

Analog Communication Circuits
ECE 431
Fall 2006 Semester

ECE UIC
Department of
Electrical and Computer
Engineering

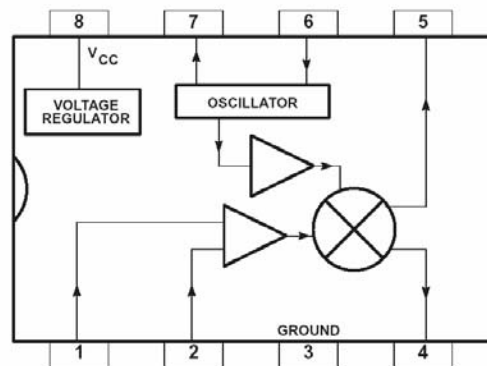
Experiment #3: Mixer and Power Supply Circuits

1. Introduction

In addition to wiring up the +5V voltage regulator circuit, this experiment deals with constructing and testing the mixer circuit. We are taking advantage of an integrated circuit that makes this part of the radio almost guaranteed to work properly. The IC is an implementation of the Gilbert Cell mixer by Philips Semiconductors, the SA612A double-balanced mixer and oscillator. (We will not be taking advantage of its on-board oscillator building block.) Priced at \$2.00 it is the single most expensive component in the radio circuit, so please double check your pin connections prior to soldering. The datasheet may be found at this link at the web site where the SA612A was purchased:

<http://partsandkits.com/SA612A.pdf>

For your reference here is the datasheet pin diagram and functional description of the SA612A mixer I.C.:



Refer to the attached diagrams:

Figure 3.1 – Mixer and voltage regulator stage layout areas and solder pad locations.

Figure 3.2 – Schematic diagram of the regulated power supply and mixer circuits.

Figure 3.3 – Schematic diagram of the regulator and mixer with solder pad nodes shown.

