EMITTER FOLLOWER or VOLTAGE FOLLOWER PHYS321

The transistor can be configured in a unity gain situation. This is called the emitter follower or voltage follower. Vout is taken from the emitter junction and follows the input voltage Vin. In essence it is a current amplifier with unit gain.

The input impedance Rin is high and Rout is proportional to the driving source's output impedance Rsource

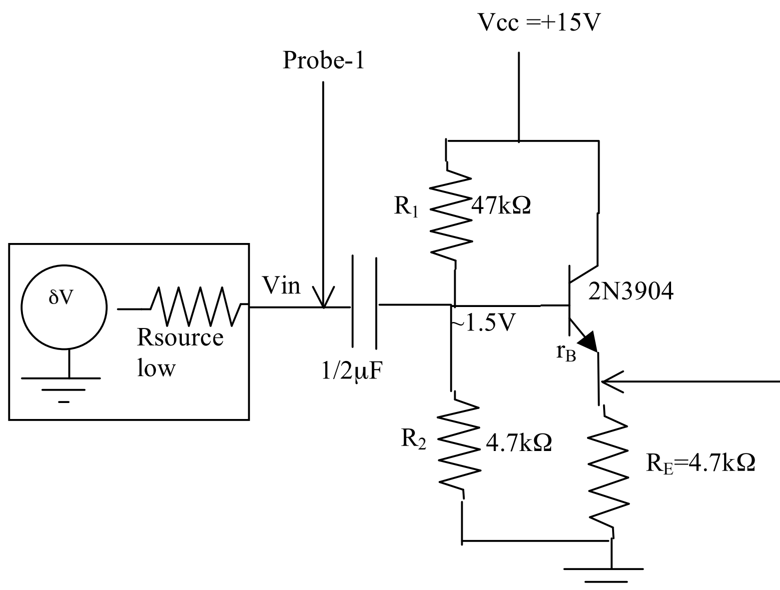
$V_E = V_B - 0.6V$ or $\delta V_E = \delta V_B$ **Vout ~ Vin** (1)

$\mathbf{I_E} = \delta V_E / R_E = \boldsymbol{\delta V_B / R_E}$ (2)

$\mathbf{I_E} = I_C + I_B = \beta I_B + I_B = \mathbf{(1+\beta)\, I_B = \delta V_B/R_E}$ (3)

Looking in to the base **Rin** $= R_B = \delta V_B/I_B = I_E R_E/I_B = R_E\,(1+\beta) \sim \boldsymbol{\beta\, R_E}$ (4)

Looking out from the emitter **Rout** $= R1 + (\beta/\text{Rsource} + 1/R_E)^{-1}$ **~ Rsource/β** (5)



Vout = Vin
Rin = β R_E
Rout = Rsource/β

Construct the Voltage follower circuit. Drive it with the smallest sine wave from your generator at **f =1kHz**. Measure Vin (Vpp) on your oscilloscope channel-1. Measure Vout (Vpp) on channel-2 of your oscilloscope. Record these values.

Vin = ______________ Vout = _____________

Check the frequency response of the voltage follower by sweeping the frequencies between 10Hz and 1MHz.

f (Hz)	10	100	1K	10K	100K	1M
Vout (V)						
Vin (V)						
gain						
$\Delta\phi$						

Question#1- Does the output signal replicate the input signal? Explain why or why not in terms of transistor function.

Question#2- Is there a phase change between input and output signal?

Question#3- What is the input and output impedance of your emitter-follower?

Rin = ____________ Rout=____________

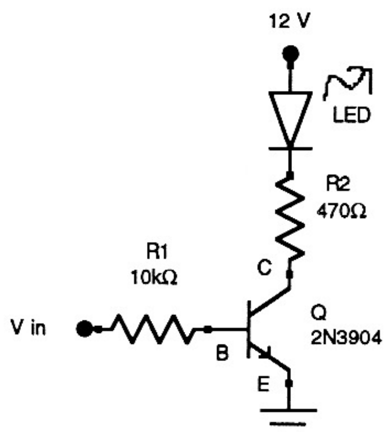
TRANSISTOR SWITCH **PHYS321**

One of the main uses of a discrete transistor is that of a switch. Often one needs to control a large current source from a small current source. We create a high impedance source by placing a a 10kΩ resistor in series with our 50Ω signal generator.

Thus a high impedance source (low current) drives a low impedance output LED. On the positive half-cycle the transistor conducts $I_C > 0$ and the LED is turned on. On the negative half-cycle the transistor cuts off and the LED goes off.

The LED takes about 1.6 volts to turn so about 10.4 V is dropped across the 470Ω R_C.
R_C limits the current through the LED or it may burn out if the current is too high.

$I_B = 5V/10k\Omega = 0.5mA$ (1)
$I_C = (12-1.6)/470\Omega = 10.4V/470\Omega = 22mA$ (2)



(1) Construct the transistor switch circuit with your 2N3904.

(2) Apply a +DC voltage to the input Vin = 0-5V nominal value to determine when the LED just turns on. Record this voltage. Then increase the voltage to ~ 5V, the LED should be ON.

V_{ON} = ____________

(3) Measure the voltage drops along the Collector-Emitter-Ground path.

Vcc = +12 V ΔV_{LED} = ____________ V ΔV_{R2} = ____________ V

ΔV_{2N3904} = ____________ V

(4) Do the individual drops and total correspond to what you expect? Calculate I_C from your measurement as in Eq (2).

I_C = ____________ A

(5) Apply a 10Vpp sine wave to Vin. Explain the LED behavior.