Expt 4 - Current Source, Current Mirror, and Differential Pair

EE 230 Analog Circuits Lab

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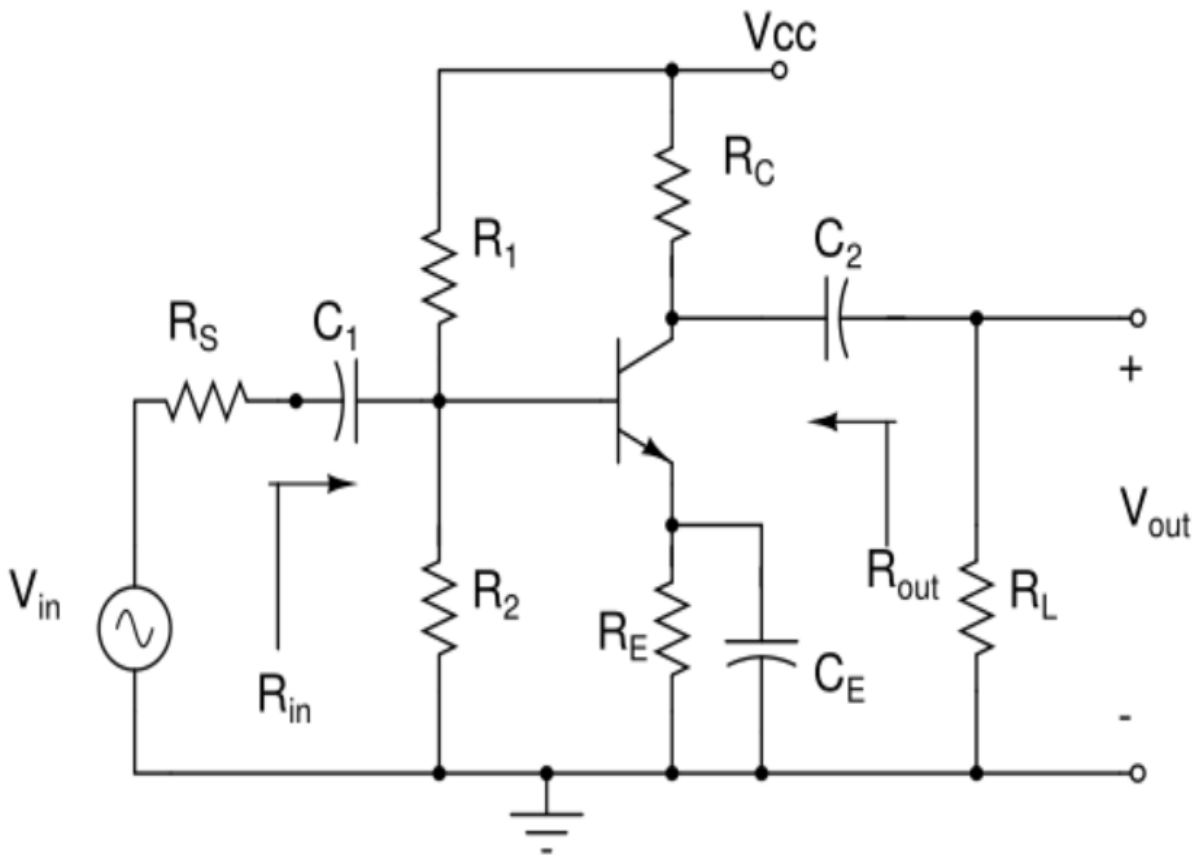
2021-22/I

Summary

- Expt 3 – Frequency Response of a CE Amp
  - Common Mistakes
- Expt 4 - Current Source, Current Mirror, and Differential Pair

