

DESIGN OF GILBERT MULTIPLIER USING EMITTER COUPLED CIRCUIT

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THEORY-

A **Gilbert multiplier** (or **Gilbert cell**) is a widely used **analog multiplier circuit** designed by Barrie Gilbert. It is commonly used in **RF mixers, modulators, demodulators, and analog signal processing** applications, particularly in **communication systems**.

Key Features of the Gilbert Multiplier:

1. **Four-Quadrant Multiplication** – It can handle both positive and negative input signals, making it suitable for **modulation and frequency conversion**.
2. **Differential Inputs** – It has two sets of differential input pairs, allowing **linear multiplication** of two signals.
3. **Balanced Structure** – Reduces even-order distortion, improving signal fidelity.
4. **Current Mode Operation** – Provides high speed and low voltage operation.

Circuit Architecture:

- The Gilbert cell is based on a differential amplifier structure with a **translinear core** formed by **BJT transistors** (MOSFET versions exist for CMOS implementation).
- It consists of **two differential pairs** whose outputs are modulated by a control signal.
- The output current is proportional to the **product of the input voltages**.

Mathematical Operation:

For two input signals:

- **V1** (differential input voltage)
- **V2** (another differential input voltage)

The output current **I_{out}** is directly proportional to V1 and V2

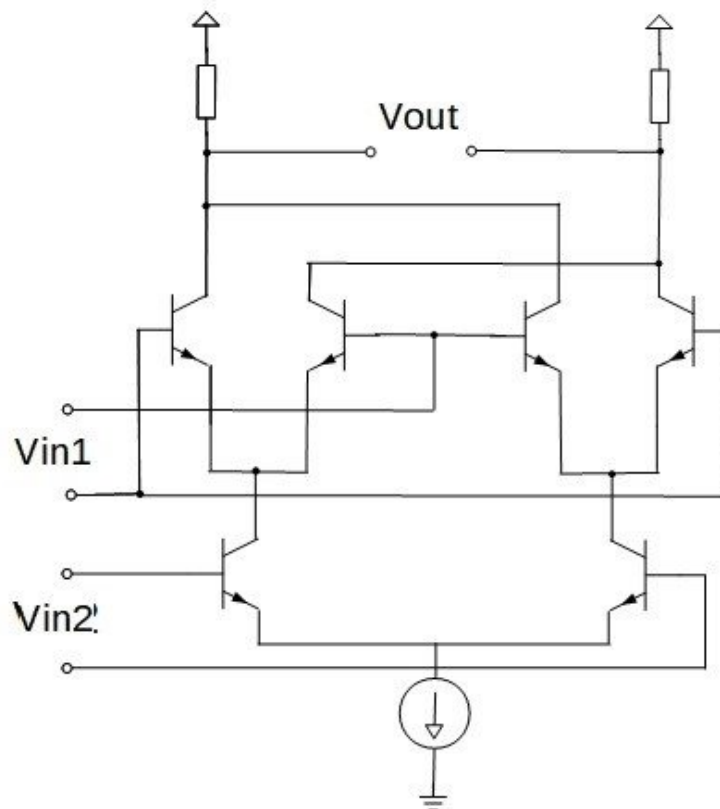
Thus, it effectively performs **multiplication**.

Applications:

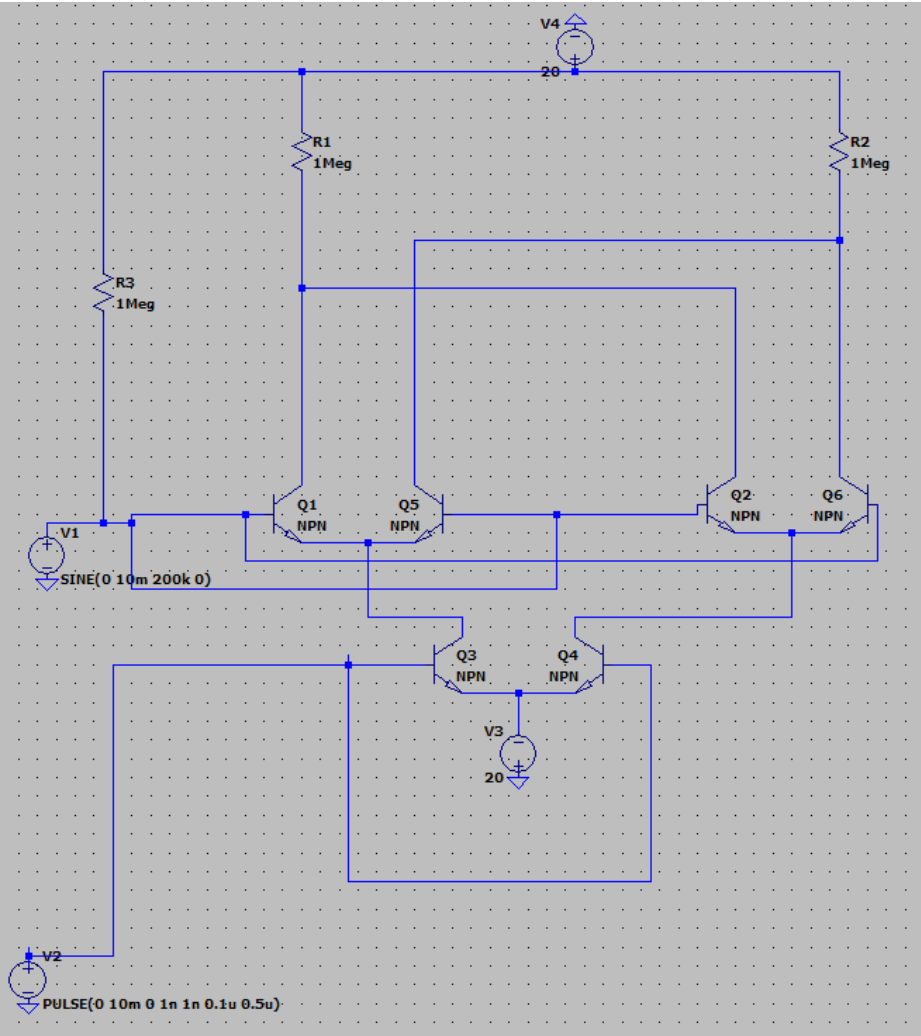
1. **RF Mixers** – Used in heterodyne receivers for frequency conversion.
2. **Modulators/Demodulators** – Used in **AM, FM, and PM** systems.
3. **Phase Detectors** – Found in PLL (Phase-Locked Loop) circuits.
4. **Analog Computation** – Used in **analog signal processing** (e.g., correlation, squaring).

CIRCUIT DIAGRAM-

The circuit of the gilbert multiplier looks like this with the two input as V_{in1} and V_{in2} and the double ended output taken at V_{out} .