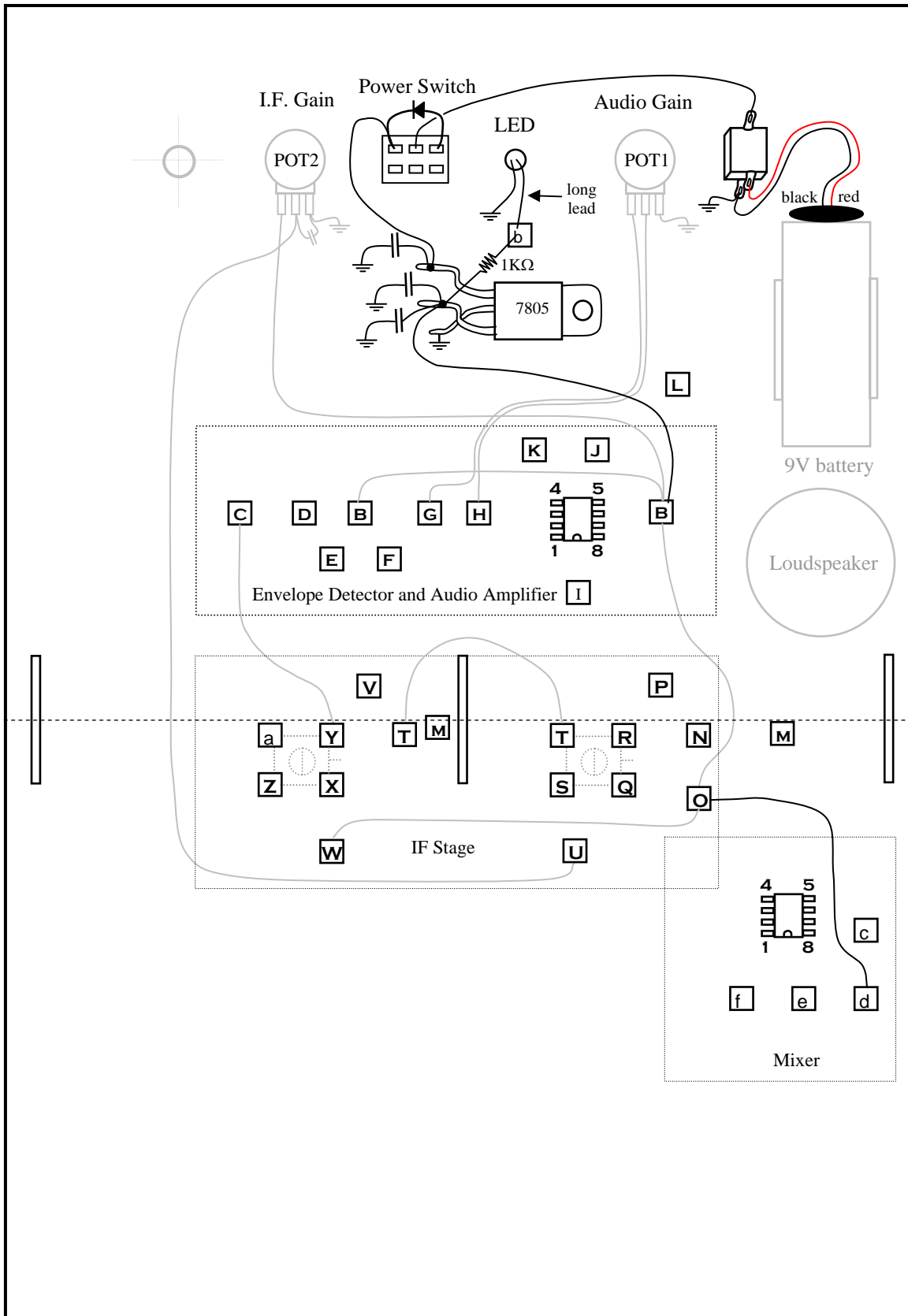


Figure 3.1 – Mixer and voltage regulator stage layout areas and