

EE322 Lab 04: DTMF Control Box

Introduction

In this lab, you will learn how signals generated in MATLAB can be used to perform useful functions. Here, you will generate DTMF tones to control relays that are used to power a standard wall outlet (120 V_{ac}, 60 Hz power). These relays and outlets are contained in the DTMF Control Boxes located at each lab station. In order to accomplish this, you will be using your *create_DTMF* and *create_silence* functions developed in Lab 03.

I. DTMF Control Box

A. Background

The DTMF Control Box can be used as an interface between a controlling device and a high-powered load circuit. The relays inside the box can be turned on and off using DTMF tones (which we will use in this lab) or by sending serial codeword bits over an RS-232 cable (which we will not use in this lab). For example, we have used MATLAB and DTMF control boxes on a few senior design projects, to unlock our Biometrics Lab door upon recognition of fingerprints or irises. In fact, we have a hard-wired DTMF control signal set up to unlock the Biometrics Lab door using the commercial LG iris system for access.

You've created DTMF tones in MATLAB as part of Lab 03, and you've played them with the *soundsc* command so you could hear them. In that case, the audio output was sent to the speakers. In this lab, instead of sending the audio output to the speakers, it will be sent to the "Audio In" port on the DTMF Control Box.

A general and quick explanation of how the DTMF Control Boxes work follows:

1. Each relay is turned on or off using 4 DTMF tones with an appropriate period of silence in between each tone. The DTMF tone duration you should use is 120 msec with 180 msec of silence between tones.
2. There are 7 relays contained in the Control Box. You will use relays #1, #2, #3 and #4 in this lab, which are relays that control power (wall outlets). You can turn each one on/off individually, or all on/all off simultaneously in accordance with the following table:

Command	Sequence	Notes
Turn Individual Output ON	*X1#	X is in the range 1-7, where 1 → Relay 1 2 → Relay 2 3 → Relay 3 4 → Relay 4 5 → Relay 5 6 → OUT0 7 → OUT1
Turn Individual Output OFF	*X0#	
Turn All Outputs ON	*A1#	
Turn All Outputs OFF	*A0#	

B. DTMF Control Box Function in MATLAB

1. Write a MATLAB function called *DTMF_control* that will turn on or off any one or all of the four relays (#1, #2, #3 and #4) on a DTMF control box. There will be three inputs. The first input will be either a relay number in single quotes (that is, '1', '2', '3' or '4') or 'ALL' or 'all' or 'All' for all relay operation. The second input will be a string, either 'on' or 'ON' or 'On' or 'off' or 'OFF' or 'Off.' The third input is the sample frequency.

There should be an error if the 1st string doesn't contain a single character digit ('1', '2', '3', or '4') or the words 'all' or 'ALL' or 'All.' There should be an error if

the 2nd input string doesn't contain the string 'on' or 'ON' or 'On' or 'off' or 'OFF' or 'Off.' There should be an error if the sample frequency is less than 4 kHz.

To compare strings, you should use the *strcmp* (short for “string compare”) function instead of the “==” operator. The “==” is really only good for single character comparisons. For example to compare a string called 's1' to the word 'open', you would use:

```
>> if (strcmp(s1, 'open'))
```

instead of:

```
>> if (s1 == 'open')
```

In case of error, your function should display an appropriate error message and not do anything to the DTMF control box.

Some possible uses of the *DTMF_control* function:

```
>> DTMF_control('1', 'ON', 12000); % turn relay # 1 on
```

```
>> DTMF_control('1', 'off', 12000); % turn relay # 1 off
```

```
>> DTMF_control('all', 'OFF', 12000); % turn all relays off
```

The *DTMF_control* function should have calls to your *create_DTMF* and *create_silence* functions in order to generate the appropriate DTMF tones.

3. Connect an audio cable from your PC headphone jack to the DTMF control box's *Audio In* port if not already done...this carries the DTMF signal you create to control the relays on the DTMF control box. Ensure the DTMF control box is energized (status light should be blinking green) and that the relays 1-4 are turned off (power switches' "O" button is depressed). **Important:** Adjust the volume on your computer (the sound control adjusted in Windows) to a mid-range level. A high volume can cause clipping in the audio output level passed to the DTMF control box, and it may not work as expected.
4. Test your *DTMF_control* function using a DTMF Control Box. Perform some simple testing on your own, with individual outlets. Nightlights are connected to each outlet of interest to help you in testing. The nightlight should energize if the outlet is on, and deenergize if the outlet is off. Be sure that each nightlight's individual power switch is in the "On" position before beginning.

Note: it is possible that if a nightlight doesn't turn on, it burnt out...let the professor know.

II. Testing and Writeup

- A. Demonstrate your *DTMF_control* function to the professor using the program called *DTMF_test*, which is downloadable from the course website under the "Labs" section. Note that this test program uses the MATLAB `pause` command to halt execution of MATLAB commands until you press any key.

For this lab writeup, turn in your *DTMF_control* code, and perform the demonstration to the professor using the *DTMF_test* program