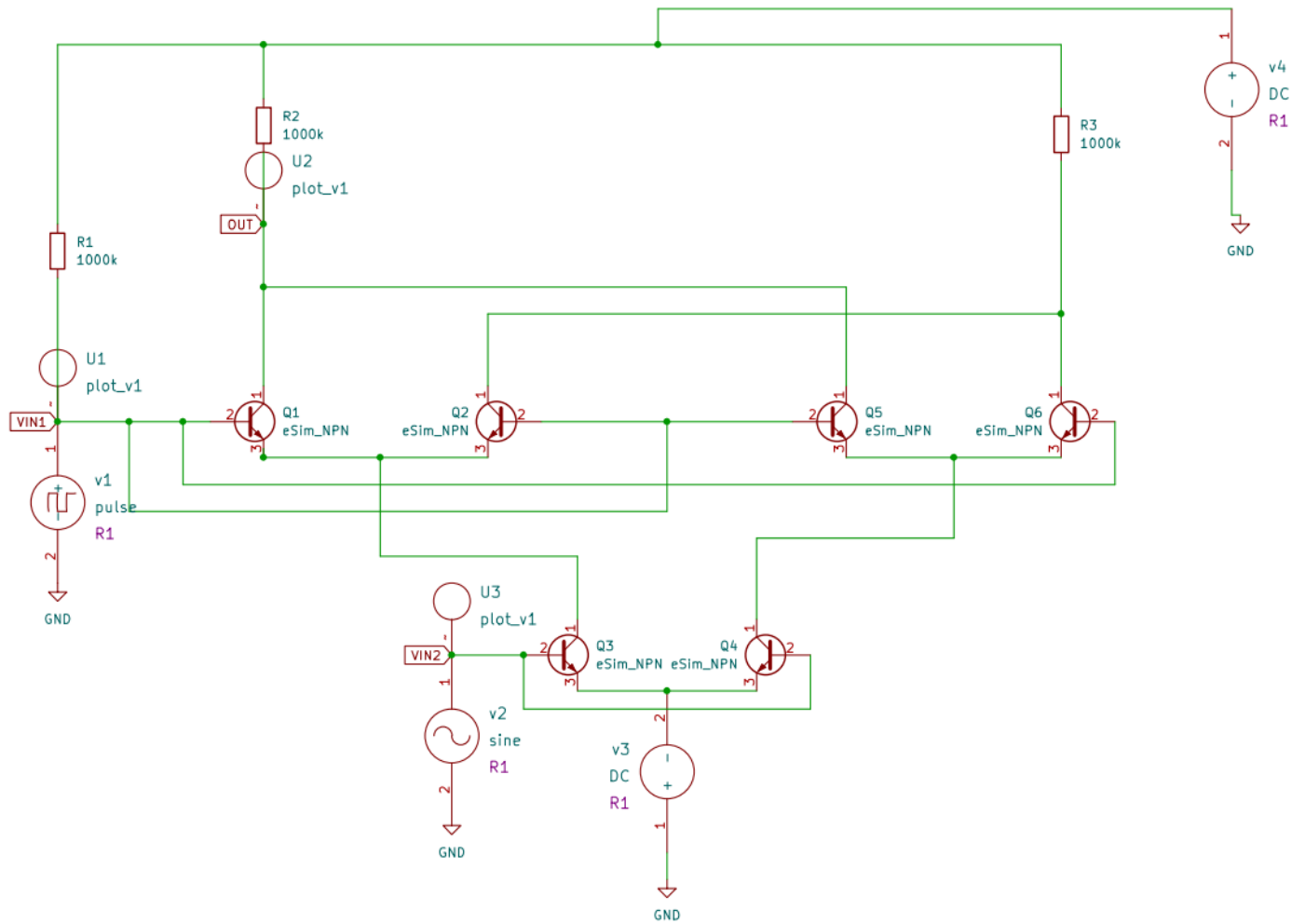


LT SPICE CIRCUIT DIAGRAM-



ESIM SCHEMATIC-

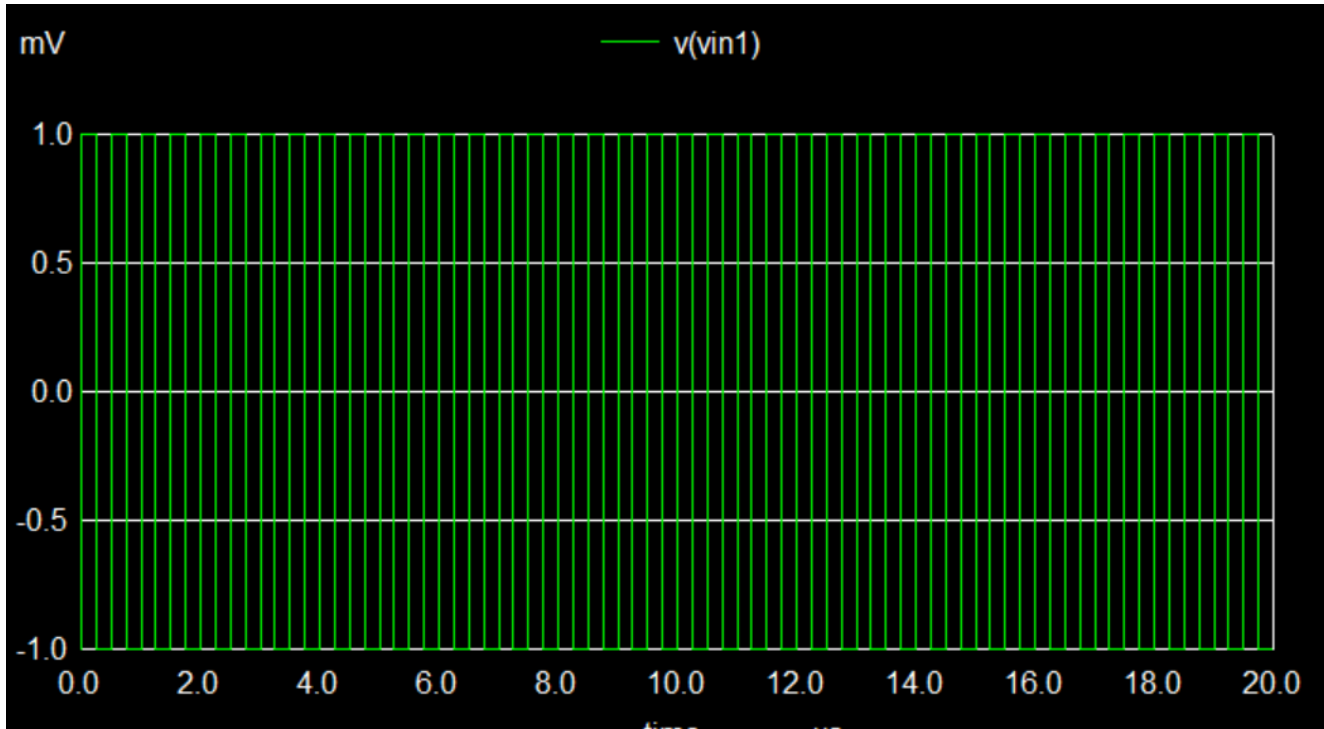
The following schematic has been made using Kicad with ESim environment.



