequency compensation networks

Typical wrinkles caused by delay line; brought about by inter-section impedance mis-matches, with resulting reflections and standing waves



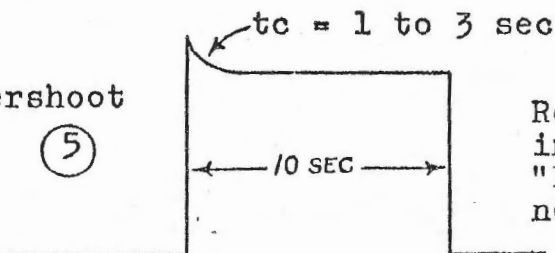
Adjust all trimmers (or as necessary) on the delay line but only after all other sources of overshoot have been eliminated

Typical severe case of "cathode interface" --- a vacuum tube defect



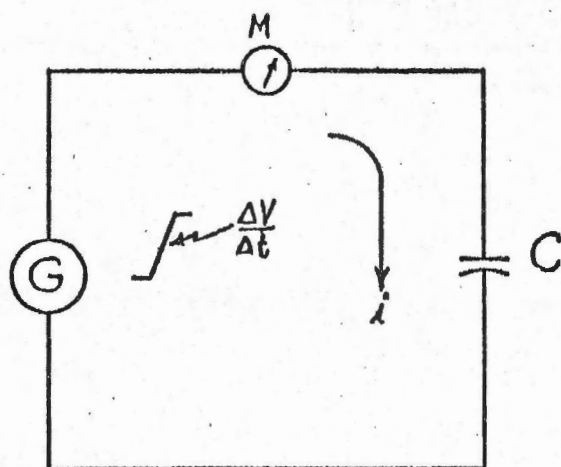
Replace tubes until a set is found which shows very little "interface".

Typical "DC-shift" overshoot caused by a vacuum tube defect



Replace tube(s) involved or adjust "DC-shift" compensation network.

NOTE: You may have all five of these overshoots present in a vertical amplifier at one time!



$$I = \frac{\Delta V}{\Delta t} C$$

Example:

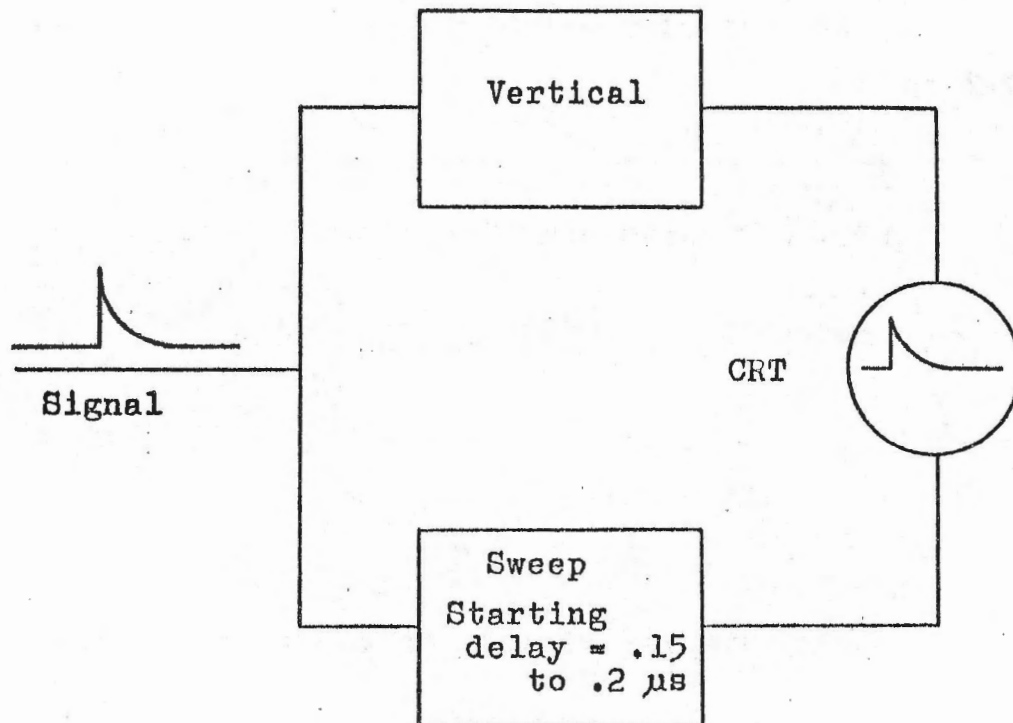
V = 100. volts

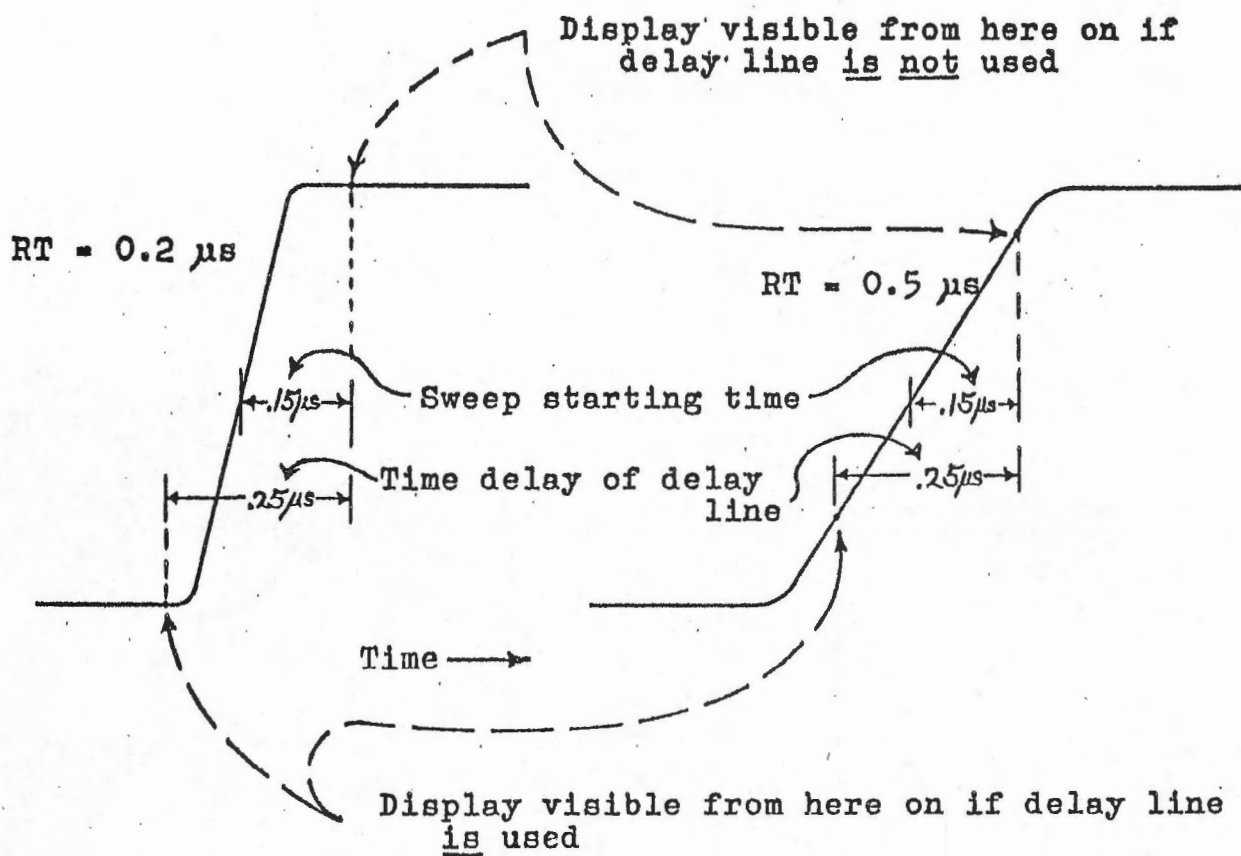
C = 5 μ fd.

