Embedded Code Generation

DEMO MODEL

Simple Model

A simple model to get started with the TI C2000 TSP

Last updated in C2000 TSP 1.2

www.plexim.com

▶| Request a PLECS and PLECS Coder trial license

▶| Get the latest TI C2000 and RT Box Target Support Package

▶| Check the PLECS, RT Box and TI C2000 TSP documentation

1   Overview

This demo features a simple model that shows how to use Texas Instruments (TI) C2000 microcontrollers (MCUs) with the PLECS Coder and the TI C2000 Target Support Package.

The model is split into four distinct subsystems called "28069", "280049", "28377S" and "28379D". Each subsystem can be independently deployed to the corresponding TI C2000 LaunchPad hardware. The following sections provide a brief description of the model and instructions on how to simulate it.

2   Model

The top level schematic contains four separate subsystems, as shown in Fig. 1. The subsystem labeled "28069" is configured for the TI 28069 LaunchPad [1], the subsystem labeled "280049" is configured for the TI 280049C LaunchPad [2], the subsystem labeled "28377S" is configured theTI 28377S Launch-Pad [3] and lastly the subsystem labeled "28379D" is configured for the TI 28379D LaunchPad [4].

Each subsystem is enabled for code generation, as indicated by the thick outer border of the subsystem blocks. This step is necessary to generate the model code for a subsystem via the PLECS Coder. This setting is configured by selecting the subsystem, opening **Edit + Subsystem + Execution settings...** menu, and then selecting the **Enable code generation** option.

The generated code runs at a base sample time on the MCU. This sample time also defines how the continuous states of the model equations are discretized. The sample time is configured in by the **Discretization step size** setting in the **Execution settings...** menu. In this model, the discretization step size of each of the subsystems is set to $100\,\mu s$.
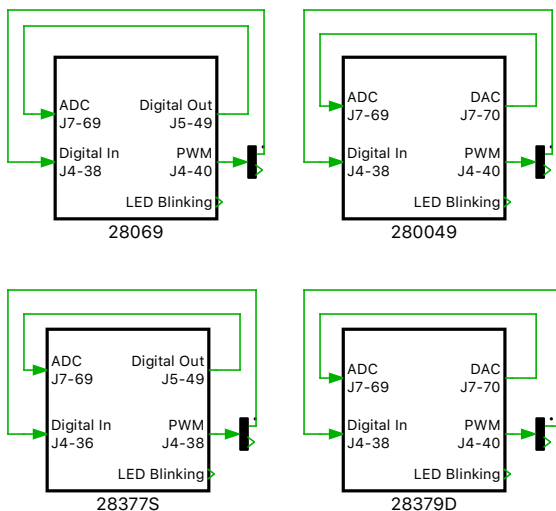

Figure 1: Top level schematic of the model with four subsystems

Each of the subsystems includes a simple model to blink an LED on the LaunchPad, using a Digital Out block of the TI C2000 Target component library, and to generate two sinusoidal waveforms that are measured with a PLECS Scope, as shown in Fig. 2.

The MCUs pulse-width modulator (PWM) peripheral is configured by the PWM block, as shown in Fig. 3. Duty cycle is provided as an input to this block. The **Carrier type**, **Carrier frequency** and **Blanking time** parameters can be configured from the **Main** tab of the PWM block parameters window. Note that each PWM generator configures the PWM output pins as a complementary PWM pair, i.e. ePWMxA and ePWMxB will be opposite polarity excluding the blanking time.

By externally connecting the PWM output to a digital input via a jumper wire, the generated PWM signals can then be sensed and used in the model environment. The Digital In block is used for this purpose.
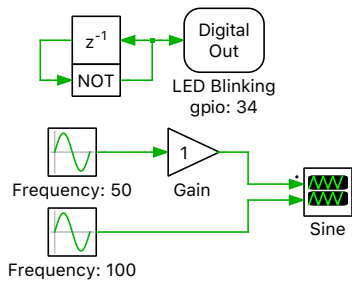
Figure 2: Circuit to blink an LED and generate sine waveforms

Analog signals are sensed by configuring the analog-to-digital (ADC) peripheral of the MCU. Similarly, analog signals are generated by using the digital-to-analog (DAC) peripheral device, which are available on the 280049 and 28379D LaunchPad devices.

