HEARm User's Manual

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ENEE440 Spring 2013
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I. Introduction

The HEARm is an audio synthesizer. A user can create a tone by specifying both the frequency and intensity of this tone. Then the user can either play back this single tone (although playback is currently not implemented), or save it to a list of tones to be reviewed at a later time.

II. Turning on the Device & Reset Mode

To turn on the device, you simply connect it via USB cable (male Standard-A USB connector to male Mini-B USB connector) to a power supply. The Standard-A plug goes into the PC or whatever power source. The Mini-B plug goes into the Mini-B socket on the P24 I/O board, or the Mini-B socket on the microcontroller itself. After connecting the device to its power source, it will automatically turn on. Conversely, it will only turn off when unplugged.

When you plug in the device, it will always turn on in **reset mode**. No LEDs are on during reset mode. This lets you know that the device was just reset to default parameters (no tones in memory, default test intensity value, default test frequency value). In reset mode, you can't really do anything, and the screen displays all zeros. The **frequency button** (switch S9) is the only user input that will work in reset mode, and pressing it puts the device in **test mode** with the current frequency being displayed.

III. Test Mode

Test mode is where you create, playback, and save individual tones. If in review mode, you enter test mode by holding switch 11 for one second (but no greater than five). If in reset mode, you enter test mode by pressing the frequency button. If you were in test mode before, then coming back to test mode you'll have the same frequency and intensity values you left off with.

A. Frequency Display & Adjustment

As stated earlier, pressing the frequency button while in reset mode will put the device in test mode, and display the current frequency at its default value of 125 Hz. When in test mode and displaying the frequency, you are in the frequency submode of the test mode. The test mode also has an intensity submode.

You can also press the frequency button whenever in test mode in order to enter the frequency submode and display the most recent frequency you left off at. You can tell it's frequency being displayed (and not intensity), because the value will be zero-padded from the left. Intensity values, on the other hand, are displayed with no left zero-padding.

You may adjust the digits of the displayed frequency value by pressing the switches directly underneath that digit. The bottom switch will decrement that digit by one, the upper switch will increment it by one. This means that switches 1 through 8 are frequency-editing switches, and that is

their only function. The increment/decrement operation is circular, in that once you get to the highest digit (nine) and then increment again, you'll be back at zero. Similarly, zero will decrement to nine. Note that the frequency value has a lower limit of 125 (displayed as 0125), and an upper limit of 8000. If you attempt to go to a higher or lower frequency than that, the value will just settle on the respective limit.

To indicate that you are in the frequency submode, the top-left LED (LED1) will be lit. This is the **frequency LED**.

If you ever wish to return to this frequency submode from the intensity submode, just press the frequency button (switch 9). The frequency you left off at will still be there, and the same goes for the intensity submode.

Note that one can use the switches to adjust the frequency value when in the frequency submode, but one cannot use the rotary encoder to adjust the intensity value when in the frequency submode.

B. Intensity Display & Adjustment

One can go to the intensity submode from the frequency submode by pressing the **intensity button** (S10, or switch 10). So using the frequency and intensity buttons, we can go back and forth between frequency and intensity. The default intensity when coming out of reset mode is -10.

When you are in the intensity submode, you can adjust the intensity value. You do this by turning the rotary encoder. This is the knob located to the lower right of the numerical display. Turning it clockwise will increment the intensity value displayed; turning it counter-clockwise will decrement the intensity value displayed. The intensity only changes by increments of five. The intensity value has a lower limit of -10 and an upper limit of 110. The intensity value will saturate at these limits, and continuing to turn the knob in that direction will cause no change.

To indicate that you are in the intensity submode, the **intensity LED (**LED2) will go on. If you wish to return to the frequency submode, then you can press the frequency button as usual. Note that editing frequency will reset the intensity to -10, however.

Note that one cannot use the frequency-editing switches (switch 1-8) while in the intensity submode.

C. Play Current Tone

In order to play the current tone (where the current tone is a combination of the frequency and intensity from before), you must press the intensity switch while in the intensity submode. This will toggle playback. Playback is indicated by the **play LED** (LED6) blinking at 3 Hz. Successive presses to the intensity button toggles playback on and off.

When you are in playback, you can still switch back to the frequency submode by pressing the frequency button. This will turn off playback. If you then come back to the intensity submode, the playback will still be off.

Note that sound generation hasn't been implemented, so the blinking light is the only indication of playback.

C. Save/Delete Current Tone

In order to save the current tone to the list of saved tones, you must press switch 12 while in test mode. In order to delete the most recently saved tone, you must press switch 11.

IV. Review Mode

Review mode is where you review the saved list of tones. You enter review mode (thereby exiting test mode, as the two are mutually exclusive) by holding switch 11 for one second. You can only enter review mode, however, if you have saved tones. Then LED3, the **review LED**, will light up, to indicate that you have now entered review mode. In order to exit review mode, just hold the review LED again for 1-5 seconds.

When you first enter review, the intensity of the most recently saved tone will be displayed. You can switch between the frequency and intensity of a tone as usual by pressing the frequency or intensity buttons. You will not be able to change the frequency or intensity, since the point of this mode is reviewing and not editing.

Pressing switch 12 will step through all the saved tones, circling back around to the first tone when you get to the end of the list.

V. Reset

You may reset the device at any point in its operation (unless already in reset mode). In order to reset the device, press and hold switch 11 for ten seconds. After one second, review/test mode will be toggled (this always happens if you are trying to reset the device), rremembering the exception that you can only go into review mode if you have saved tones. After five seconds, the **erase warning LED** (LED5) will begin flashing. As you continue holding switch 11, the warning LED will flash faster and faster until ten seconds have passed. At this point, the screen will flash zeros four times while the **reset LED** (LED4) turns on for two seconds. Then, the device will be in reset mode.

Resetting puts the device in reset mode (like it was when it was turned on). It will have no list of tones in its memory, the display will be all zeros to indicate that it was just reset, and all the buttons (except for the frequency button) and encoder will be disabled. To begin using the device again, press the frequency button to put it into test mode.

VI. Programming the Device

You may reprogram the device's firmware (i.e., overwrite the current functionality of the board) by plugging the USB cable into the microcontroller directly. You then load your machine code onto the device, say using the Keil uVision IDE. Finally, you must replug the device. Now it will be running your code!