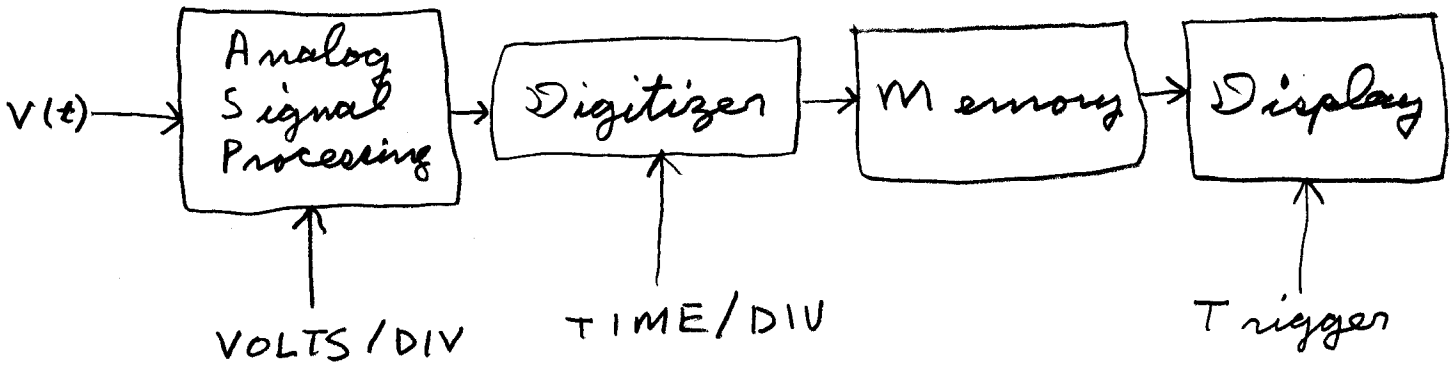
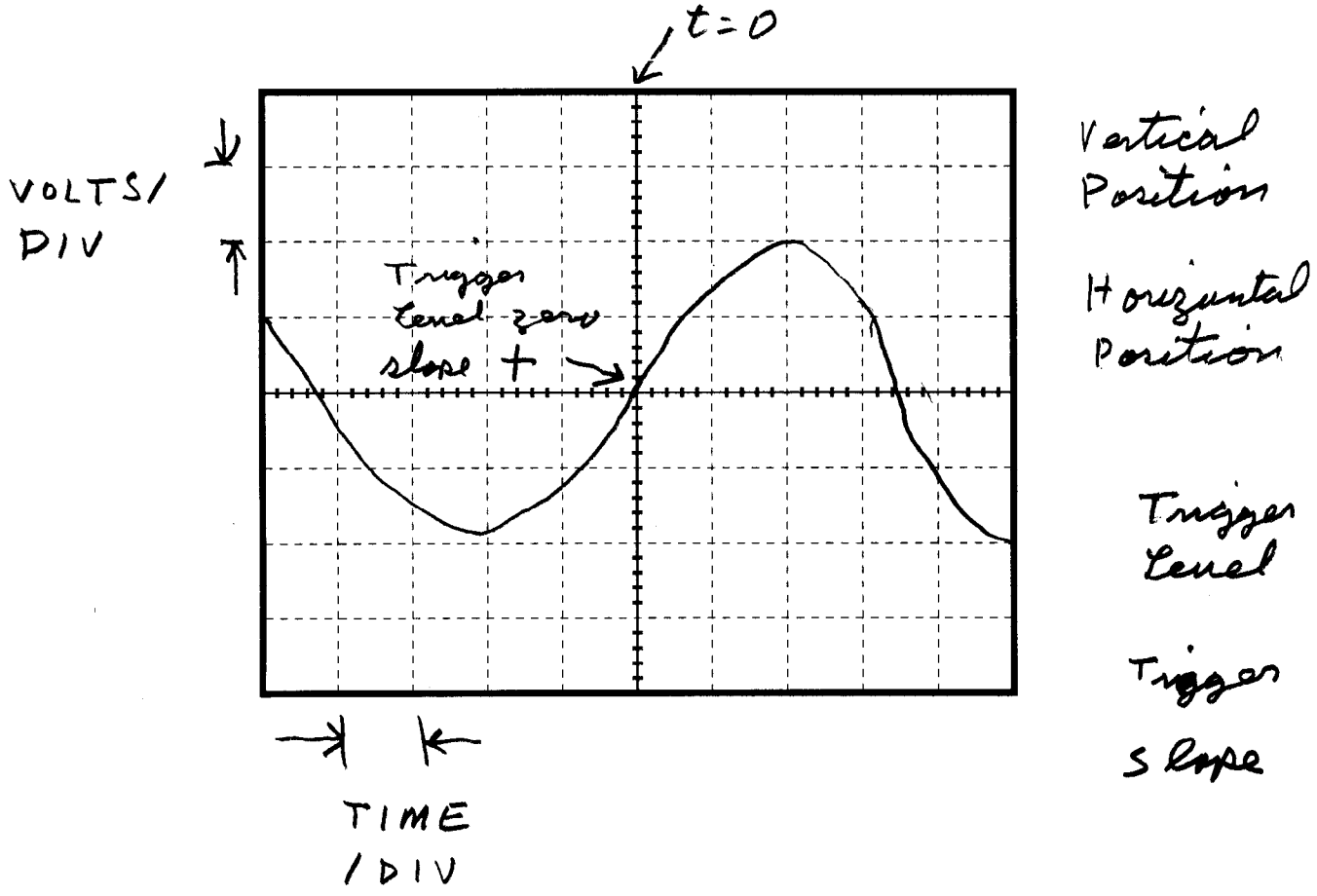
Oscilloscope or Scope

