xPC Target – ServoToGo Tutorial

This tutorial will walk you through steps on creating a Simulink model to interface with a ServoToGo card for real-time data acquisition and control. As an example, you will create a signal loop-back model for verification of your hardware/software functions. You will send a signal out through the D/A port (analog output) and read it back in through the A/D port (analog input).

1. **Creating a target Simulink model.** The target Simulink model will be compiled and downloaded to the target computer, and it will run in real-time within the target computer.
    a. Create new model (from File menu).
    b. Open Simulink library by typing "`simulink`" in the command window. Also open the ServoToGo library by typing "`servotogo`" in the command window. This should work if the ServoToGo drivers are installed and the directory is added to the MATLAB path. You also need to have two C-codes (GLOBAL.c, STGMEMBS.c) inside your working directory. Consult your fearless leader if it's not setup correctly.
    c. Copy the following blocks to your new model:
        i. From the "**ServoToGo**" library, copy "**Init**", "**Analog Input**", "**Analog Output**".
        ii. From the "**Simulink/Sinks**" library, copy "**Out1**".
        iii. From the "**Simulink/Sources**" library, copy "**Sine Wave**".
        iv. From "**xPC Target/Misc**" library, copy "**Scope (xPC)**".
    d. Connect "**Sine Wave**" to "**Analog Output**". Connect "**Analog Input**" to "**Target Scope**". Also connect "**Out1**" to the signal line coming out of "**Analog Input**". *Note: you need an Out port for every signal you want to log (record) in the target buffer.*
    e. Double-click "**STG (Init)**" block. Set sample time to be 0.001 sec, and IRQ to be 5. Check with Brent on the base address of the ServoToGo card.
    f. Note the channels used for "**Analog Input**" and "**Analog Output**".
    g. Wire the hardware, so that the D/A channel is connected to the A/D channel. Also connect the ground pins together. Consult the ServoToGo hardware manual for pin outs.
    h. Go to "**Simulation parameters…**" under "**Simulation**" menu.
        i. Under the "**Solver**" tab, set the Stop time to be "**inf**". You will manually start and stop the model. Select "**Fixed-step**" solver type. xPC Target does not work with variable-step solver type.
        ii. Under the "**Workspace I/O**" tab, select "Time" and "Output" if you want to log any of these data on the target. This step is necessary, in addition to adding an "Out" port (see d.). Uncheck "**Limit data points to last**" box. You specify this later in buffer size.
        iii. Under the "**Real-Time Workshop**" tab, select the "**xpctarget.tlc**" System target file.
        iv. In "**xPC Target code generation options**" category, enter the base address of the ServoToGo card.
        v. Take note of the Signal Logging buffer size. This determines how much data the target machine records (number of samples). The limit to the buffer size is the amount of RAM in the target machine. Each sample (double) takes up 8 bytes of memory.
    i. Save the model.

2. **Creating a host Simulink model.** The host Simulink model will allow you to send and receive information from the target during the execution of the real-time code. It is useful for things like parameter tuning and signal monitoring. Since data is being transmitted through a serial or an Ethernet connection, there will be a noticeable decrease in sampling rate, but it will not interfere with the real-time operations occurring on the target machine.
    a. Create a new model.
    b. For every **signal** you want to **monitor**, copy the "**xPC Target/Misc/From xPC Target**" block. For every **parameter** you want to **tune**, copy the "**xPC Target/Misc/To xPC Target**" block.
    c. For this tutorial, copy one "**From xPC Target**" block and two "**To xPC Target**" blocks. Also copy a "**Simulink/Sinks/Scope**" block and two "**Simulink/Sources/Constant**" blocks. You will monitor the Analog Input signal, and tune the frequency and the amplitude of the sine wave.
    d. Connect "**From xPC Target**" to "**Scope**". Connect each of "**Constant**" blocks to the two "**To xPC Target**" blocks.

e. Double-click the "**From xPC Target**" block. For "**XPC application name**", enter the name of the target Simulink model. For "**Signal name**", enter "**Analog Input**". This is the name of the Simulink block from which you want to obtain the signal.
f. Double-click the "**To xPC Target**" block. For "**XPC application name**", enter the name of the target Simulink model. For "**Path to block in model running on xPC target**", enter "**Sine Wave**". This is the name of the Simulink block whose parameter you want to tune. For "**Parameter name**", enter "**Frequency**" for one and "**Amplitude**" for the other block.
g. Go to "**Simulation parameters…**" under "**Simulation**" menu. Under the "**Solver**" tab, set the Stop time to be "**inf**". Select "**Fixed-step**" solver type.
h. Save the model.

3. You are now ready to **build and download** your model to the target machine.
   a. Go to your target Simulink model. Select "**Tools/Real-Time Workshop/Build Model**" from the menu.
   b. If everything goes well, your model should compile and after download, your target monitor should display a scope.
   c. In the MATLAB workspace, your target model is represented by a target object named "**`tg`**". The name can be changed in the "Simulation Parameters". Type "**`tg`**" in the command window and see the target object parameters.
   d. Type "**`start(tg)`**" in the command window to start the real-time model. You should see some signal display in the target machine monitor. Your model is running in real-time.
   e. Go to your host Simulink model and start the simulation.
   f. Open the scope by double-clicking the "**Scope**" block. You should see a signal. You may need to adjust the "time range" and "number of data points". Notice that the host model runs in simulation time, not real-time.
   g. To adjust the parameters (in this example, frequency and amplitude of the sine wave), double-click on the "**Constant**" block, enter the desired value, and click OK. Notice the change in the scope signal. You should also see a message "Parameter # updated" on the target monitor.
   h. To stop the real-time model, type "**`stop(tg)`**" in the command window. To stop the host model, select "Stop" from the menu.
   i. If you have created "**Out**" ports (see 1. d.), those signals are stored in the target buffer (size specified in the properties). You can upload the acquired data to MATLAB workspace by typing "**`y=tg.OutputLog;`**" in the command window. If the host and the target are connected by a serial cable, it may take some time to upload. You can upload the time vector by typing "**`t=tg.TimeLog;`**".

4. A good **resource** for using xPC Target is the Mathworks documentation on the toolbox:

   http://www.mathworks.com/access/helpdesk/help/toolbox/xpc/

   Note that, the documentation is for the most recent version of the toolbox, so some parts may be different from the one installed on the host computers.