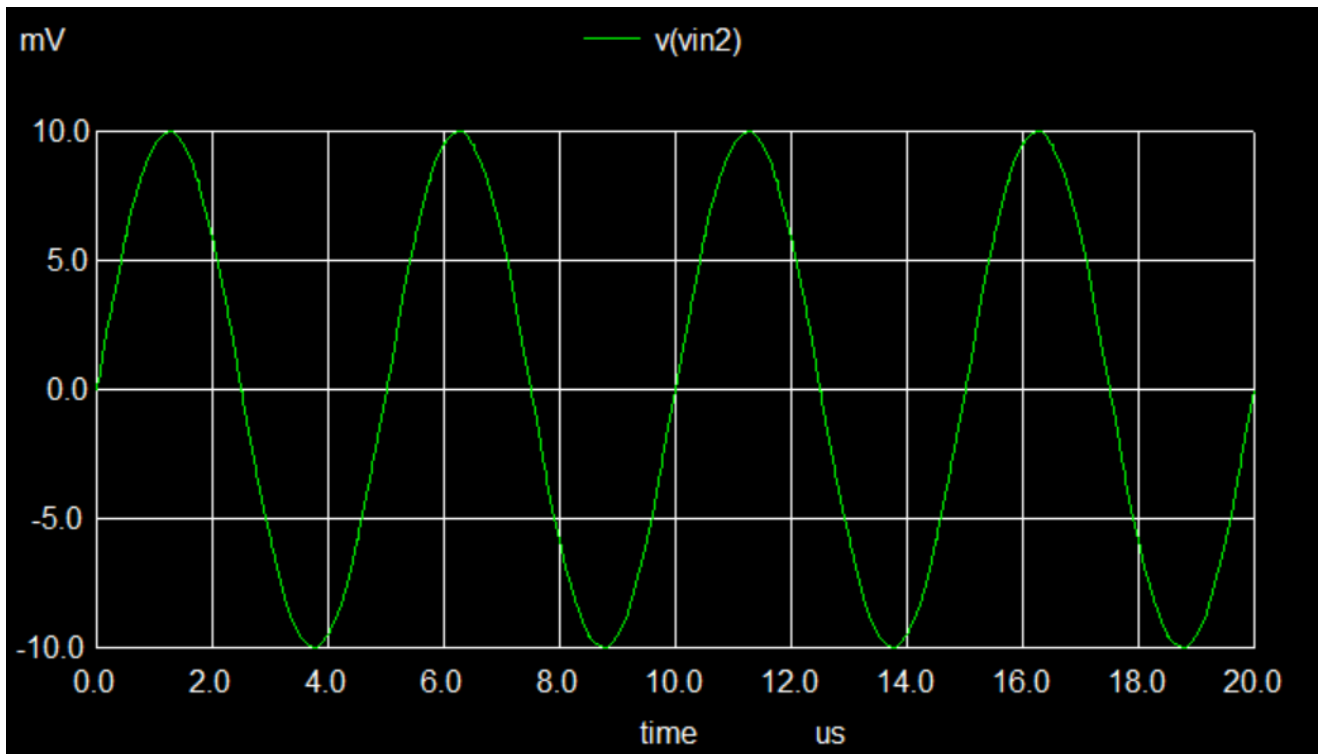
RESULTS/OUTPUT-

The following results were obtained by successful simulation of the project.