solder pad locations.

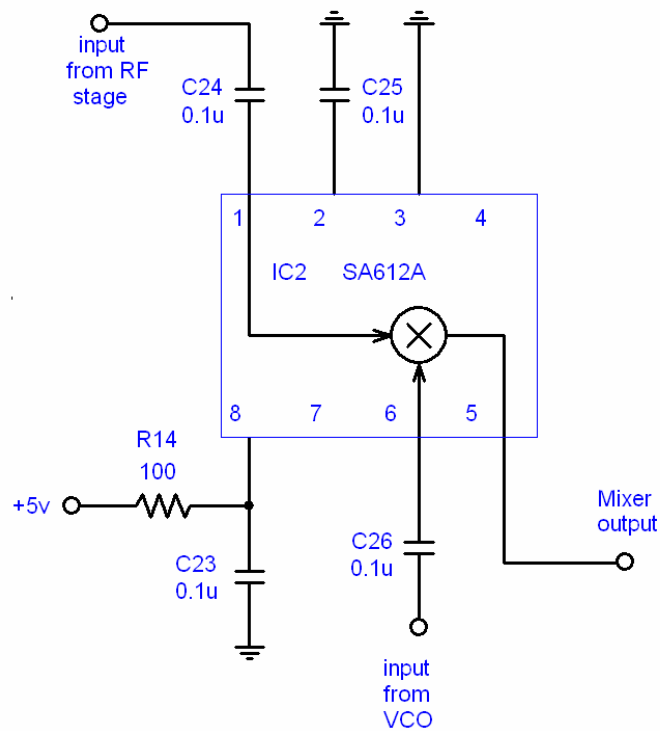
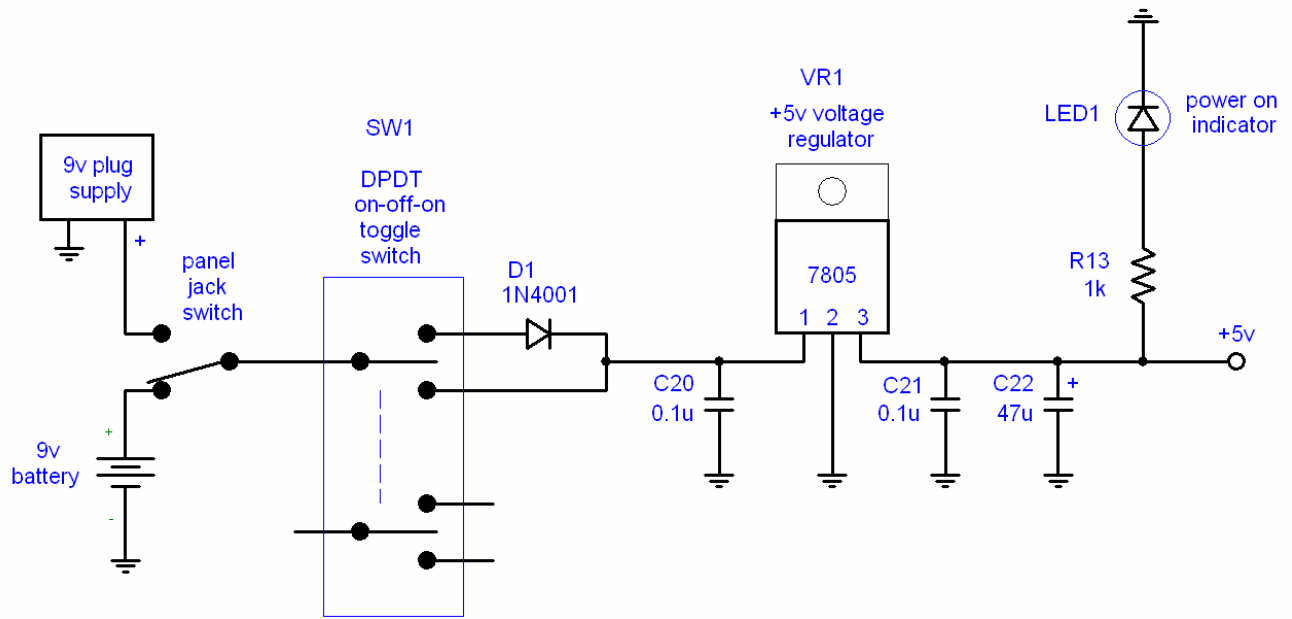