Frequency Response of a CE Amp

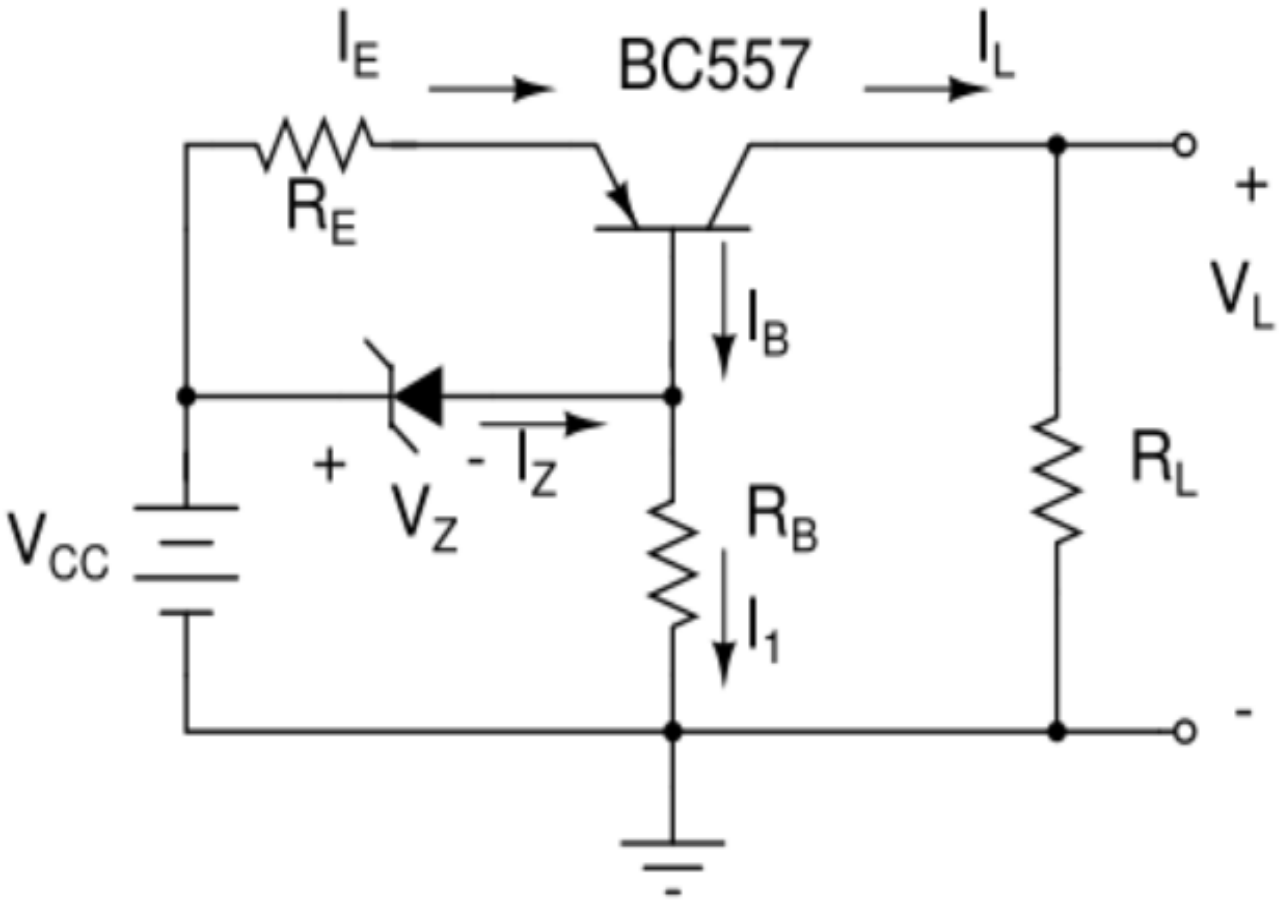


- f_L – Low Freq Cut Off
- f_H – High Freq Cut Off

Expt 4

- Current Source,
- Current Mirror, and
- Differential Pair

Part A: BJT Current Source
(using a Zener diode and a *pnp* transistor)



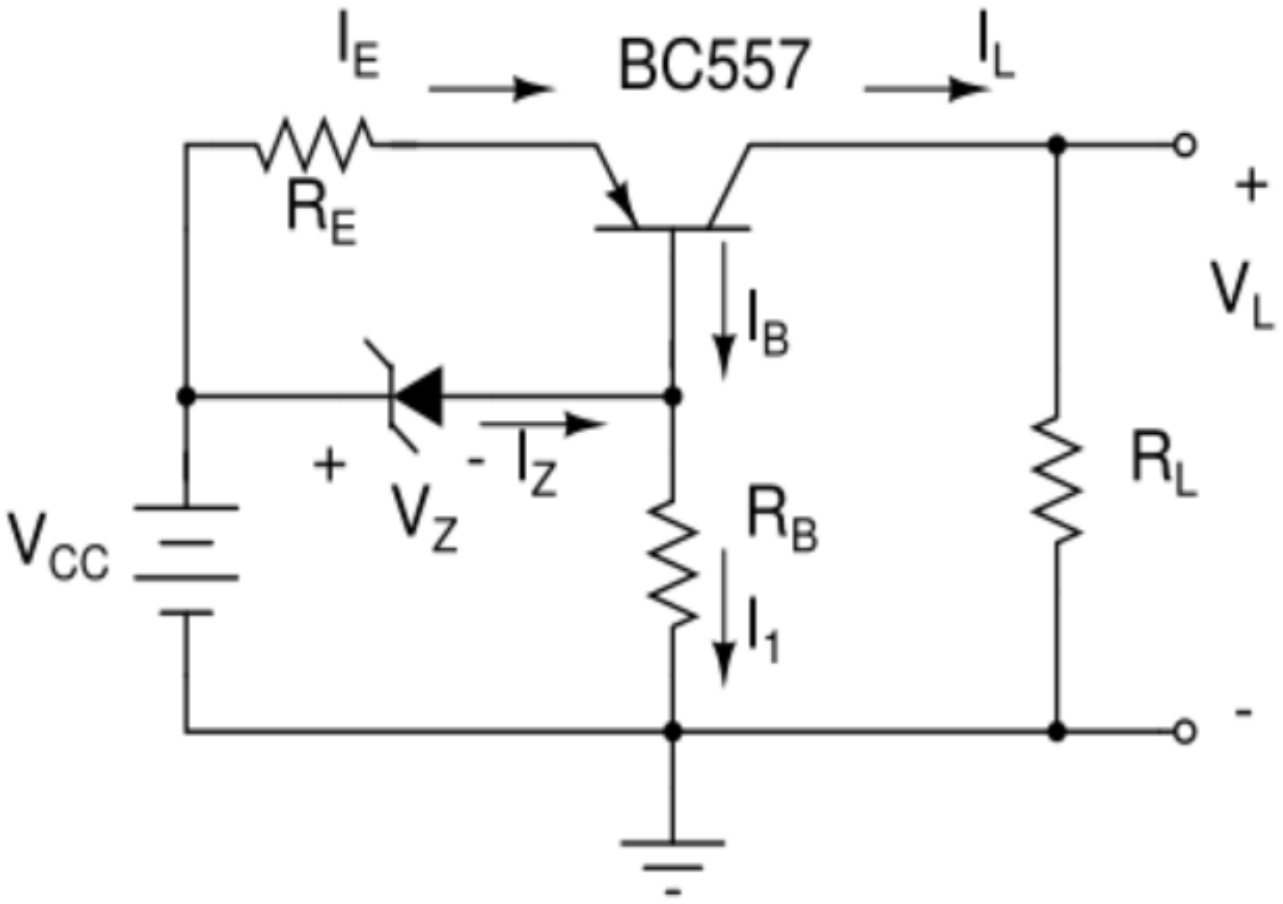
- Features
- I_L can be changed by changing RE
- Works for reasonably large values of R_L