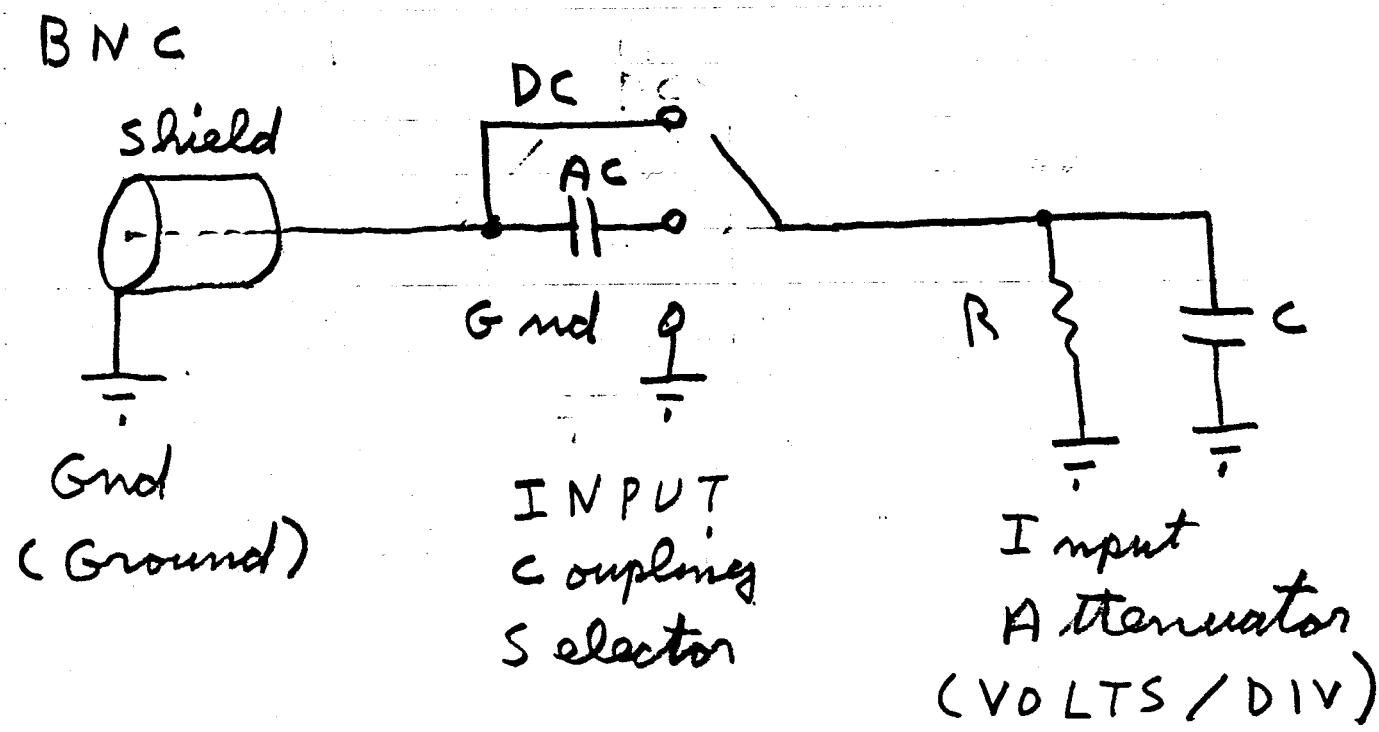


Tektronix 3012B 2 channel 100 MHz

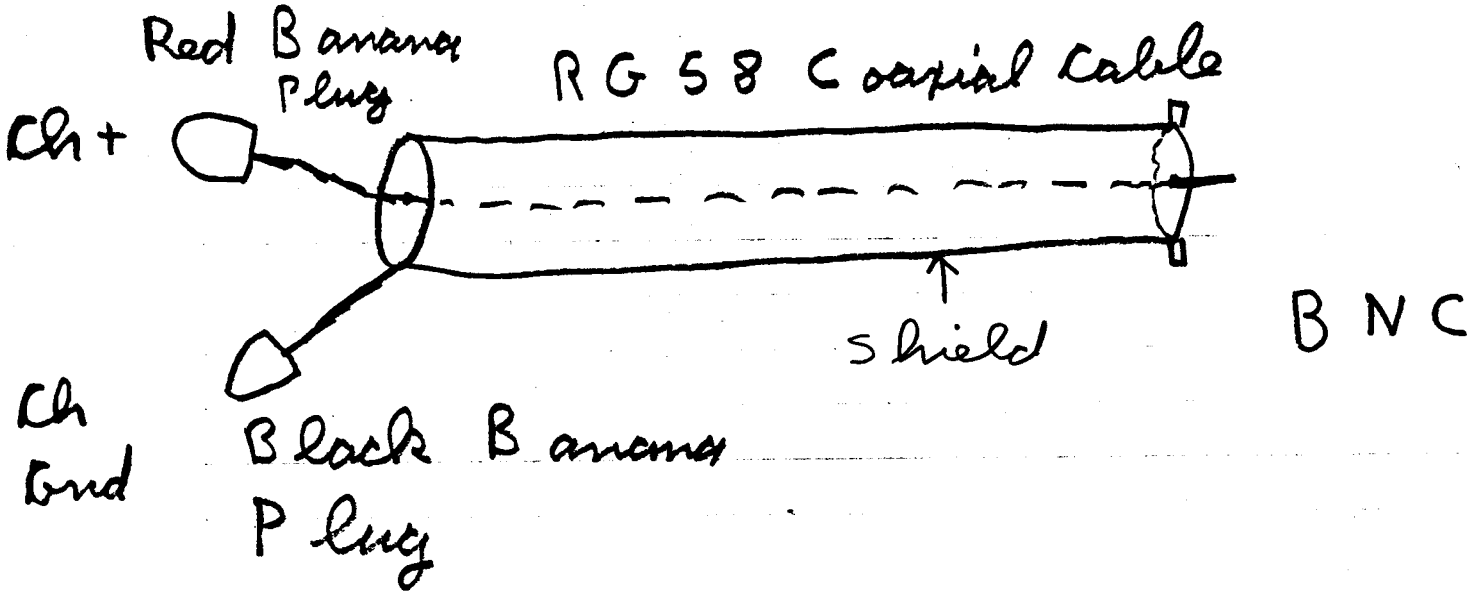
One or two signals may be plotted as a function of time providing that the frequency content is less than 100MHz



