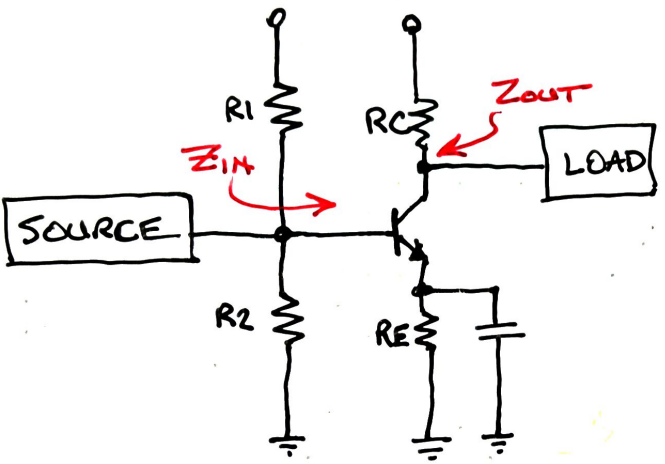
W2AEW

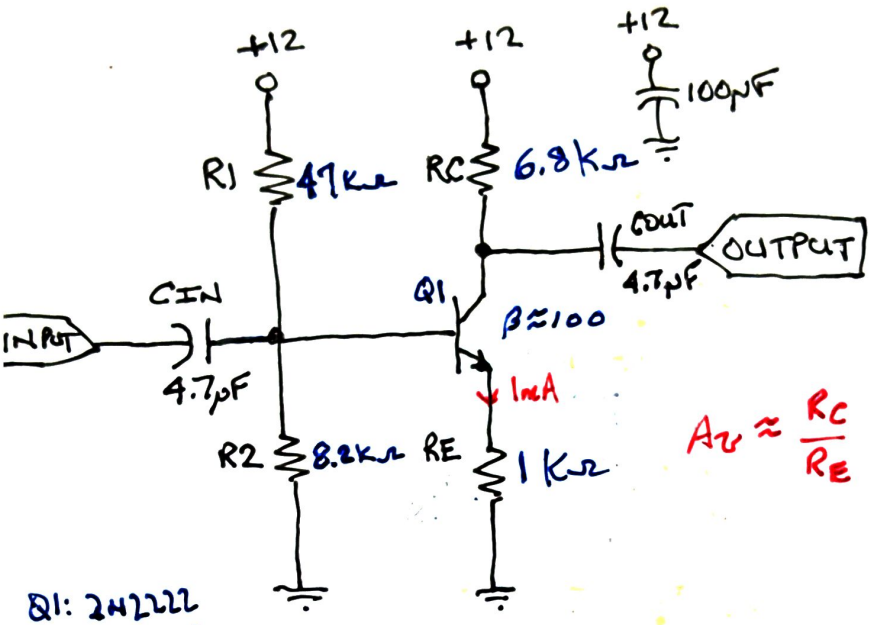
# INPUT & OUTPUT IMPEDANCE OF COMMON-EMITTER AMPLIFIERS



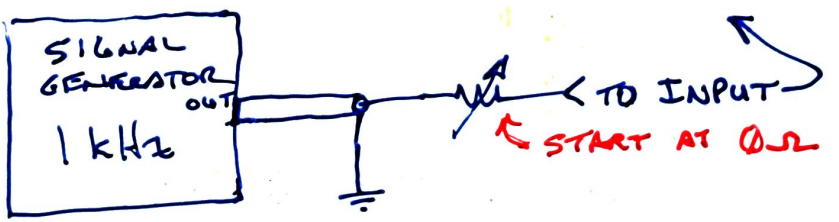

## WHY WE CARE...

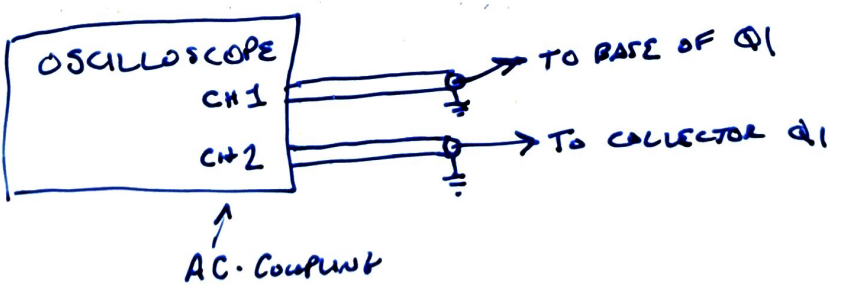
- THE INPUT IMPEDANCE MAY LOAD DOWN THE SOURCE THAT IS PROVIDING THE INPUT SIGNAL
- THE LOAD MAY LOAD-DOWN THE OUTPUT (ZOUT) AND CHANGE THE GAIN OF THE AMPLIFIER

# TEST CIRCUIT #1

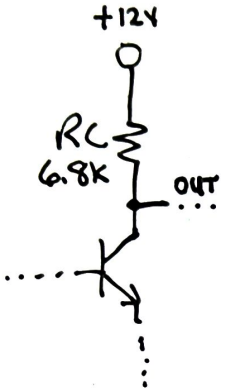



Q1: 2N2222
2N3904
ETC.