Current source Characteristics

- Voltage Sources – Ideal vs Practical

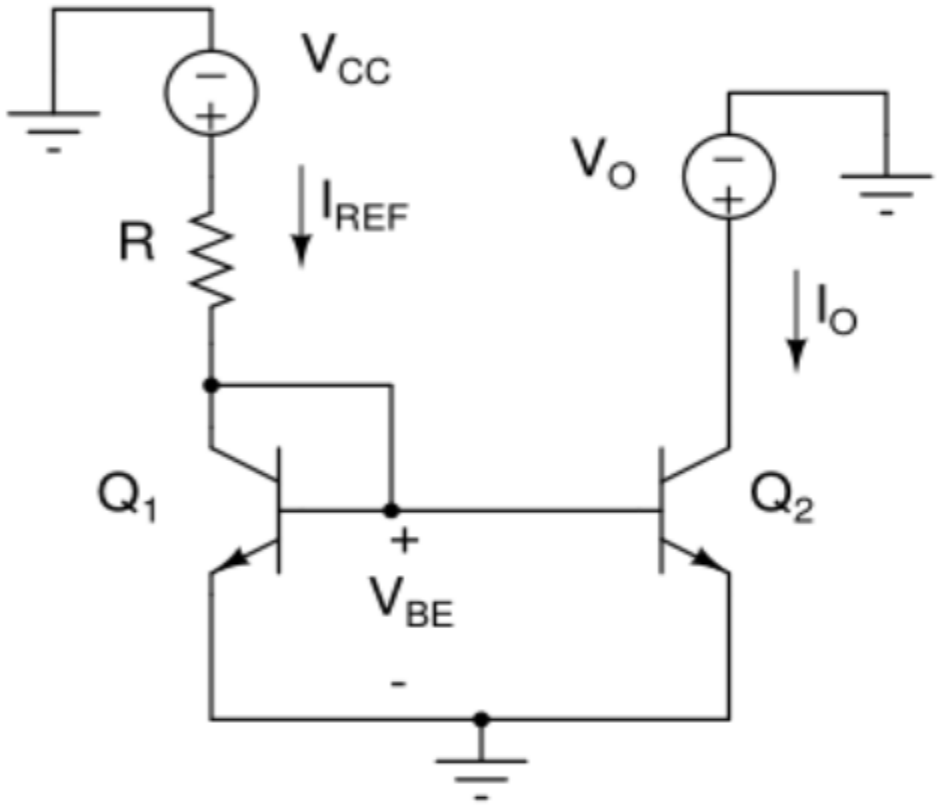
- Current Sources – Ideal vs Practical

BJT Current Source



- Operation
- Ideally should work for any value of R_L
- $R_L \uparrow$, $V_L \uparrow$
- BJT will saturate for high R_L values
- For a given circuit there is an R_{Lmax}