Analog Signal Processing

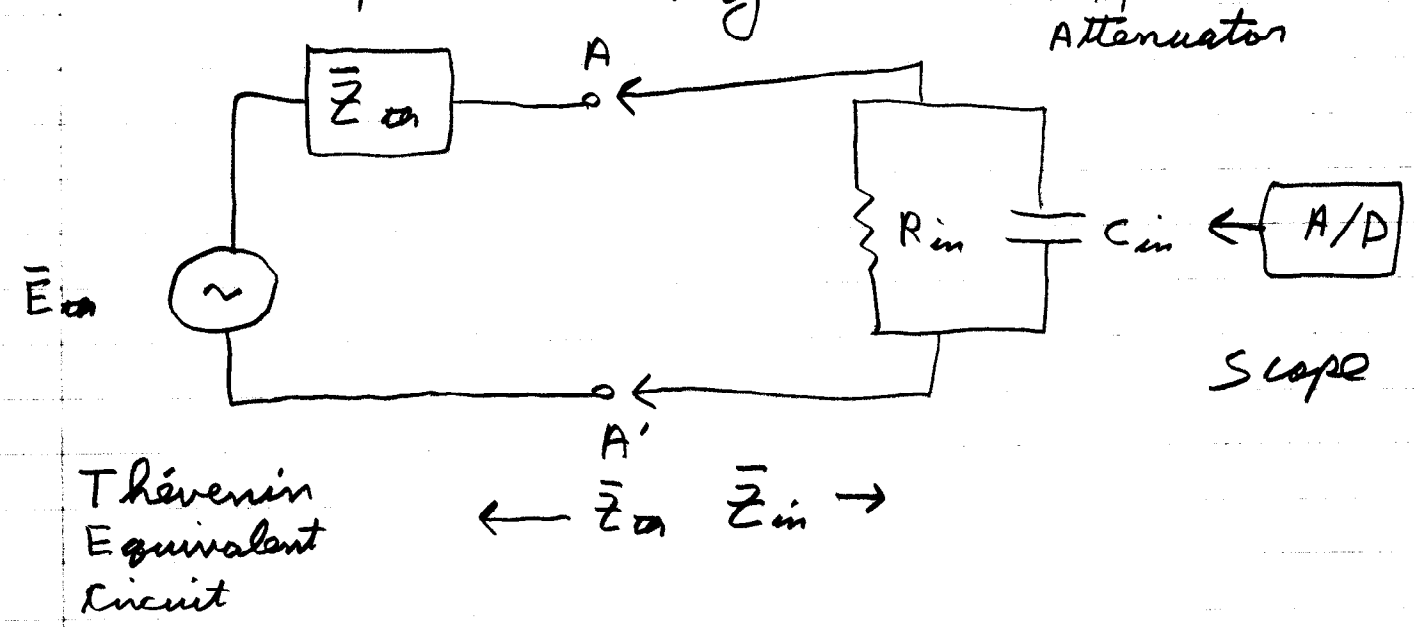


1X Scope Lead



$Z_0 \equiv$ characteristic impedance $= \sqrt{\frac{L}{C}} = 50\,\Omega$ for RG58

Scope Loading



The impedance seen looking into the scope

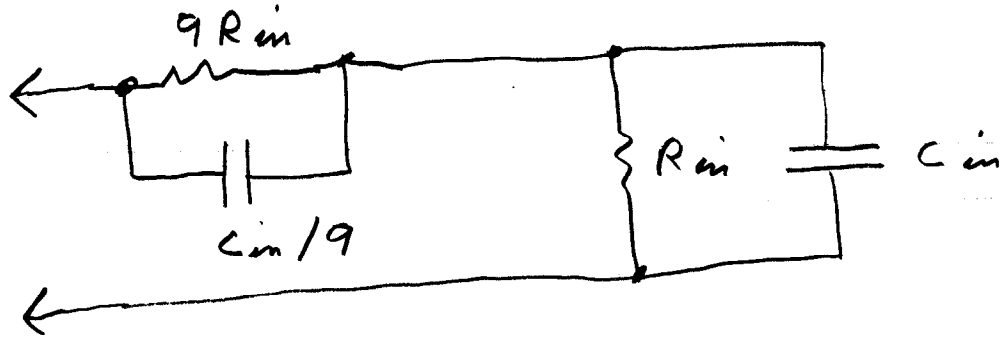
$$\bar{Z}_{in} = R_{in} \| \left(-j \frac{1}{\omega C_{in}}\right) = \frac{R_{in}}{1 + j\omega R_{in} C_{in}}$$