t = .005 microseconds

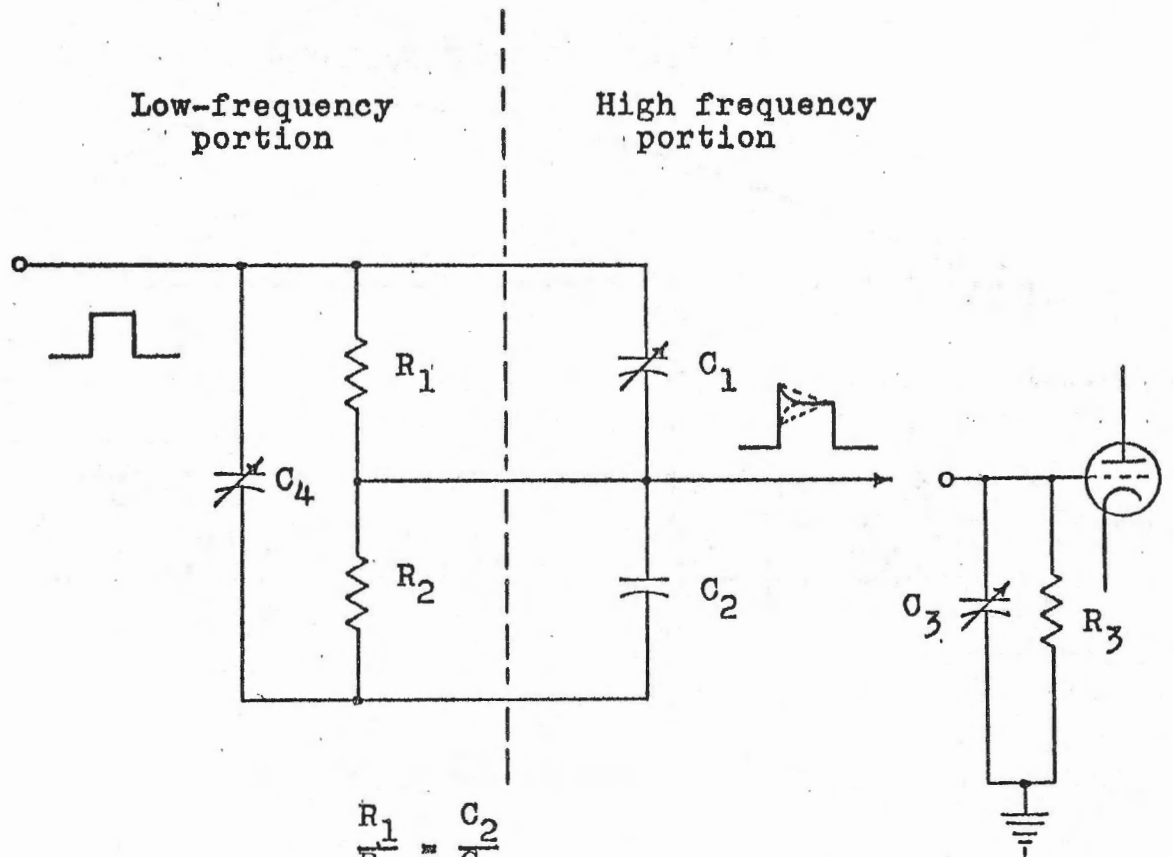
$$i = \frac{(100) (5) (10^{-12})}{(.005) (10^{-6})}, \text{ amperes; } = 100 \text{ mA}$$

