Unit IV: Matlab/Simulink

Signal Processors Lab

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1 Introduction to Matlab/Simulink

Setup

After starting Matlab in the Virtual Machine you should see the window shown in Fig. 1. By clicking on "New" → "Simulink Model" you create a new Simulink Model. Now you should see the screen shown in Fig. 2. Click on the setting button (marked red in Fig. 2) and make sure the following is set up correctly:

- Section "Solver":
  - Start Time: 0.0
  - Stop Time: inf
- Section "Code Generation":
  - System Target File: idelink_grt.tlc
  - Subsection "Coder Target"
    - Tab "Target Hardware Resources"
      - IDE/Tool Chain: Texas Instruments Code Composer Studio v5 (makefile generation only)
      - Sub-Tab "Board":
      - Board: SD C6713 DSK
      - Operating System: None

Click "OK" and "Apply" to save the configuration.

Simulink Libary Browser

To add Simulink Blocks to the workspace, click on the symbol left to the settings icon. Doing this, you will get to the Simulink Library Browser as it can be seen in Fig. 3. There the section with the blocks concerning our development board is opened. To add the blocks to the workspace, simply drag and drop them.

Load to Hardware

To compile and load the executable to the connected DSP, simply click on the "Build Model" icon (shown in Fig. 2 on the right hand side).

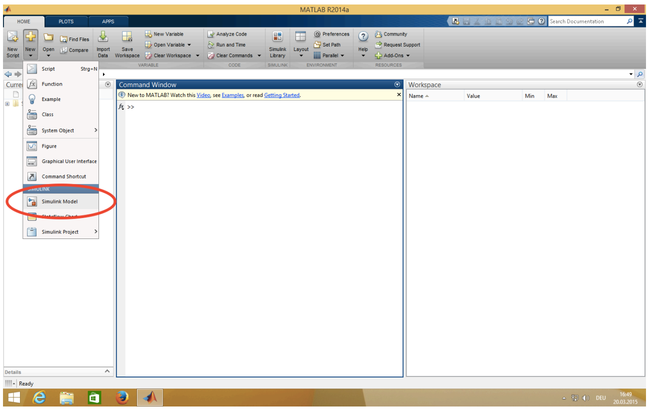

Figure 1: Creating a new Simulink model.

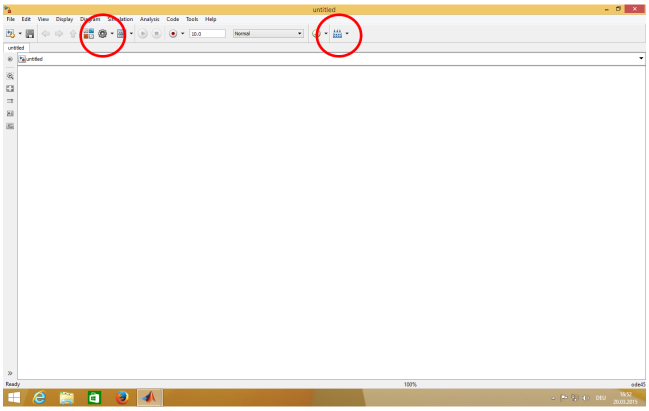

Figure 2: Simulink start screen.

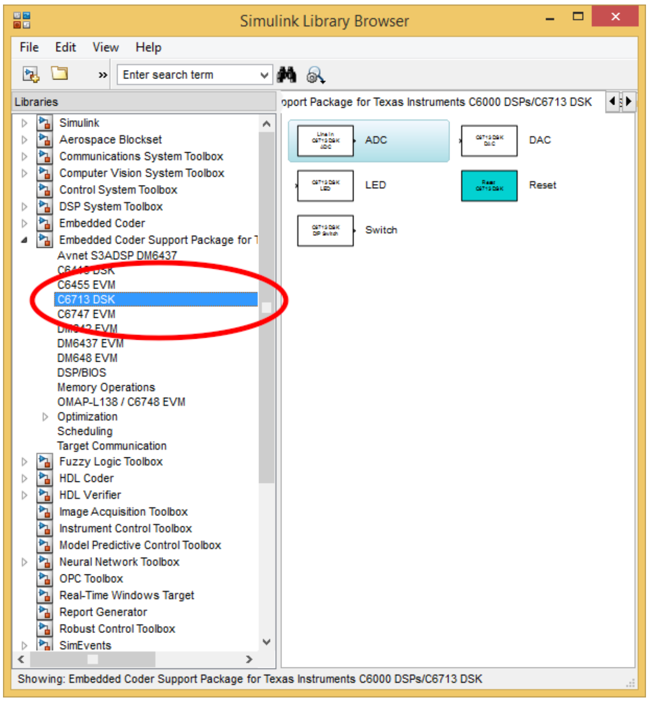

Figure 3: Simulink Libary Browser.

2 Tasks

Task 1 – Getting Started: De-noising using Wavelets: To get used to the environment, try to reverse-engineer the Simulink model given in “Wavelet_denoising.slx”. Build the project and run it on the DSP. Try to use different parameters and observe the differences. Use the switches to turn the de-noising on and off as well as to light up the LEDs.

Try different sampling rates as well as the options to use the mic as well as the line-in input. Can you identify any differences? Report your observations.

Task 2 – Amplification, Clipping, Adding a Sine-wave, Band-pass Filtering: This task combines 4 different operations on the input signal (Sample with 8000Hz). To perform the switching between these modes, use the 4 switches. The active mode should be represented by activating the according LED. All modes should be able to perform simultaneously as well as on their own. The signal flow should be in the following direction:

(a) **Adding a Sine-wave:** If switch 1 is pressed, two sine-waves (one left, one right with 50 and 3500Hz) should be superimposed (add two signals to stereo using “Vector Concatinate” on multidimensional data on the second dimension) on the input signal.