Figure 3.2 – Schematic diagram of the regulated power supply and mixer circuits.

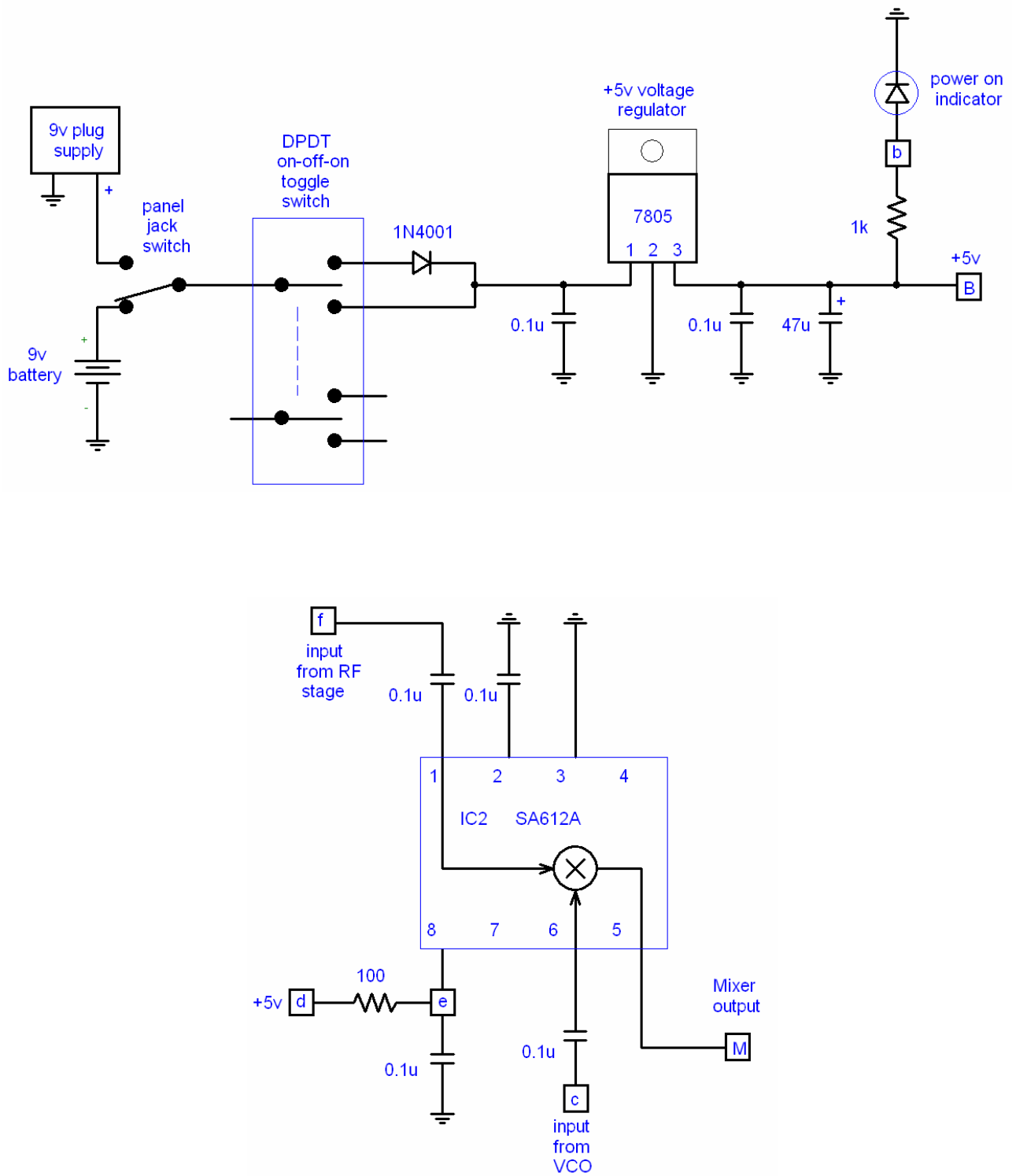


Figure 3.3 – Schematic diagram of the regulator and mixer with solder pad nodes shown.

Label	Part	Description	Quantity
IC2	SA612A	Gilbert Cell Mixer	1
VR1	7805	+5V, 1A voltage regulator	1
D1	1N4001	Rectification diode	1
SW1	DPDT on-off-on	Switch	1
LED1	Yellow T1 size	LED	1
R13	1K	Resistor	1
R14	100 Ohms	Resistor	1
C20, C21, C23, C24, C25, C26	0.1 uF	a.c. bypass capacitor	6
C22	47 uF	electrolytic capacitor	1

Table 3.1: Component list for Experiment 3.

2. Circuit Construction

Power Supply Wiring

- a) Take the unregulated 9V plug supply and cut off its connector. Solder in its place the 1/8" male plug connector that mates with the female panel jack. The wire with the white stripe is +, solder it to the center terminal. (Slide the strain relief onto the wires prior to soldering.)
- b) Solder the voltage regulator heat sink to the copper-plated board in the position shown in Figure 3-1. Leads 1 and 3 should be bent upwards, and lead 2 bent downward so that it may also be grounded.
- c) Wire the 9V battery clip to the panel as shown. The black wire is connected to the panel jack terminal closest to the copper board, and these are then grounded. The red wire is connected to the upper terminal just above the black wire. With this wiring scheme the internal switch of the panel jack will disconnect the battery whenever a plug is inserted.
- d) The panel jack's output terminal is then connected to the top middle lead of the DPDT toggle switch. Connect a diode across the other two switch terminals as shown¹, and from the diode cathode terminal run a wire to pin 1 of the 7805 voltage regulator.
- e) Solder C20, C21 and C22 from the voltage regulator terminals to ground. These capacitors keep the regulator from oscillating and help remove any 60 Hz hum from the unregulated external power supply.
- f) Hook up the power-on indicator LED as shown. The LED is not biased for maximum brightness in order to save battery power. (The long lead of the LED identifies its anode.)
- g) Run a wire from the regulator output pin 3 to node B in the audio amplifier. This node is the +5V distribution point.

Mixer Wiring

(nothing difficult here)

¹ Later this diode will prevent the LCD backlight from turning on while the radio is in manual tuning mode, to save battery power.

D.C. voltage measurements

If you have a 9V battery, install it carefully and turn the switch on in any direction. The potential measured at pin 3 of the 7805 regulator should be 5 Volts. Next plug in the external supply and verify that that same result is obtained. Be aware that the voltage regulator output can oscillate if it is not properly interfaced.

A.C. measurements

Now you can simulate the reception of a radio station by providing the mixer two input signals: one from a simulated LO, and one from a simulated RF station. Because the mixer has gain, you should drive it at node **f** with a very low amplitude AM signal. Try using a 1.0 MHz carrier that has 80-100% AM using a 400 Hz tone, produced by the RF signal generator, for this purpose. Then drive node **c** with a 250 mV p-p sinusoid at 1.455 MHz from the function generator. If your speaker outputs a 400 Hz tone, then all is working properly.

Lab Report

1. Simulate a single-transistor mixer in PSpice. Use the approach presented in class, where the transistor is operating in CE mode at one frequency and in CB mode at another.
2. Also in PSpice, simulate multiplication by a square wave using a switching transistor circuit. How is mixing achieved?
3. Explain the operation of a Gilbert Cell mixer. What is meant by unbalanced, single-balanced, and double-balanced mixing action?

Neatly show your work for these three parts in the format shown below. Submit your lab reports to the T.A. in lab on the specified due date.

Report Format

Purpose – the goal of performing this lab

Procedure – describe what was done

Theory – theoretical explanation of predicted circuit behavior

Data – measured data recorded in tables or graphs

Analysis – is the theory supported by actual measurements?

Conclusion – summarize everything concisely for those who read only the last paragraph

Appendix – data sheets for semiconductors/ICs used in the circuit