for the Tektronix 3012 B $R_{in} = 1 M\Omega$, $C_{in} = 13 pF$

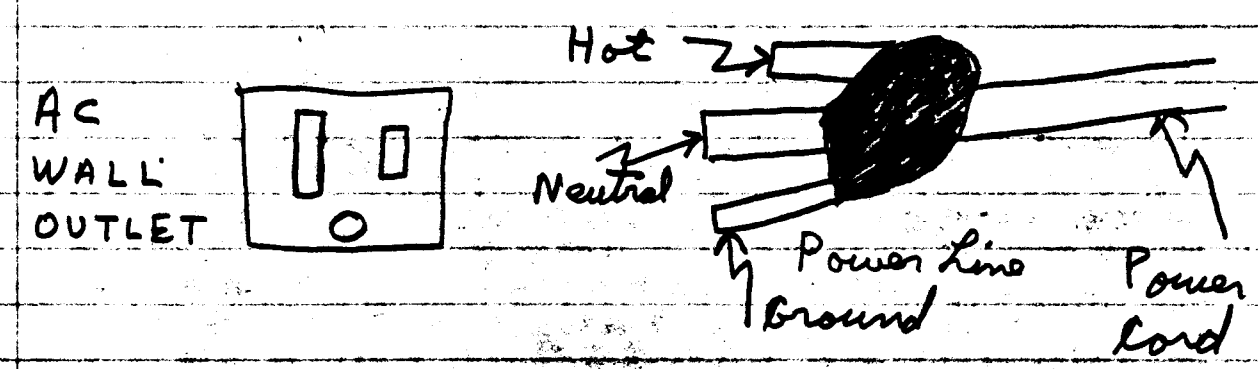
$$\% \text{ error} = 100 \left[\frac{1}{\left| 1 + \frac{\bar{Z}_{on}}{\bar{Z}_{in}} \right|} - 1 \right]$$