Vertical must have about $0.25 \mu\text{s}$
delay line





COMPENSATED VOLTAGE DIVIDER

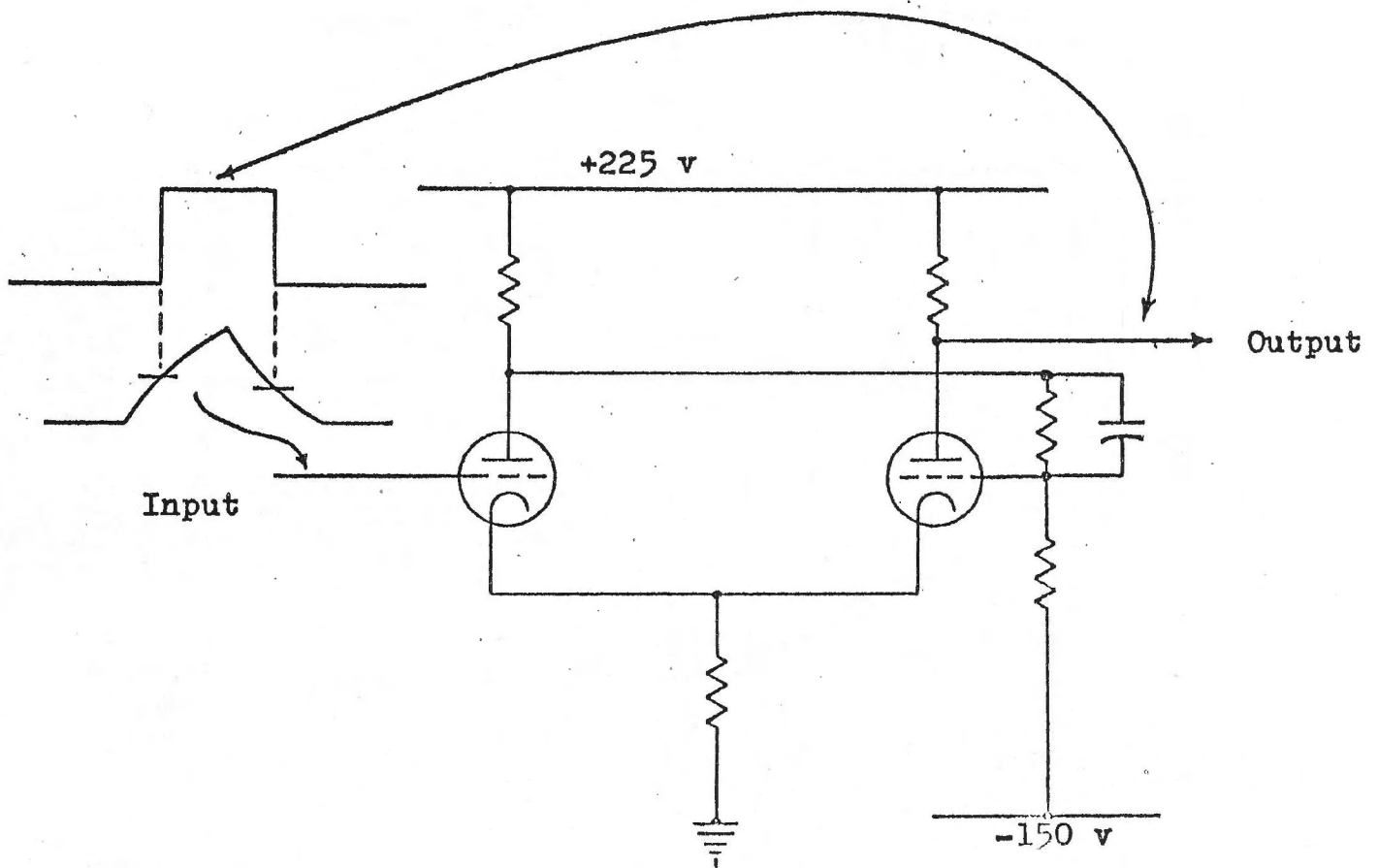


$$\frac{R_1}{R_2} = \frac{C_2}{C_1}$$

or

$$R_1 C_1 = R_2 C_2 \quad (\text{Time constants equal})$$

BISTABLE MULTIVIBRATOR

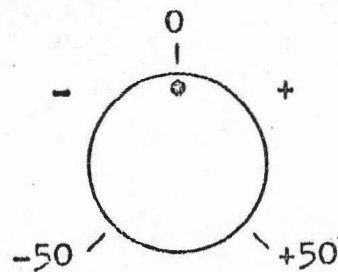
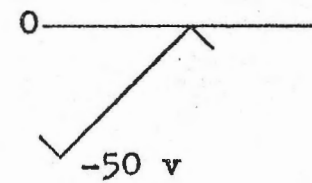
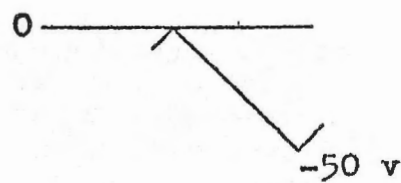
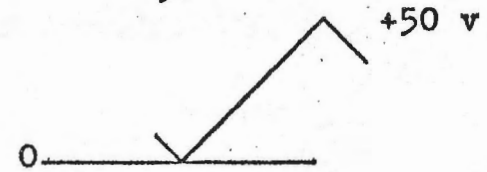
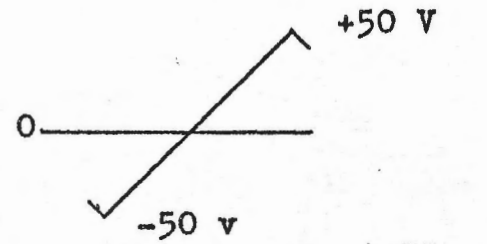
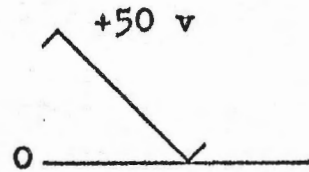
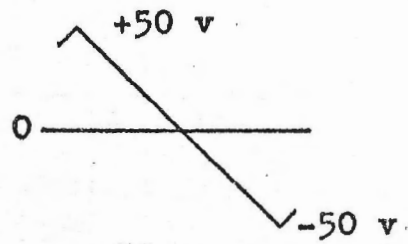