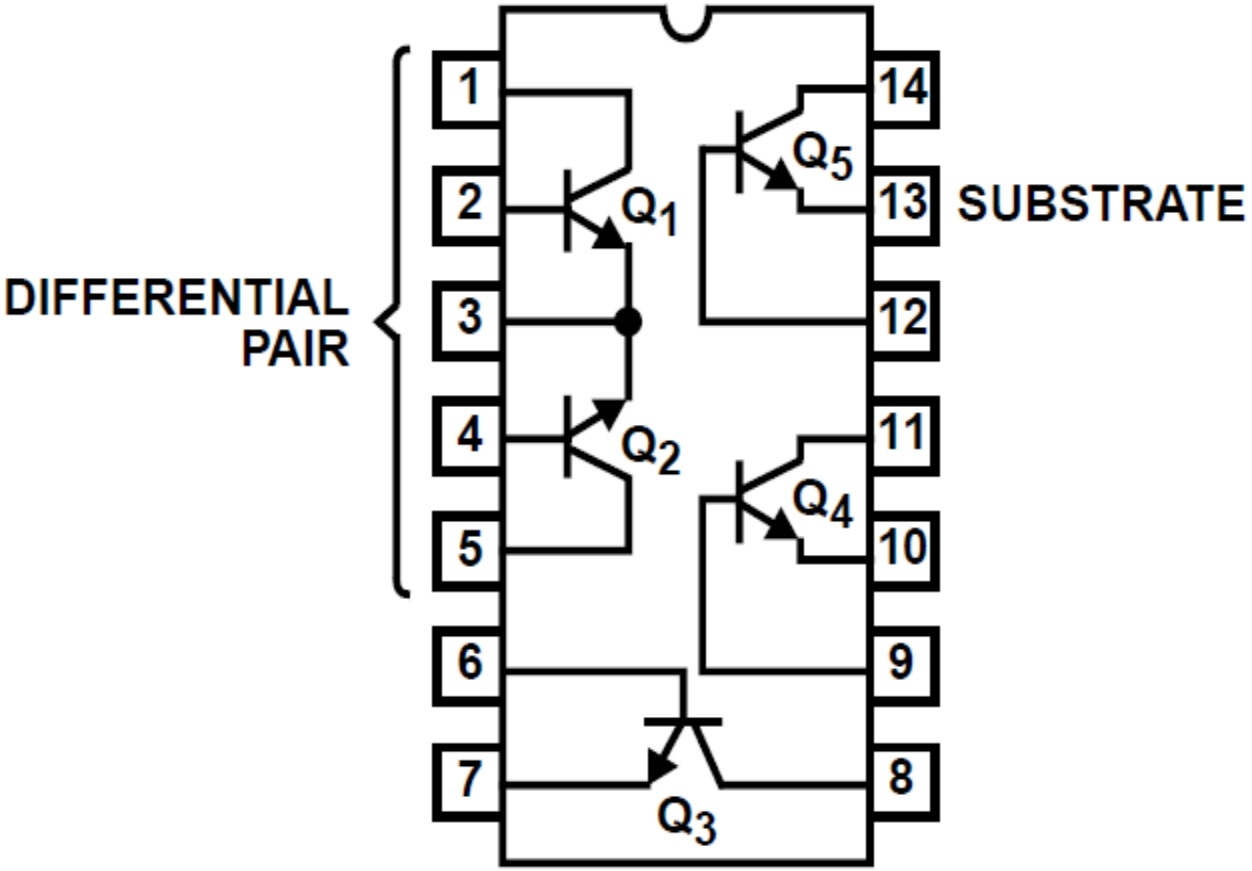
Part B: Current Source (using a Current Mirror)



- Current sources extensively used
- IC biasing
- Active loads

- Current Sources made of BJT arrays (ICs)
- Advantage
  - Monolithic
  - Better matching of V_{BE}

LM 3046 *npn* Arrays

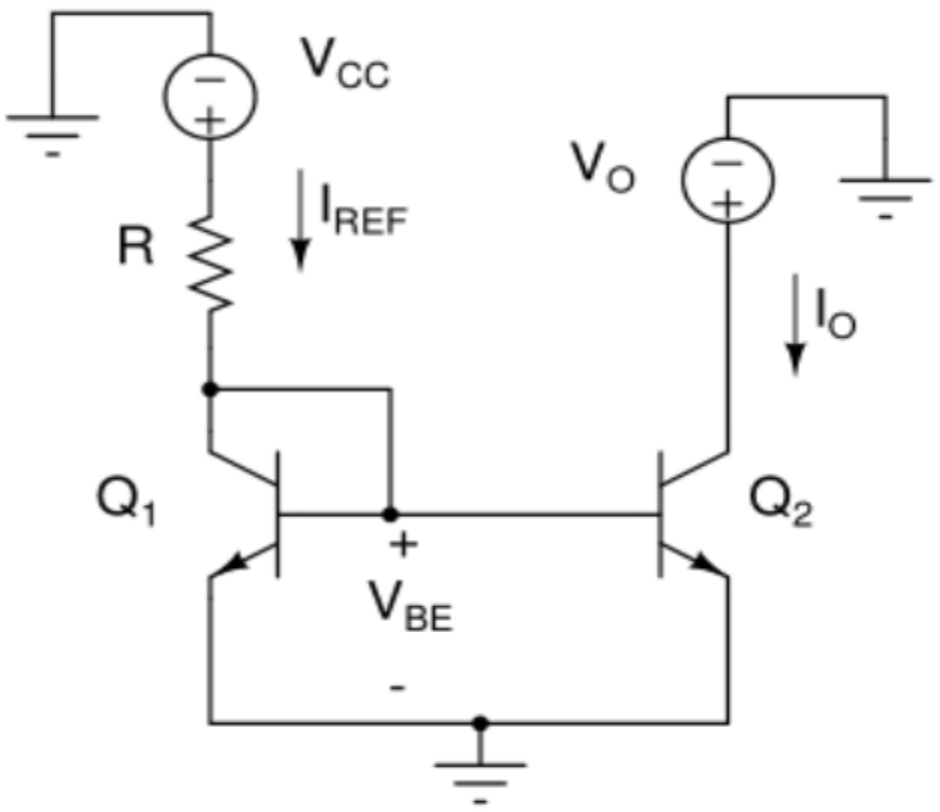


- 5 npn BJTs
- DC to 120 MHz
- One diff pair

- Monolithic design
  - V_{BE} match (+/- 5 mV)