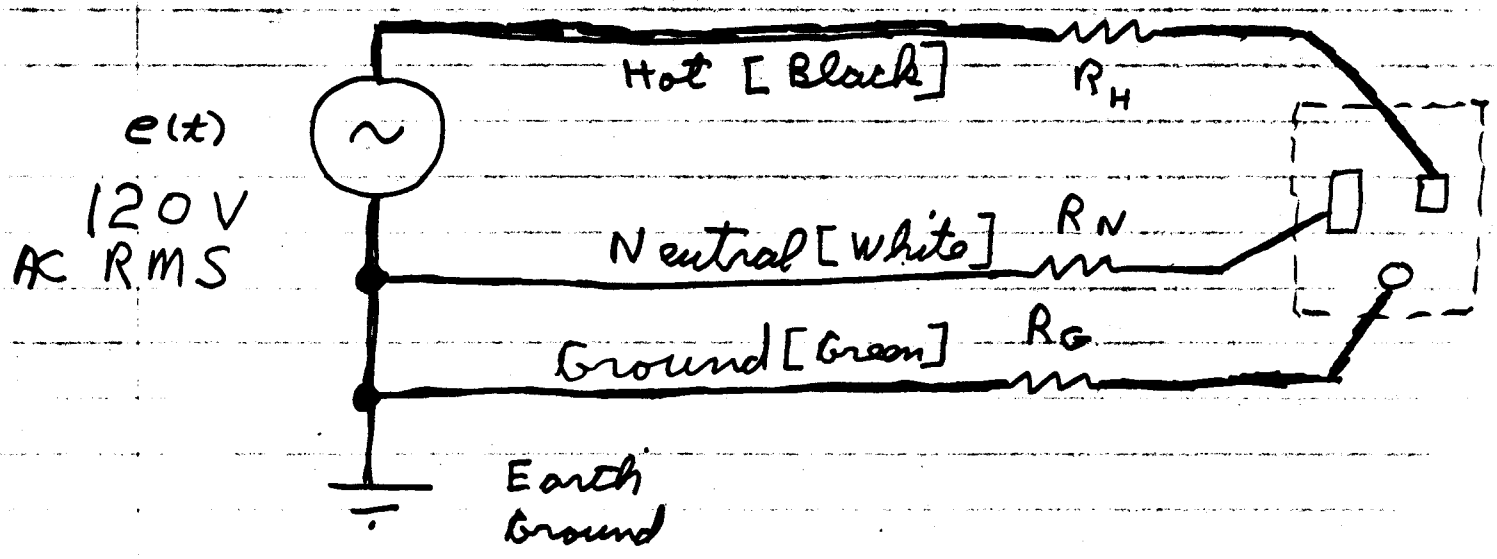
---

10 X Scope Probe

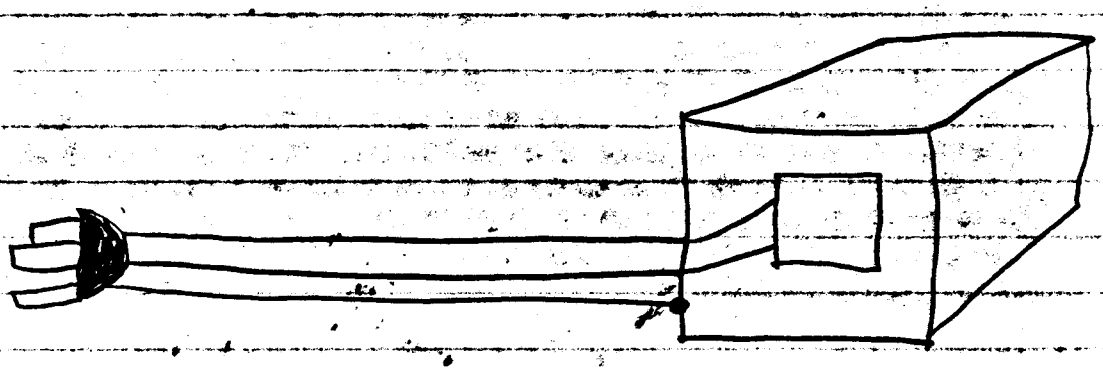


Electrical Grounding



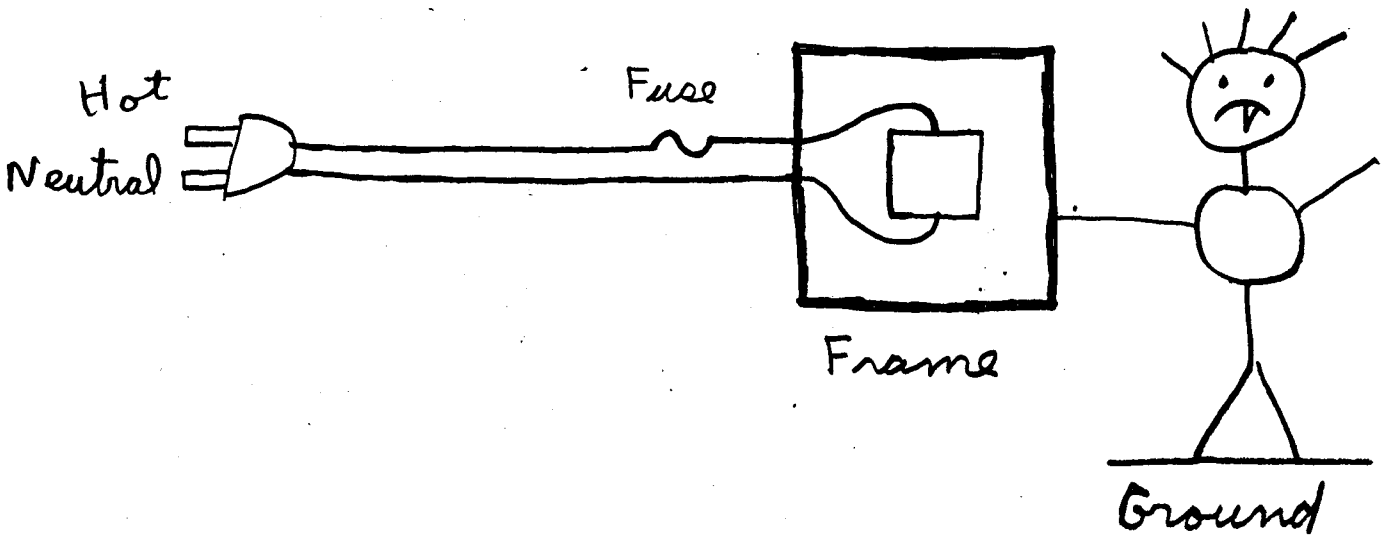


Instruments and Appliances Usually have their metal chassis connected to the AC ground wire.

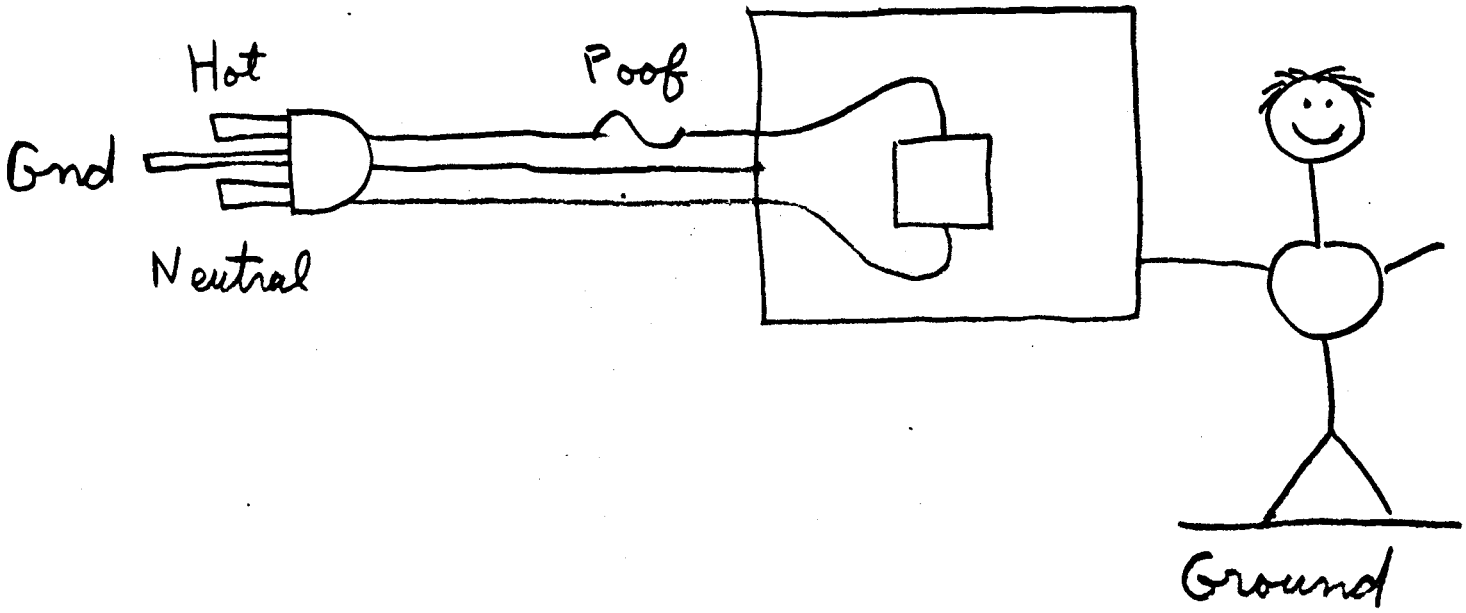


Grounded Case or Chassis

2 Wire Power Cord



3 Wire Power Cord



Circuit Protection Devices

Fuses

Circuit Breakers

Ground Fault Interupters

If the instrument’s chassis is not connected to the AC power ground, the chassis is said to “float” above ground.

If none of the input or output connectors of an instrument are internally connected to AC ground the instrument is said to “float.”

