

6.002 Demo# 18RP (Load Set up demo#18RP.set) Energy and Power in CMOS

Fall 01 Lecture 22

Prof. Parker

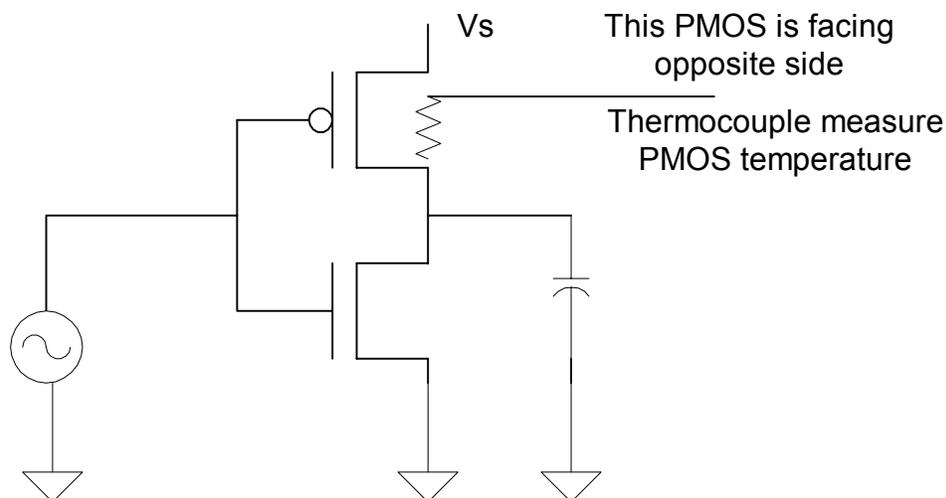
Purpose: This demo measures the temperature of a CMOS inverter using a thermocouple and verifies that the dissipated power is proportional to $V_s^2 F$, where V_s is the supply voltage, and F is the switching frequency.

The difference between the transistor temperature and room temperature (20 degrees) is assumed to be proportional to the amount of power being dissipated in transistor.

Steps:

1. With $V_s=10$ v, $F= 2$ KHZ, display the input and output waveforms of the CMOS inverter, on the scope.
2. Switch the display to an overhead camera and showing the circuit and the multimeter readout of the thermocouple. The temperature should be about 30 degrees (10 degrees above ambient). Play the output waveform on a speaker so that the audience is aware of subsequent changes to V_s (volume of tone) and (pitch of tone). This is useful for the audience because the display shows the video camera view rather than the scope screen waveforms.
3. Increase F to 8 KHZ. Ideally, the temperature will rise to 60 degrees (40 degrees above ambient). You may have to wait a while for the temperature to settle.
4. Decrease V_s to 5 v, ideally, the temperature will drop to 30 degrees (10 degrees above ambient) You may have to wait a while for the temperature to settle.
5. For fun, crank up V_s to 15 v and F to 100 KHZ. The transistor should smoke.

Demo concept



Description: The Energy and Power in CMOS.

- 1) **Attach thermocouple wire to rounded face of PMOS transistor using half-width slice of electrical tape. Thermocouple tip must make good contact with plastic body of transistor. Video camera should be set up to show circuit and thermocouple readout. Set up speaker to play output of CMOS (CH2)**
- 2) **Once the scope waveforms have been shown, switch to the video display and proceed through the Vs and F settings given in the steps.**

Oscilloscope Setup

CH	V/DIV	OFFSET	MODE	FUNC	MATH	VERTICAL	HORIZONTAL
1 on	5	-5	DC	off			
2 on	5	15	DC	off			
3 off			DC	off			
4 off			DC	off			
Horizontal: 1 ms		Acquisition:		AUTO AUTO	4	Trigger:	CH1

Waveform Generator Setup

Power Supply Setup

UNIT	WAVE	AMP	OFFSET	FREQ	+6	+25	-25	OUTPUT
					off	+10	off	on
FG1	Square	5	2.5 v	2 KHZ				Trigger: INT

6.002 Demo #18RP
Energy and Power in CMOS

Prof. Parker Fall 01