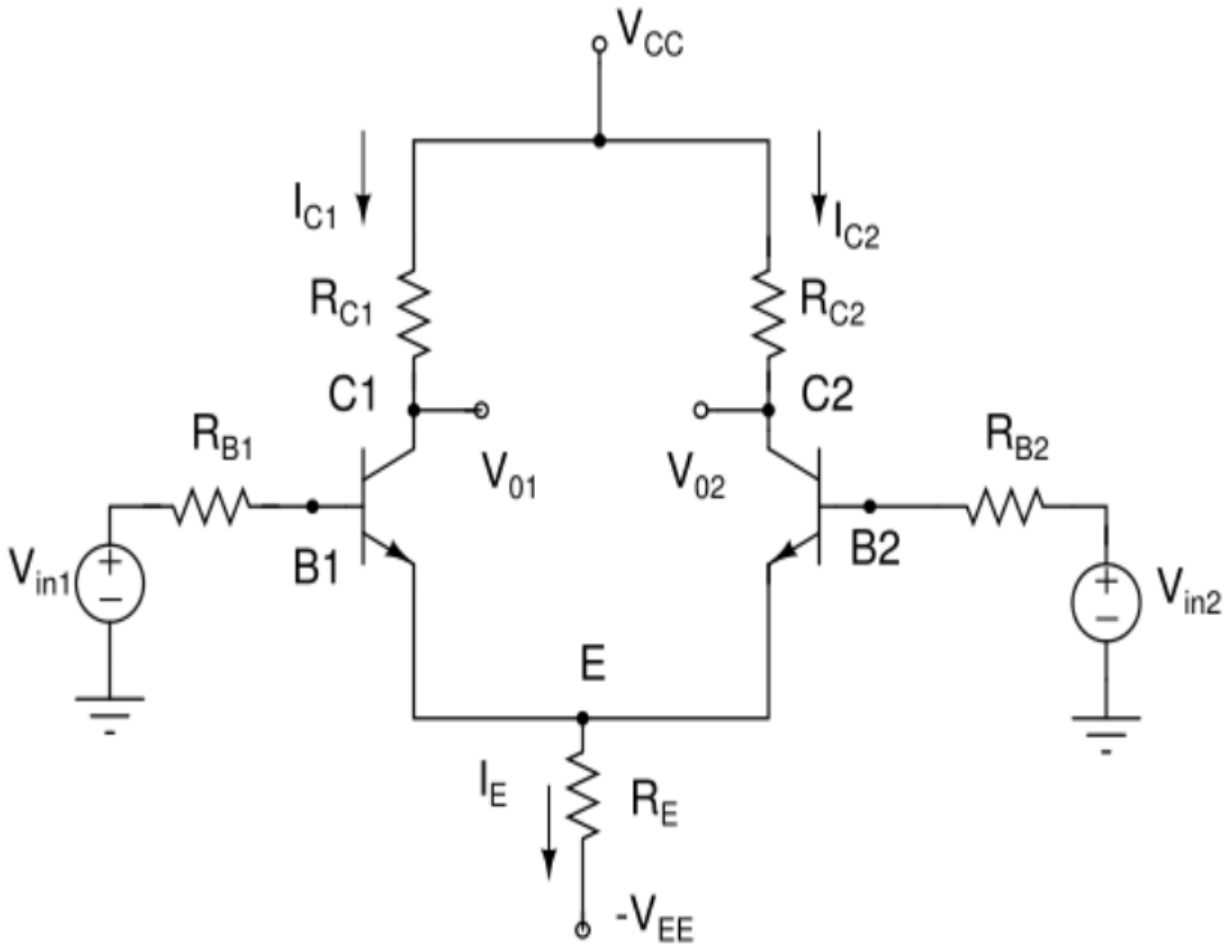
- I_C up to 10 mA
- V_{CE} up to 10V
- Max Power Diss: 300 mW (single BJT)