(b) **Amplification:** Using the hardware setup shown in Fig. 4, use Simulink to generate an executable which amplifies the input (hint: Block ADC) and puts it on the output (hint: Block DAC). Try different amplification factors (hint: see “Simulink” → “Commonly Used Blocks” → “Gain”).

(c) **Band-pass Filtering:** If switch 3 is pressed, the signal should be Band-pass filtered. Doing this, use the block "FDATool" and try different filter types and filter frequencies to remove the distortions added by pressing switch 1.

(d) **Clipping:** If switch 4 is pressed, the signal should be clipped. Try different clipping values.

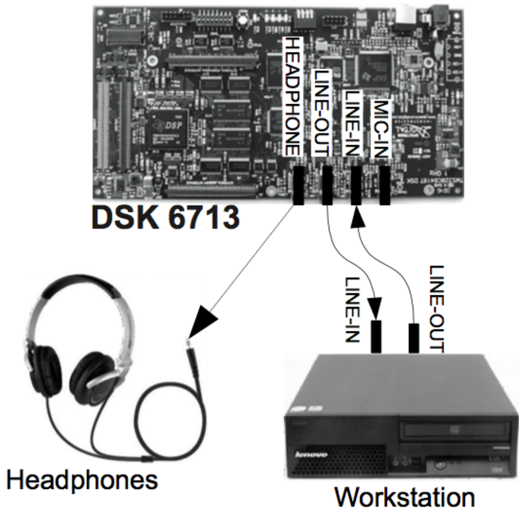

Figure 4: Hardware Setup.

Questions:

- Is the Band-pass filter able to eliminate the distortions? Why? Why not? Which configuration did you use? Document your results in the report.
- Doing the clipping with active sine-wave distortion, what do you observe using the PicoScope? Are there any differences between the high and low frequency signal?
- The DAC provides the option to choose between "Wrap" and "Saturate". What is the difference and what can you observe by applying the gain? Document your results in the report.

Task 3 – Removing Distortions: The sound-file "Beethoven.wav" is distorted by multiple sine waves at different frequencies. Using Matlab find the frequencies of these distortions and try to remove them using notch filters. Implement you solution in the given Simulink Model in the sub-function "Distortion". You can again use the "FDATool" block to generate the filters and the switch box to enable them. Use one switch to switch the channels before applying the filter (left to right and vice versa). Apply them and report your observations as well as the found frequencies. Hint: Separate the Stereo Channel to Mono using two "Submatrix"-Blocks.

Task 4 – Amplitude Modulated Communication between DSPs: We want to build a AM communication channel between two DSKs. Doing this, you will need 2 kits, later referenced as DSK

A and DSK B. To demonstrate the functionality, you should transfer the spoken audio signal sampled at Microphone-In of DSK A, modulate it onto a 30kHz carrier wave, put this modulated signal to Line-Out and get it again to Line-In of DSK B. Here, demodulate the signal and put it to the output "Headphones" of DSK B (see Fig. 5).
Hint 1: $\cos(\alpha) \cdot \cos(\beta) = \frac{1}{2} (\cos(\alpha - \beta) + \cos(\alpha + \beta))$
Hint 2: AM Demodulation can be simply done using a diode and a low-pass filter.

Use as input a sine-wave and capture the transmitted AM signal using the PicoScope. How does the parameters (gain of input signal, added offset, carrier frequency) change the behaviour of the transmission? Add plots to the report and describe your observations.

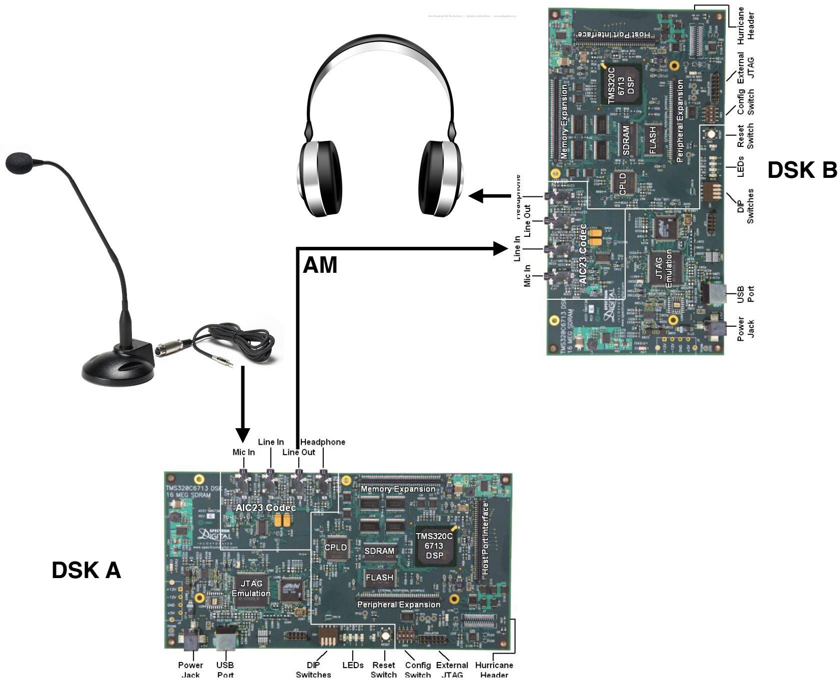

Figure 5: Hardware Setup for the AM Task.