RT Box Analog Breakout Board

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Introduction

The PLECS RT Box is a powerful real-time simulator based on a 1 GHz Xilinx Zynq system on a chip (SOC). With its 64 digital and 32 analog input and output signals (I/Os), the RT Box is well equipped for hardware-in-the-loop (HIL) testing as well as rapid control prototyping.

The front panel of the RT Box is comprised of four connectors for analog and digital I/Os. The I/Os need to be connected by the user to the device-under-test (DUT). If the RT Box is employed for HIL simulations, the DUT is the real control hardware and the RT Box emulates the plant. If the RT Box is used for rapid control prototyping, the DUT is the real plant controlled by the RT Box.

To simplify the connection to external hardware and to provide convenient access to the RT Box inputs and outputs, Plexim offers different sets of RT Box accessories.

The Analog Breakout Board facilitates a simple access to the analog input and output channels of the RT Box via BNC connectors. This board is typically used in conjunction with the Digital Breakout Board, which allows pin-by-pin access to the digital I/Os of the RT Box.

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Breakout Board Description

The Analog Breakout Board provides provides access to the 16 analog input and 16 analog output channels of the RT Box via BNC connectors. Fig. 2.1 shows the top view of the analog breakout board.

Figure 2.1: RT Box Analog Breakout Board

Analog Inputs

The 16 analog input channels are connected to dedicated BNC sockets labeled **Ch-0 ... Ch-15** on the top section of the board. The input voltage range can be set for all channels together to either $\pm 10\,\mathrm{V}$ or $\pm 5\,\mathrm{V}$ using the **Target** tab under the **Coder Options** window of the PLECS Coder.

The analog-to-digital converters (ADCs) inside the RT Box are capable of a maximum sampling rate of $2\,\mathrm{MSPS}$ with no-cycle latency. As the firmware of the RT Box currently limits the cycle time to a minimum of $1\,\mu\mathrm{s}$, a sampling rate of up to $1\,\mathrm{MSPS}$ can be realized.

The analog inputs play an important role when the RT Box is used for rapid control prototyping. To allow instantaneous sampling of the input signals, the analog inputs do not have internal anti-aliasing filters. If the bandwidth of the input signal shall be limited, such filters must be added externally.

To improve the signal/noise ratio, the input impedance of each input channel can be reduced from 1 MΩ to 10 kΩ using DIP switches labeled **Term. 10 k**Ω and **Term. 1 M**Ω.

Another set of DIP switches labeled **Single end.** and **Differential** allow to individually select differential or single-ended operation for all input channels. The corresponding analog input channel numbers are labeled above the DIP switch component.

Differential measurement

The analog inputs are capable of full differential measurement. The measured voltage is the difference between the positive and the negative input. The full-scale differential input range is $\pm 10\,\mathrm{V}$ or $\pm 5\,\mathrm{V}$, depending on the configuration selected in the PLECS Coder.

A ground connection between the DUT and the RT Box is required even in differential mode, because the inputs cannot float freely with respect to GND. For linear operation, the input voltages referenced to GND should not exceed $\pm 10.8\,\mathrm{V}$. As a consequence, the acceptable common mode voltage range is $\pm 5.8\,\mathrm{V}$ (for $\pm 10\,\mathrm{V}$ operation) and $\pm 8.3\,\mathrm{V}$ (for $\pm 5\,\mathrm{V}$ operation).

Single-ended measurement

To configure an input channel for single-ended measurement, only the positive input is used for signal measurement while the corresponding negative input

is clamped to GND. The full-scale input voltage range is either $\pm 10\,\mathrm{V}$ or $\pm 5\,\mathrm{V}$, depending on the configuration selected in the PLECS Coder.

Analog Outputs

The 16 analog output channels are connected to dedicated BNC sockets labeled **Ch-0 . . . Ch-15** on the bottom section of the board. The analog output channels of the RT Box are typically used for HIL simulations. They provide the voltage signals from sensors inside the simulated plant and need to be connected to the analog inputs of the controller.

The full-scale voltage range of the outputs can be set to $\pm 10\,\mathrm{V}$, $0 \ldots 10\,\mathrm{V}$, $\pm 5\,\mathrm{V}$ and $0 \ldots 5\,\mathrm{V}$ using the **Target** tab under **Coder Options** window of the PLECS Coder.

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