Measured Results



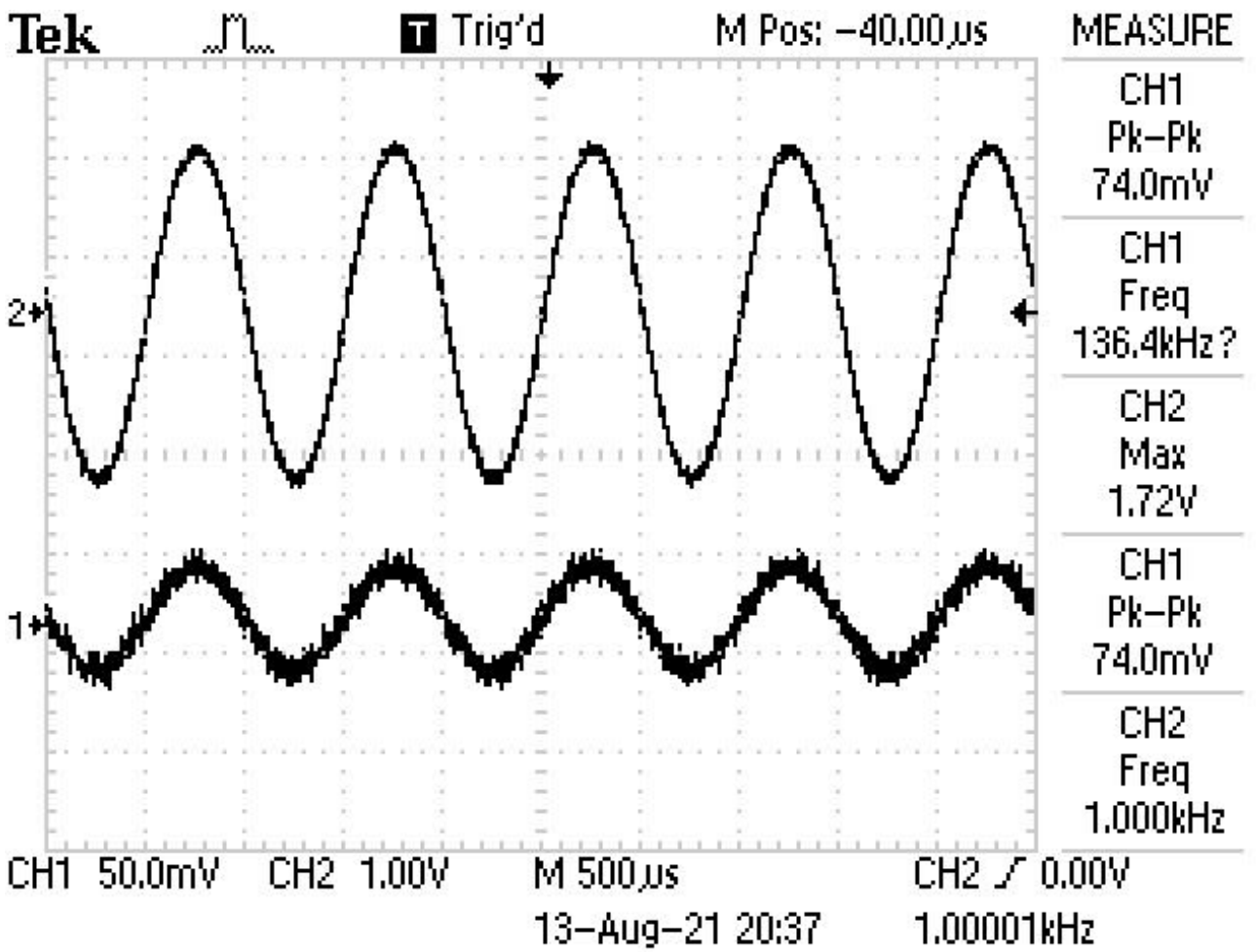
- Vcc = 12 V, R = 10 kΩ, V_{BE} = 0.7 V
- V_O : 1 V , I_O = 1.125 mA
- V_O : 5 V , I_O = 1.2 mA