In this model a DAC block is used to generate an analog signal and an ADC block is then used to sense the signal, using an external jumper wire to connect appropriate pins. Optionally, scaling and offset factors can be configured for each channel via the parameter window of the ADC and DAC blocks.
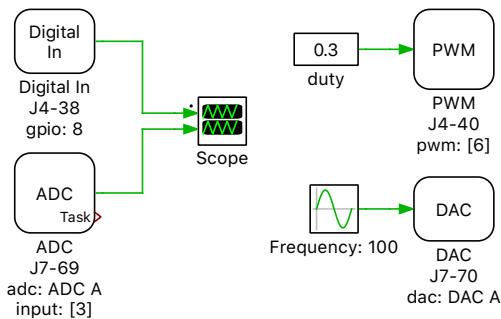

Figure 3: Circuit to generate PWM and analog waveforms on 280049 and 28379D

Since 28069 and 28377S LaunchPads do not have the DAC peripheral, a pulsating digital signal is fed into the ADC instead of an analog signal, as shown in Fig. 4.
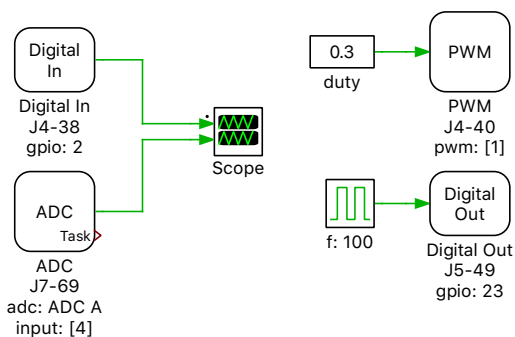

Figure 4: DAC block is replaced with a Digital Out block on 28069 and 28377S

3 Simulation

Each subsystem can be directly converted into target specific code for the corresponding TI LaunchPad hardware.

Note   Before proceeding, ensure the DIP switch position and jumper configuration on the LaunchPad device are correctly configured. Guidance for each LaunchPad device is provided in the "Tips for Programming C2000 LaunchPads" section of the TI C2000 Target Support User Manual [5]

Flash the MCU

Follow the instructions below to upload the subsystems to a TI MCU.

- Connect the desired MCU to the host computer through a USB cable.
- From the **System** tab of the **Coder + Coder options...** window, select the MCU of interest.
- Next, from the **Target** tab, select the appropriate target from the dropdown menu. Then under the **General** sub-tab, select the desired **Build type**.
- Then, to `Build and program` the MCU directly from PLECS, choose either `Run from Flash` or `Run from RAM` as the **Build configuration**, then select `LaunchPad` as the **Board** type, and click **Build**.

If programmed correctly, the LED on the LaunchPad board should blink.

For advanced users who are familiar with Code Composer Studio (CCS), there is an option to `Generate code into CCS project`. Included with the TI C2000 Target Support package is a folder titled `projects`. Within the folder there are ZIP archives containing pre-built CCS projects for each MCU. Extract the ZIP archive, locate the `cg` folder within the CCS project, enter its path into the **CCS project directory** field and click **Build**. The code of the desired MCU subsystem will be automatically generated. Then, proceed to build and debug the project as a normal CCS project. Refer to "Quick Start" section of the TI C2000 Target Support User Manual [5] for detailed step-by-step instructions.

Connect the hardware

Next, connect the pin numbers listed below using jumper wires for the desired MCU.

- **28069** Connect J4-40 to J4-38; and J7-49 to J7-69.
- **280049** Connect J4-40 to J4-38; and J7-70 to J7-69.
- **28377S** Connect J4-38 to J4-36; and J7-49 to J7-69.
- **28379D** Connect J4-40 to J4-38; and J7-70 to J7-69.

External Mode

Once the generated code is running on the C2000 target, the user can enter the External Mode to update Scopes in the PLECS application with real-time waveforms and change certain simulation parameters. The steps below outline how to connect to the target device, with additional debugging details provided in the "Start the External Mode" section of the user manual [5].

- First, from the **System** menu on the left hand side of the **Coder + Coder options...** window, select the desired MCU.
- Then, from the **External Mode** tab, select the **Target device** by clicking ✎ icon next to the **Target device** field.
- Next, click **Connect** and then **Activate autotriggering** to observe the test results in the subsystem Scope.