- LOOK AT OUTPUT IMPEDANCE




- COLLECTOR "LOOKS LIKE" A CURRENT SOURCE
  ∴ VERY HIGH IMPEDANCE

- OUTPUT IMPEDANCE IS BASICALLY JUST $R_C$

- IMPLICATIONS - ANY LOAD CONNECTED APPEARS IN PARALLEL TO $R_C$

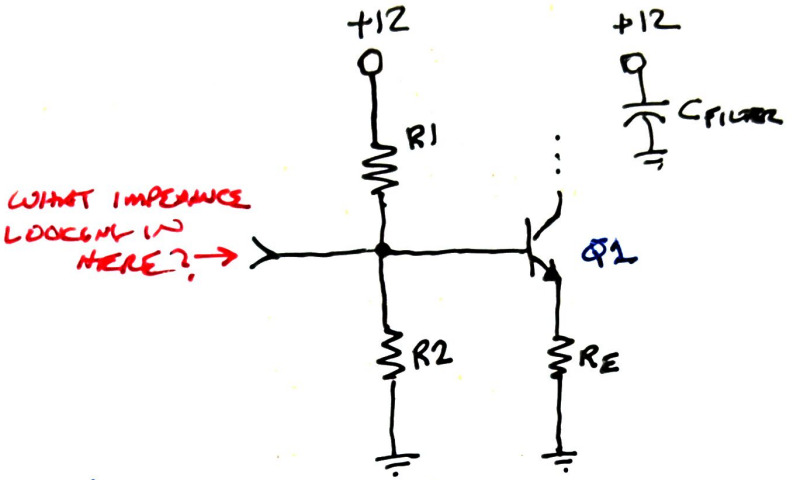
- THIS REDUCES $R_C$

- THUS, REDUCES GAIN ($\approx \frac{R_C}{R_E}$)

THUS: ANYTHING CONNECTED TO OUTPUT CAN AFFECT GAIN
- INCLUDING A CASCADED AMPLIFIER!

- SO - INPUT IMPEDANCE OF AMPLIFIERS MATTERS ALSO!

# INPUT IMPEDANCE




STEP 1:

R1 & R2 ARE IN PARALLEL DUE TO CFILTER

STEP 2:

THIS COMBO IS IN PARALLEL WITH INPUT IMPEDANCE OF THE BASE OF Q1

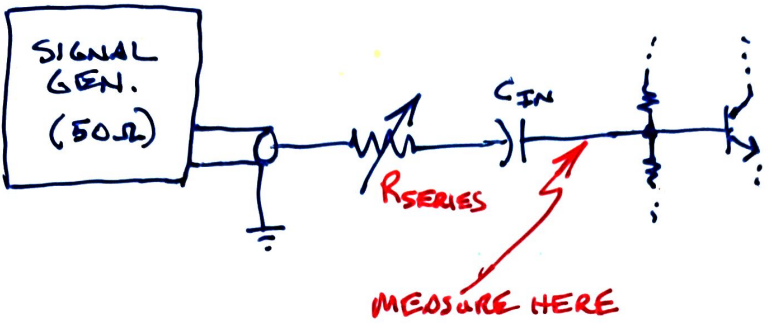
→ THIS IS TYPICALLY DOMINATED BY:

$\beta * R_E$ * (ACTUALLY $(\beta+1)*R_E$)

THEREFORE: INPUT IMPEDANCE IS

$\approx R1 \,||\, R2 \,||\, \beta * R_E$

# MEASUREMENT OF INPUT IMPEDANCE



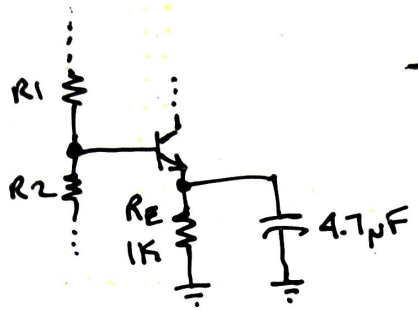

- ADJUST $R_{SERIES}$ UNTIL MEASURED SIGNAL DROPS TO 1/2 OF VALUE WHEN $R_{SERIES} = 0\Omega$

THE EFFECT OF INPUT IMPEDANCE IS NOT REDUCING GAIN, BUT RATHER ATTENUATING THE INPUT SIGNAL BEFORE IT IS AMPLIFIED.

- OF COURSE, IT COULD BE DOING THIS BY REDUCING GAIN OF THE PREVIOUS STAGE OR CIRCUIT.

# ADVANCED TOPIC:

- WHAT IF THE EMITTER IS BYPASSED TO MAXIMIZE GAIN?




- WHAT IS THE INPUT IMPEDANCE OF THE BASE IN THIS CASE?

- FROM MY PREVIOUS VIDEOS, WE KNOW THE SMALL SIGNAL EMITTER RESISTANCE ($r_e$) IS EQUAL TO: $\frac{1}{g_m} = \frac{V_T}{I_C}$ ($V_T$ TYPICALLY 26mV @ ROOM TEMP)

- THUS, INPUT IMPEDANCE OF BASE IS $\beta * r_e$ *

OVERALL INPUT IMPEDANCE:

$$R_1 || R_2 || (\beta * r_e)$$

## CALCULATIONS

OUTPUT IMPEDANCE

$R_C = 6.8K$

$R_{LOAD} = 10K$

$6.8K \,||\, 10K \approx 4K\Omega$

$A_V = \frac{4K}{1K} \approx 4$

INPUT IMPEDANCE

$47K \,||\, 8.2K \approx 7K\Omega$

$\beta \approx 100$

$\beta * R_E = 100K\Omega$

$7K \,||\, 100K \approx \underline{6.5K\Omega}$

INPUT IMPEDANCE w/ EMITTER BYPASSED

$$47K \| 8.2K \| \beta * 26\Omega$$

$$\simeq 1.9K\Omega$$