- Slope:

-Ext
-Int
-Line

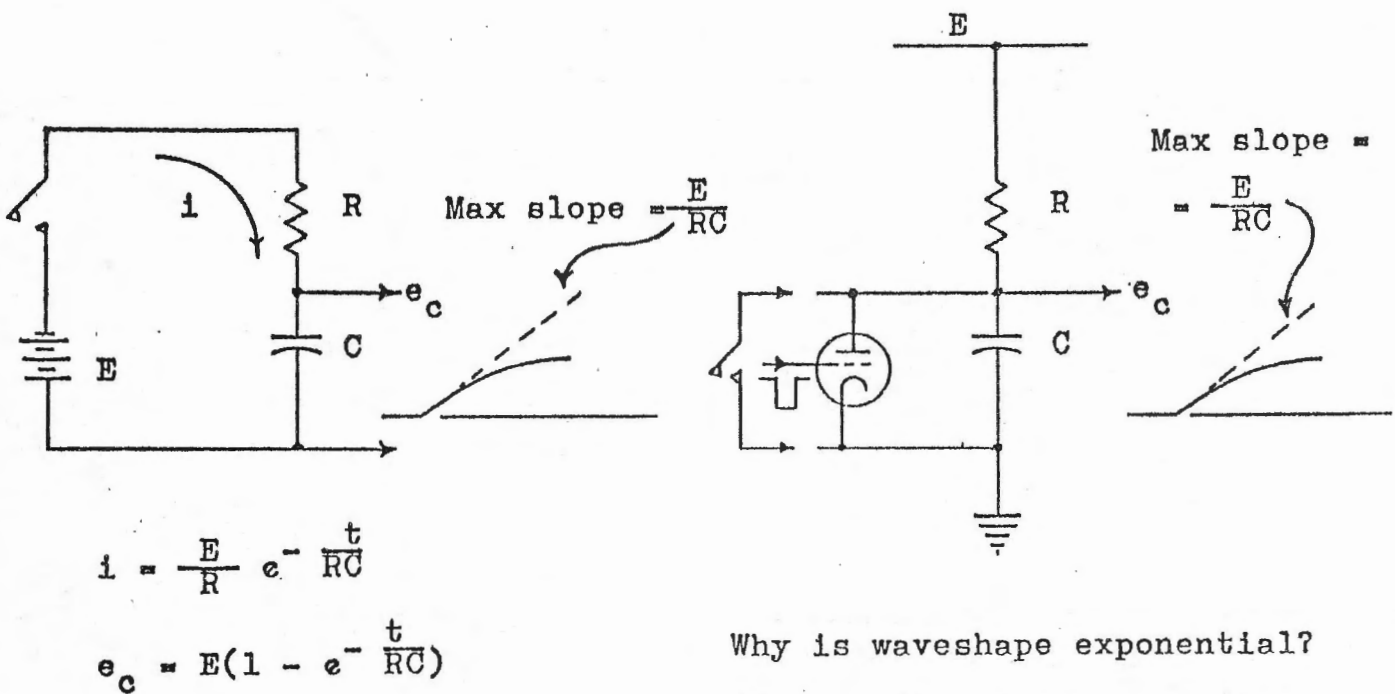
+ Slope:

+Ext
+Int
+Line



TRIGGERING LEVEL

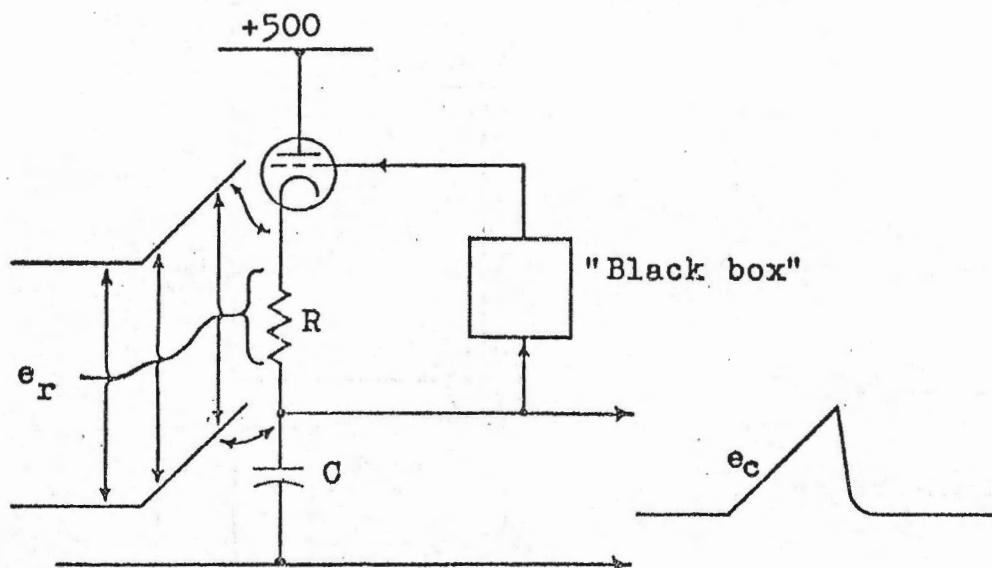
CLAMP TUBE SWEEP GENERATOR



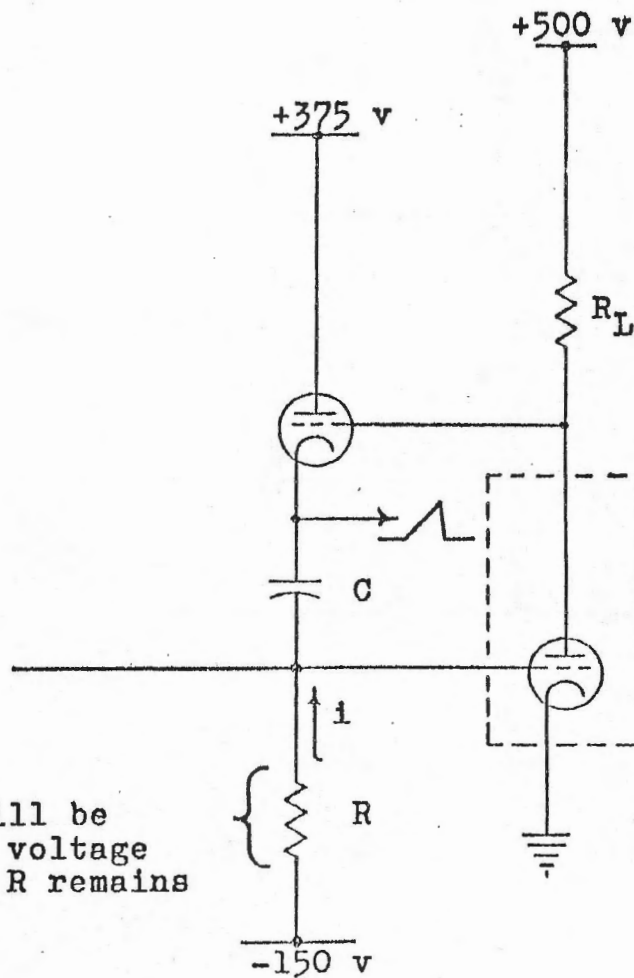
Why is waveshape exponential?

As capacitor charges, voltage drop across resistor steadily decreases --- causing a steadily decreasing current flow into the capacitor per unit of time.

BASIC BOOTSTRAP CIRCUIT



MILLER RUN-UP SWEEP GENERATOR



Current i will be constant if voltage drop across R remains constant.