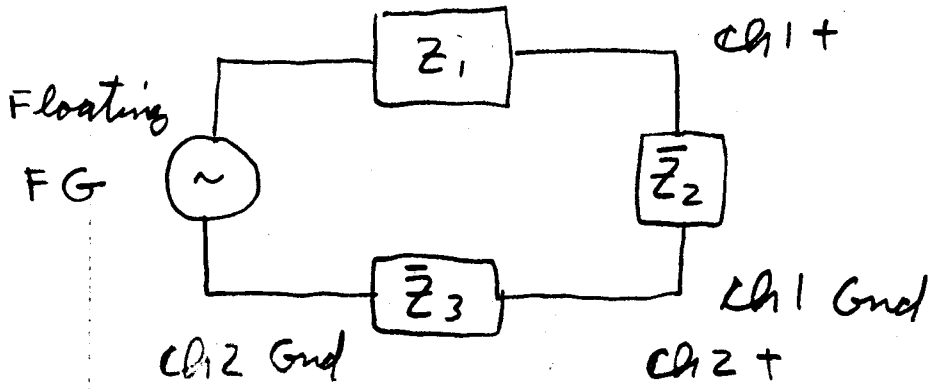
If one or more of the input or output connectors are internally connected to the AC ground the instrument is said to be grounded.

Floating

- Simpson Meter Model 260-7 Analog Multimeter
- Fluke 73 Hand Held Digital Multimeter
- Agilent 3630A Triple DC Power Supply
- Agilent 34401A Digital Multimeter
- Tektronix AFG 3022B Arbitrary/Function Generator
- National Instruments ELVIS II+
- Philips/Fluke 6300 LCR Meter
- Hewlett Packard 3311A Function Generator