Part C: Differential Pair



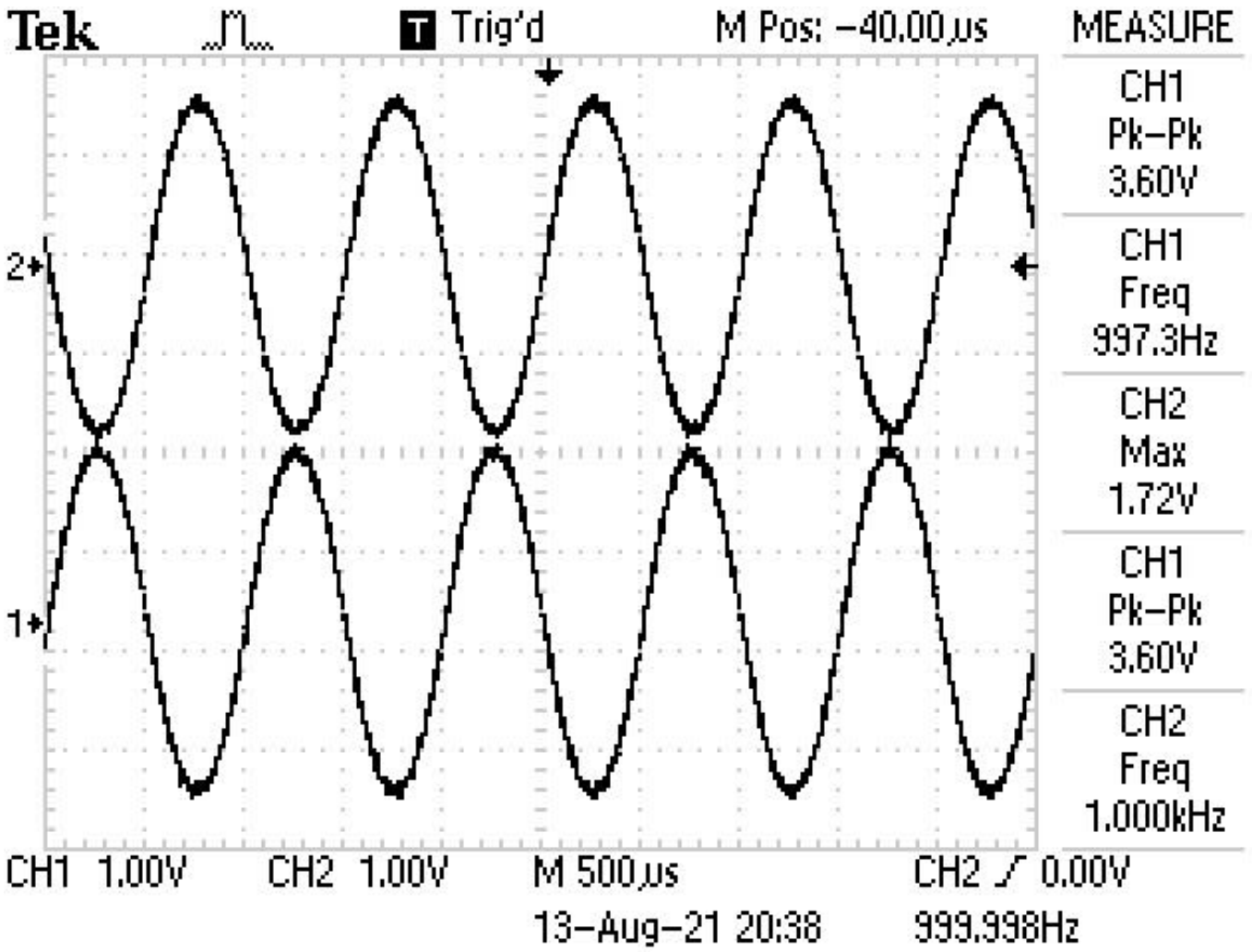
- Identical BJTs (hence IC BJT arrays preferred)
- Circuit symmetric
- Current switching
- R_E for simple Diff pair
- R_E may be replaced with a current source

Single-ended Gain



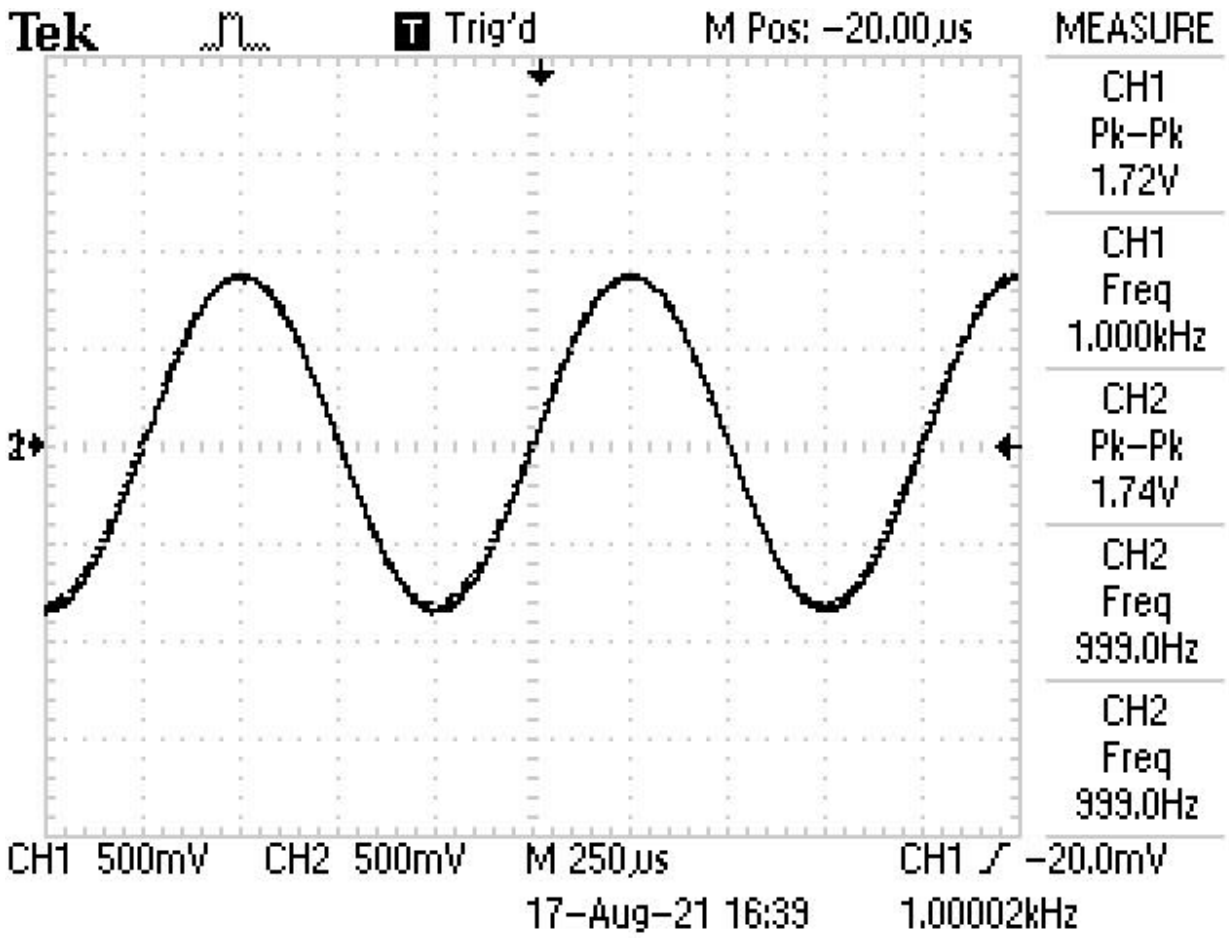
- V_{in1} – 50mVp-p
- 1 kHz
- V_{O2} – 3.6 Vp-p
- Voltage Gain: 72 V/V