The generated sine waveforms can be viewed using the scope labeled "Sine",as shown in Fig. 5. The captured PWM and ADC signals can be viewed using the scope labeled "Scope", as shown in Fig. 6 and Fig. 7, found within the subsystem of the desired MCU. A trigger level for a desired **Trigger channel** can be set from the **External Mode** tab.
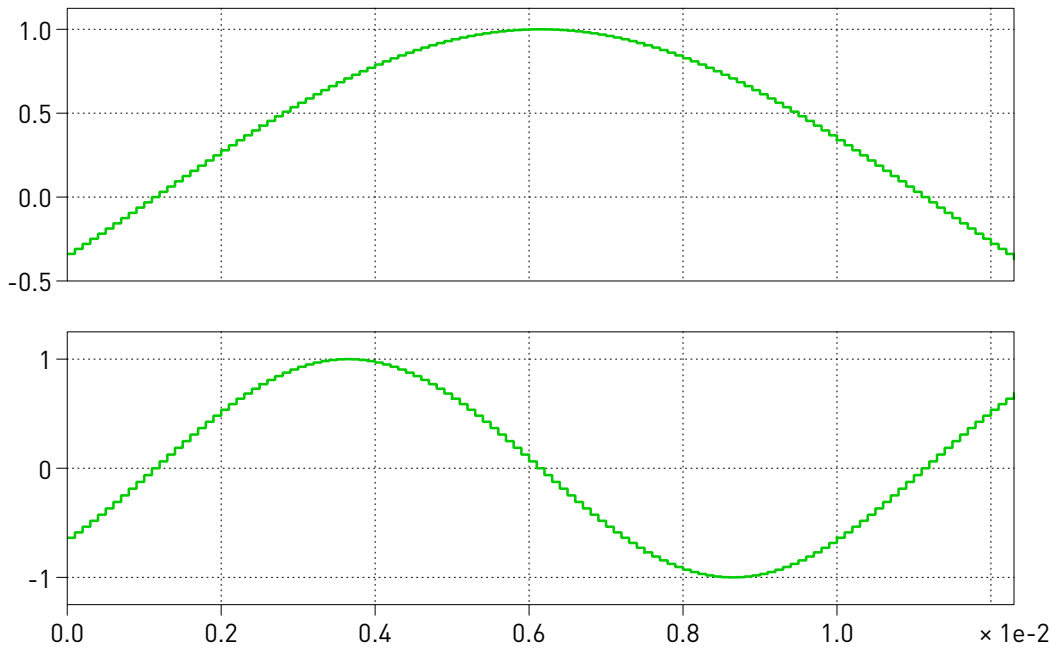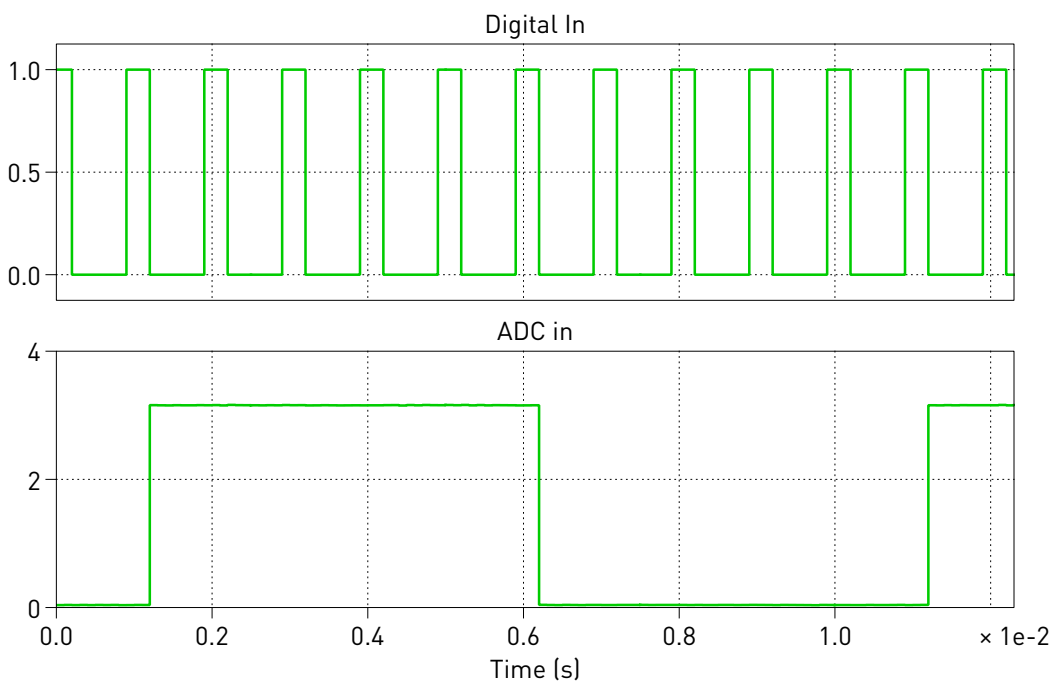
Figure 5: Generated sine waveforms on the 28069