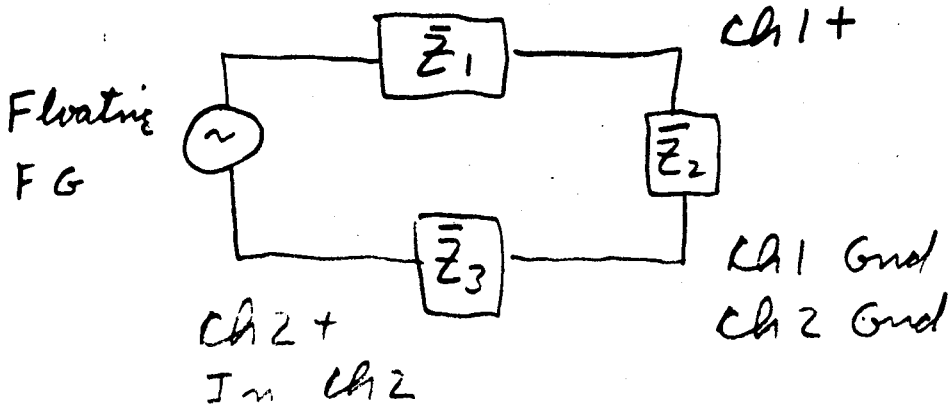
Grounded

Tektronix 3012B Oscilloscope

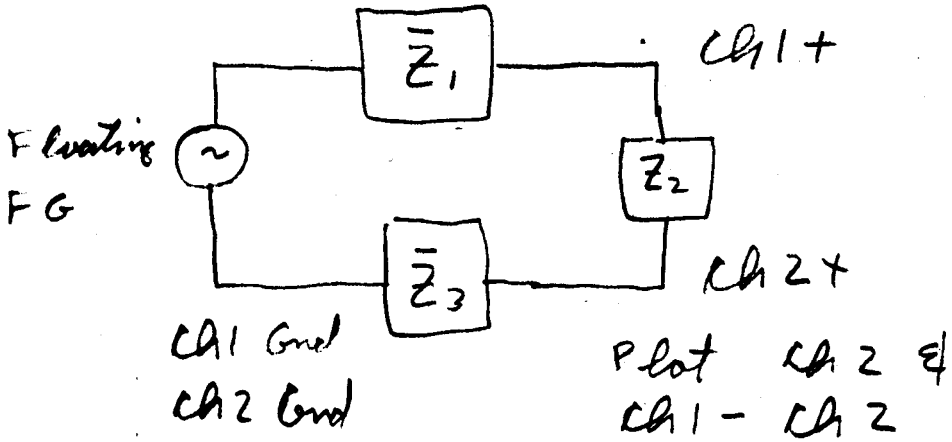


Wrong

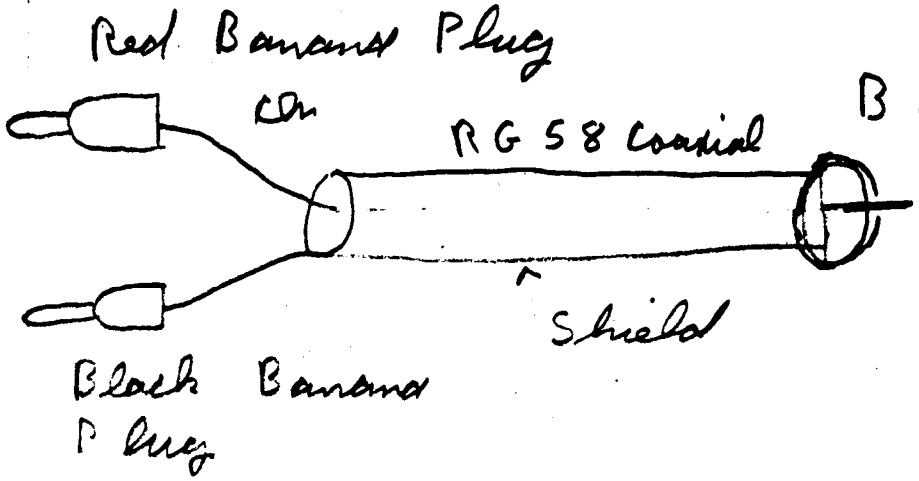
Z_3 shorted out by scope Grds



Correct

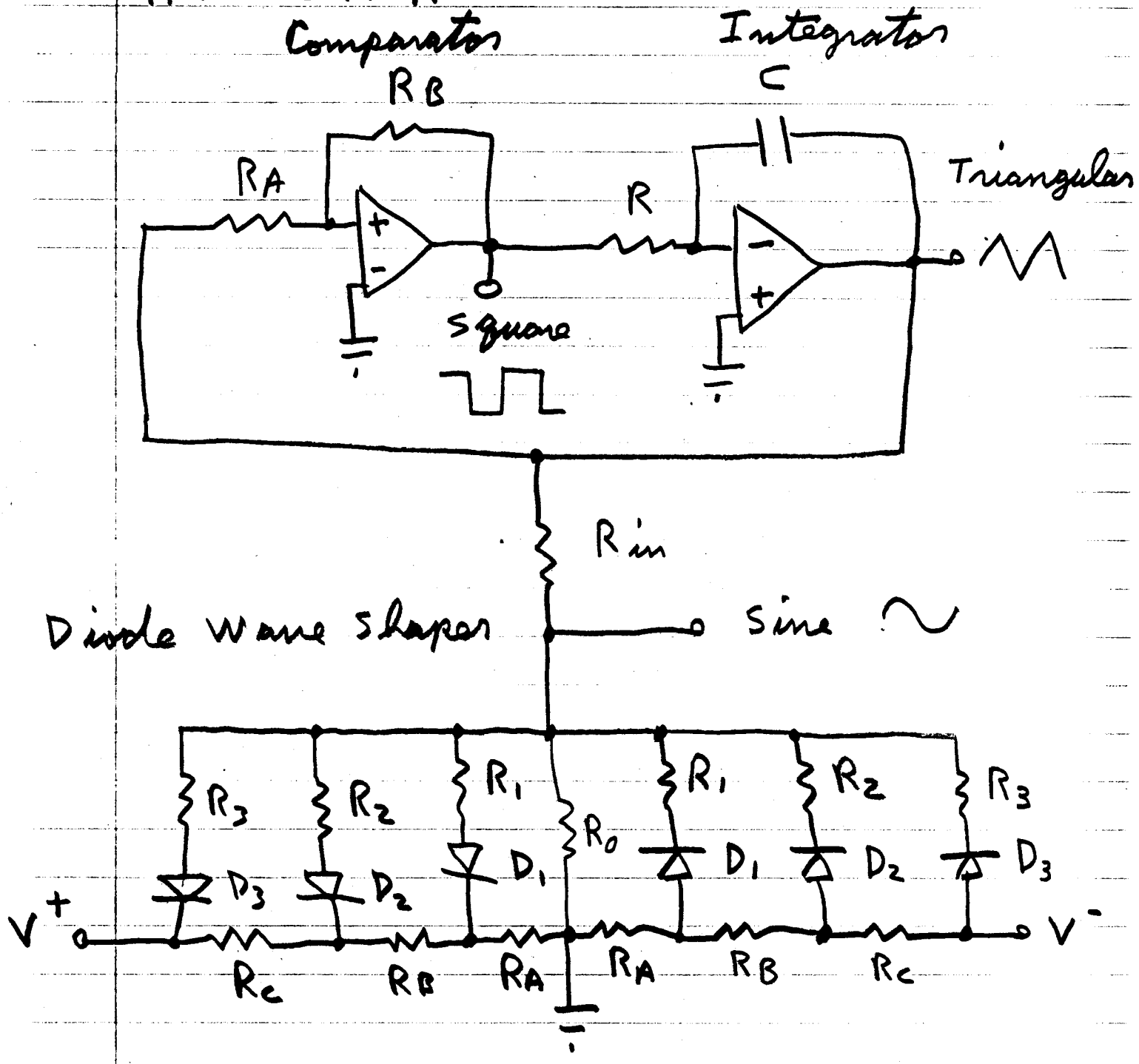


Correct

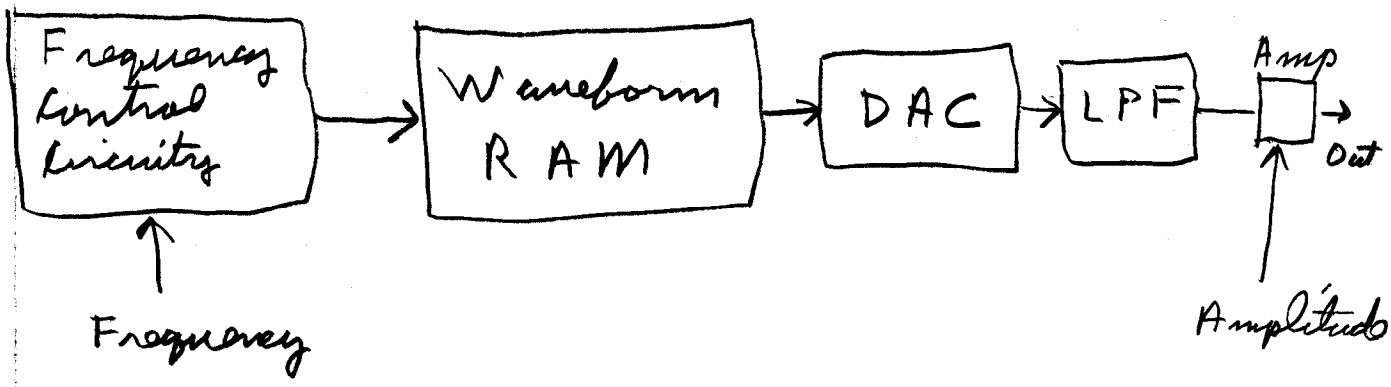


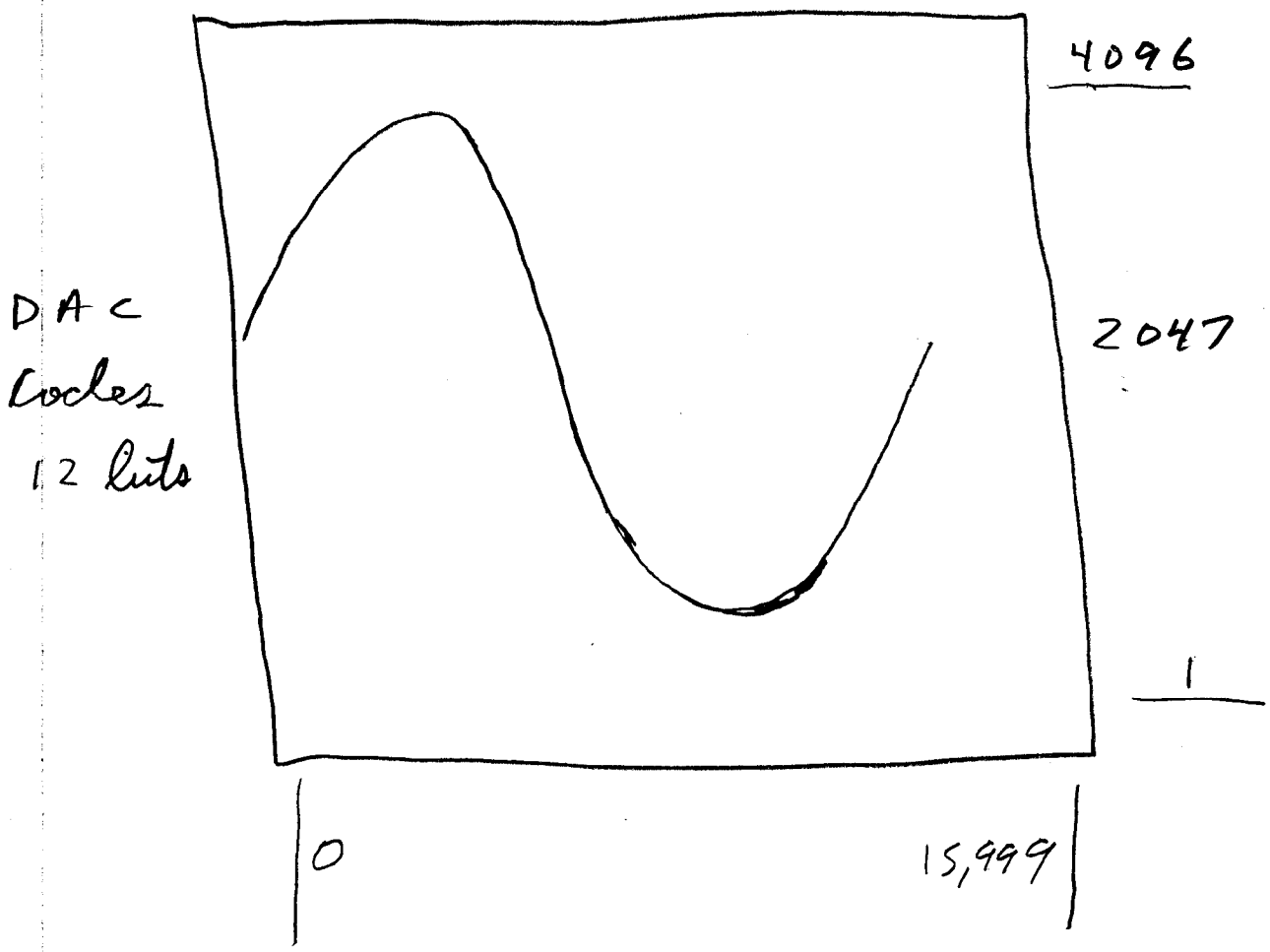
Analog Function Generator

HP 3311 A



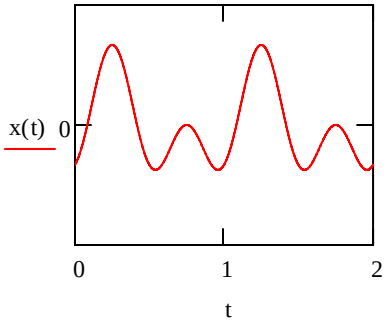
Digital Function Arbitrary Waveform Generator Agilent 33220A





Programming HP33220A Function Gen for Two Tones

$$f_p := 1 \qquad \omega_p := 2\cdot\pi\cdot f_p \qquad x(t) := \sin(\omega_p\cdot t) + \sin\left[(2\cdot\omega_p\cdot t) - \frac{\pi}{2}\right]$$



Sample with 16,000 points for HP33220A Function Generator

$$N := 16000 \qquad i := 0..N-1$$

$$d_i := x\left(\frac{i}{N}\right) \qquad Max := \max(d) \qquad Min := \min(d)$$

$$Max = 2 \qquad Min = -1.125$$

Normalize Point for Functiion Generator from -1 to + 1

$$d_i := \left(d_i - \frac{Max + Min}{2}\right)\cdot\frac{2}{Max - Min}$$

On the right is displayed the first 16 points of the 16000 in this vector. Place pointer in array, right click, click select all, right click, copy selection which then copys the array into the Windows Clipboard. Then paste into Agilent Intulink Waveform Editor.

d =

	0
0	-0.92
1	-0.92
2	-0.919
3	-0.919
4	-0.919
5	-0.919
6	-0.918
7	-0.918
8	-0.918
9	-0.918
10	-0.917
11	-0.917
12	-0.917
13	-0.917
14	-0.916
15	-0.916