

Laboratory 11

MOSFETs, Static Electricity and the Piezo Effect

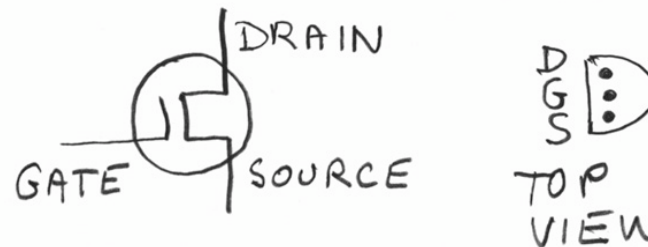
Introduction

The Field Effect Transistor (FET) is a useful device, in some ways preferable to the bipolar transistor we have already studied. Instead of an *emitter*, *base*, and *collector*, the FET has a *drain*, *gate* and *source*. Shown below is the schematic symbol for one type of FET known as a MOSFET (Metal Oxide Semiconductor FET). This device is described in Scherz Section 4.3.4. Note that we will use a simplified version of the symbol used in Scherz.

The particular MOSFET we will use in the lab is an n-channel enhancement mode MOSFET, the BS-170 (pin-out diagram below). A nice feature of the BS-170 is its high maximum drain current of 500 ma. Another is its extremely high input impedance, in the range of $10^{14} \Omega$. This makes it easy to destroy a MOSFET by touching the gate with your finger, especially if the drain or source is already connected to the breadboard. Your shoes can generate thousands of volts of static voltage, and even these relatively few electrons can destroy the thin layer high-impedance metal oxide insulating the gate from the rest of the MOSFET. **So once the FET is in the breadboard, never touch the gate lead or any wire attached to it without first touching ground on the breadboard. Never let the balloon (used later to generate a static field) touch the gate lead.**

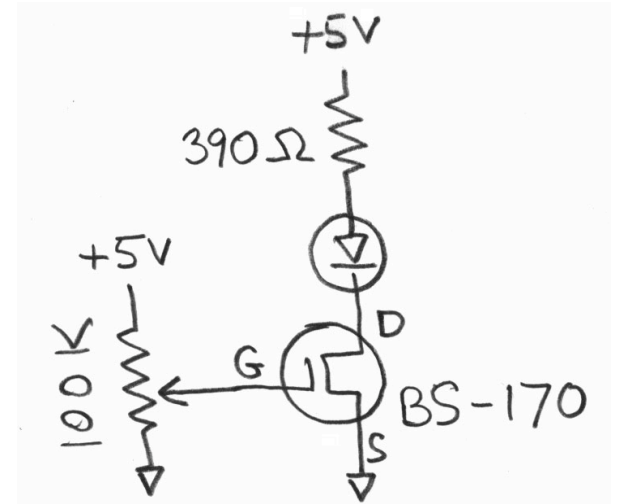
Parts List

n-channel, enhancement mode MOSFET
(BS-170)
12" latex balloon



MOSFET Test Circuit

Carefully observing the above cautions about static damage, construct the circuit shown to the right, to see if your MOSFET is working. As the gate voltage of this “enhancement mode” device is raised, a conductive channel is induced between the drain and the source and the LED should turn on (note that electrons are running “upward” from the *source* to the *drain*). The “current gain” of this device is enormous. Virtually no current is entering the gate, with its impedance of $\sim 10^{14} \Omega$. Provide a ballpark (order of magnitude) estimate of the current gain (output current / input current) of this circuit. **(A)**



Static Electricity Detector

Construct a static electricity antenna, by stripping 1/4 inch at one end of 1 foot of insulated 22-gauge single-strand wire. Do not strip the other end. Build the circuit below, inserting the stripped end of the antenna wire into the breadboard to connect to the gate of the MOSFET. The other end should not make electrical contact with anything. Be very careful not to touch any of the exposed portions of the antenna wire as this may destroy the MOSFET. With no other voltage sources attached, the gate of the MOSFET should float to a voltage between 0 V and +5 V, lighting the LED.

Inflate a 12” latex balloon and rub it on a wool shirt, sweater, or scarf. This will cause electrons from the wool to be rubbed off and end up on the balloon. Bring the balloon near to the antenna wire, **but do not touch it to any exposed portion of the antenna!** Report and explain your results. How far from the antenna can your circuit detect the presence of negative electric field generated by the balloon? **(B)**