Both Outputs



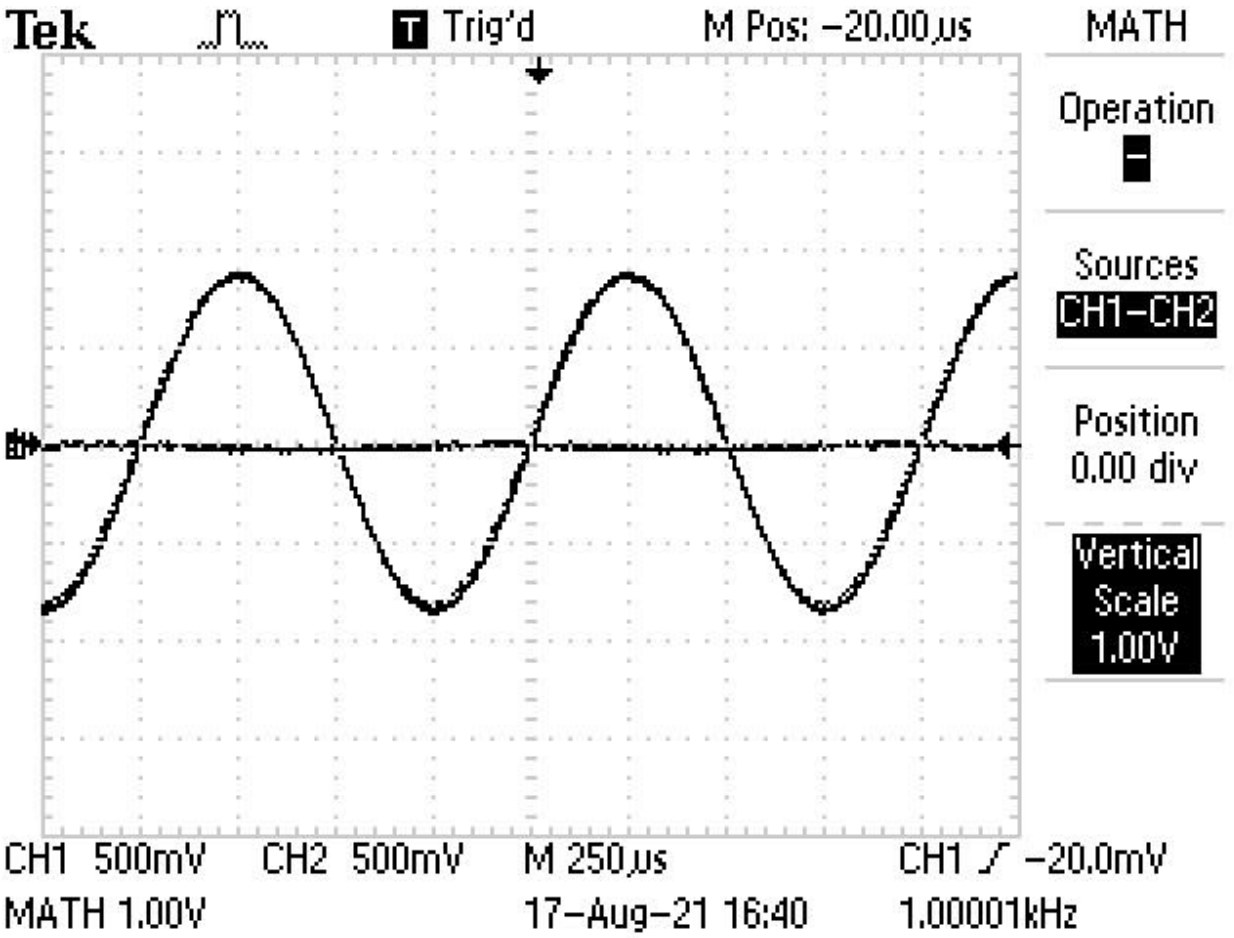
- V_{in1} – 50mVp-p
- 1 kHz
- V_{O1} and V_{O2} – 3.6 Vp-p
- Voltage Gain: 68 V/V

Both Outputs (Overlapped) – V_{O2} inverted



- V_{O1} and V_{O2} together

Common-mode Operation



- $V_{in1} = V_{in2} = 5 \sin \omega t$
- Differential Output (Through DSO Math Operation)