Part f) After you get a good score in simulation, you should debug on the real board. Because of the complexity of the system and the possibility of hardware errors, we strongly suggest you test each module separately on the real board. First you should test the DAC module, and then test the piano module. Once you are sure the DAC and piano modules are correct, your can then debug the sound module. The TExaS oscilloscope can be used for debugging on the real board.

TEXAS OSCILLOSCOPE

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DR. RAMESH YERRABALLI: In this video, we will show you

a working solution of Lab 13 and its interaction with the TExaSdisplay

software.

The two things to remember are to make sure

that PD3 is connected to the DAC output, which we will measure; and call

TExaS_Init subroutine using the ScopeOn parameter as our last value.

DR. JONATHAN VALVANO: To initialize the TExaSdisplay,

we're first going to open the serial port connection.

And you remember data streams from the microcontroller into the TExaSdisplay

through the UART.

And we're going to click the display, or the

scope parameter.

And so now we can see that the voltage is measured, or plotted versus time.

DR. RAMESH YERRABALLI: So we'll interact with our solution.

Help

So remember that this solution requires you to implement four keys.

And the first key I'm going to try is the G key.

I press the key.

And TExaSdisplay gives me a frequency of 784 Hertz, approximately.

So I'm going to release this key, test another key, which is the E key.

I press it.

I look at the frequency.

It's approximately 660 Hertz.

And I can try another key, which is a D key.

And I look at it on 588 Hertz.

And the last key is my C key, which is a 521 Hertz, approximately.

DR. JONATHAN VALVANO: So in summary, an oscilloscope measures voltage

versus time.

And we use this to make sure that the output of the DAC

has both the correct shape and the correct frequency.

DR. RAMESH YERRABALLI: So, Jon, what happens

if I were to connect the audio jack to my headphones?

DR. JONATHAN VALVANO: Let's try and see.

DR. RAMESH YERRABALLI: So I've connected it.

And I'm going to press one of the keys.

I have a G key pressed right now.

So it does show me a signal.

Obviously, it's scaled down because now there's a load.

but it is the right shape.

And it is the right frequency.

DR. JONATHAN VALVANO: All right, now you try it.

Help

Static testing The first step in debugging the hardware is to build the DAC, and write DAC_Init and DAC_Out. For this test you do not connect the headphones. If you connect PD3 to the DAC output and run this program with 1 second delay you should see the voltage on the voltmeter. You can add n to the watch window to compare the DAC digital input to the DAC analog output.

```
unsigned long n;
int main(void){
  n = 0;
  TExaS_Init(SW_PIN_PA5432, DAC_PIN_PB3210,SCOPE); // activate grader
  DAC_Init();   // your code to initialize the DAC
  EnableInterrupts();
  while(1){
    DAC_Out(n);     // your code to output to the DAC
    Delay1ms(1000); // wait 1s (later change this to 1ms)
    n = (n+1)&0x0F;
  }
}
```

Dynamic testing The second step is to reduce the delay to 1ms. Again you connect PD3 to the DAC output and run the above program with a 1ms delay and no headphones. Start the **TExaSdisplay** application, open the COM port, and select scope mode. The DAC analog output should be a ramp output with a period of about 16 ms.

Do not connect headphones during grading. Lastly, you will run your system with the real board grader. While the power is off, you will need to connect a wire from PD3 to the output of your DAC. PD3 will become an analog input and the grader will use it to record the DAC output verses time. During the real board grading you will have to push the external switches so that all five cases are tested (pressing a switch causes sound and releasing the switch does not create sound). If the “Signal is too small” then either the headphones are attached or the PD3 wire is not connected to the DAC output. If the grading test sometimes passes and sometimes fails, then your timing may be beyond the +/- 2% expected tolerance. The real board grader checks for both the frequency and the shape (sinusoidal) of the DAC output. If the grading always fails make sure you are outputting sine waves at the proper frequency.

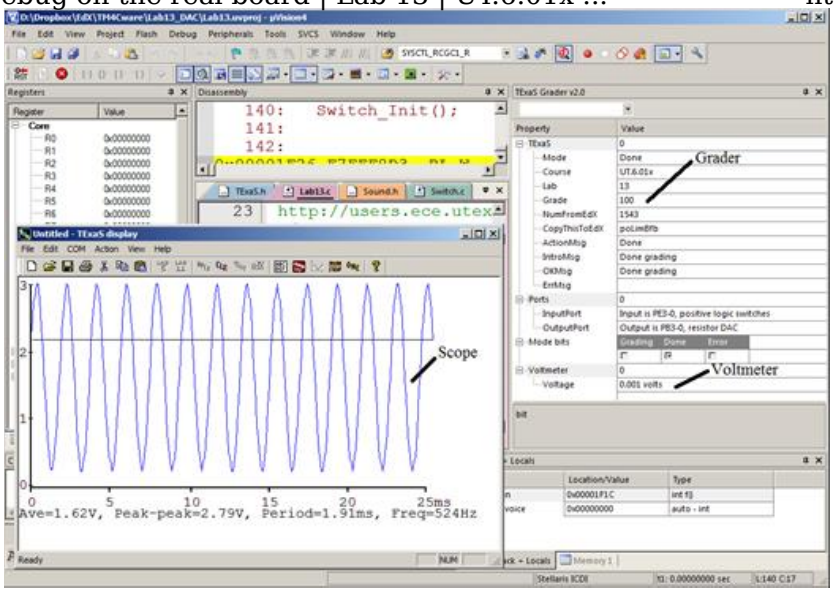

Figure 13.5. Learning environment on the real board.

GRADING ON THE REAL BOARD

DR. JONATHAN VALVANO: Hi.

Let's show you how to get a grade for the Lab 13 Real Board lab.

We begin in edX by taking this four-digit number, copy.

We go over to Keil.

Because we're on the Real Board, we have to make sure that the options,

that TExaS is the operating system, and then in the debug tab

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