Figure 6: Captured PWM and ADC signals on the 28069

Parameter Inlining

Certain values on the target device can be changed in real-time, if the component is added to the "Exceptions" list found in the **Parameter Inlining** tab of the **Coder options...** window, prior to building the model. In this case, the values labeled "Gain" and "duty" can be changed when connected to the target device via the External Mode. Changes in the parameters will be reflected in the Scope traces once they take effect.
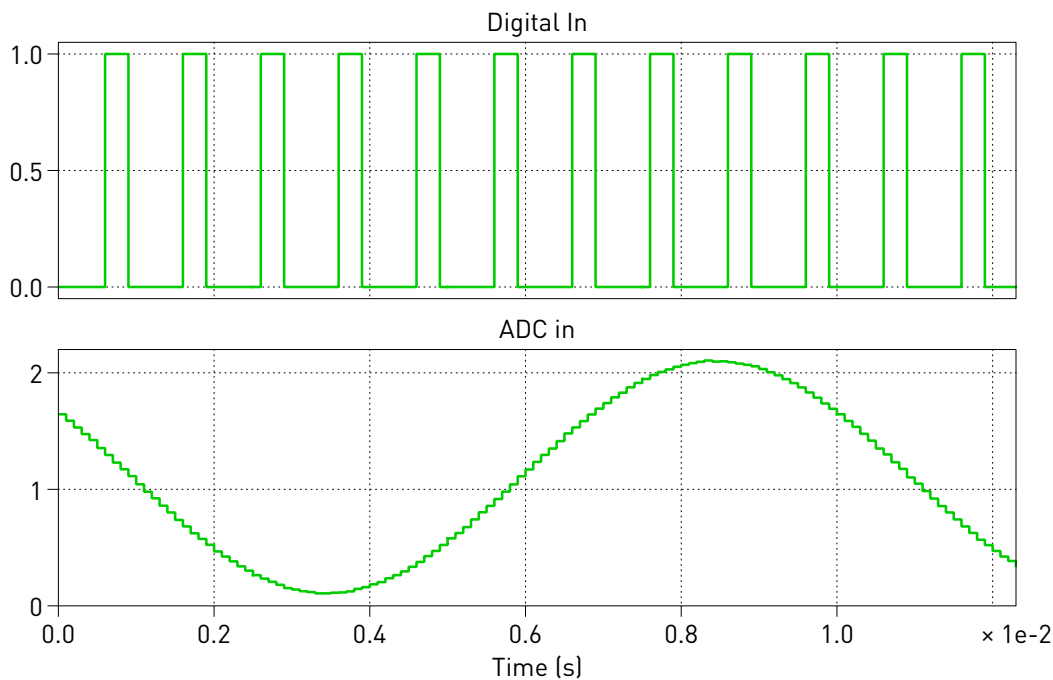
Figure 7: Captured PWM and ADC signals on the 280049

4   Conclusion

This model demonstrates how to program a TI C2000 MCU, connect to the External Mode, and also demonstrates Parameter Inlining feature using a simple model.

References

[1] TI C2000 Piccolo MCU F28069M LaunchPad Development Kit,
   URL: http://www.ti.com/tool/LAUNCHXL-F28069M.

[2] TI C2000 Piccolo MCU F280049C LaunchPad Development Kit
   URL: http://www.ti.com/tool/LAUNCHXL-F280049C.

[3] TI C2000 Delfino MCUs F28377S LaunchPad Development Kit,
   URL: http://www.ti.com/tool/LAUNCHXL-F28377S.

[4] TI C2000 Delfino MCUs F28379D LaunchPad Development Kit,
   URL: http://www.ti.com/tool/LAUNCHXL-F28379D.

[5] PLECS TI C2000 Target Support User Manual,
   URL: https://www.plexim.com/sites/default/files/c2000manual.pdf.

Revision History:

C2000 TSP 1.2   First release

How to Contact Plexim:

Embedded Code Generation Demo Model