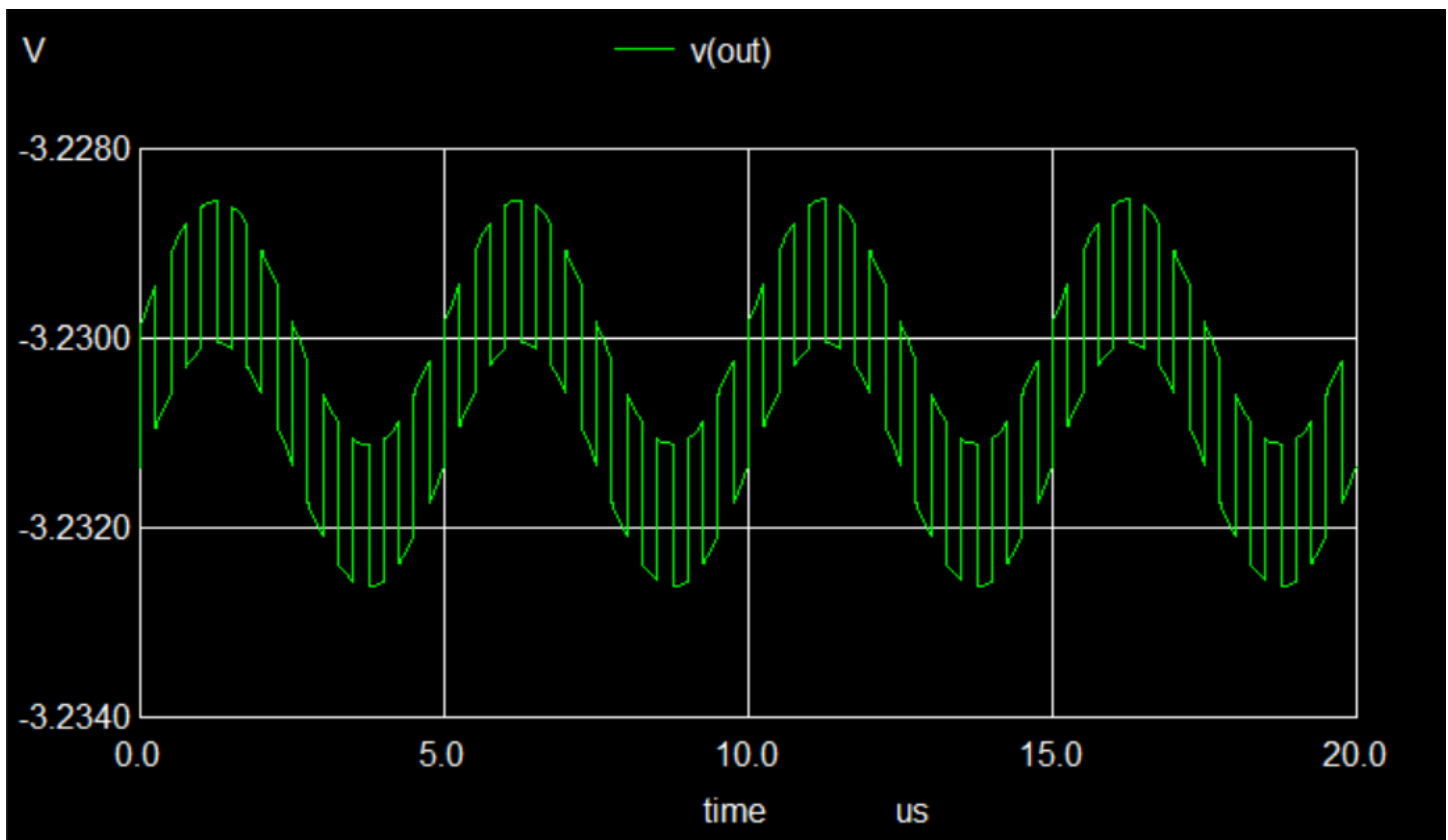
Vin1-PULSE



Vin2-SINE



VOUT-(SINE)xPULSE



REFERENCES-

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