RX610 Group

RX-Stick FPU Bouncing Ball Demo

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Introduction

The following document describes how to run the FPU Bouncing Ball benchmark RX-Stick Quick Demo.

Target Device

RX610

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1. Introduction

The RX architecture sets a new benchmark for MCU performance, offering 1.65 DMIPS/MHz and incorporating powerful features such as an on-chip Floating Point Unit (FPU), DSP-like instructions, and execution from zero wait state flash memory up to 100 MHz. These features make it possible to use the RX for demanding applications that previously were the domain of DSP's.

Single-precision floating-point capability is built into the RX in the form of its FPU and native IEEE 754 support. General purpose CPU registers store single-precision values in IEEE 754 format where floating-point instructions in the RX instruction set allow the FPU to operate on them directly, dramatically reducing the amount of time necessary to setup and perform floating point operations. Other FPU's require the application code to copy operands to and from working registers in the FPU to perform floating-point math.

This application note details running the RX-Stick FPU Bouncing Ball Demo. The demo contrasts the speed of the FPU hardware versus identical calculations carried out with software floating-point emulation.

2. Application Highlights

- Highlights performance of RX Floating Point Unit (FPU)
- Direct comparison of equivalent code running with FPU versus software floating point emulation
- The RX has a sophisticated DMA controller that is used to automatically refresh the LED display without requiring any processor overhead
- Results are displayed in HEW's watch window.

3. References

The user manual for the RX-Stick is: **REJ10J2168: RX-Stick User Manual**

The hardware manual for the RX610 is: **REJ09B0460: RX610 Group Hardware Manual**

The software manual for the RX610 is: **REJ09B0435: RX Family Software Manual**

3.1 Hardware Manual Relevant Chapters

Address Space – for details on the memory map of the RX

I/O Registers – provides a complete listing of all registers

Clock Generation Circuit – for details on how to setup the bus and peripheral clock on the RX

Interrupt Control Unit - for details on the enabling interrupts from the interrupt controller to the CPU and DMAC

DMA Controller (DMAC) – for information on the DMAC used to drive the LED display

I/O Ports – provides information on how to configure port pins for GPIO or peripheral use

16-Bit Timer Pulse Unit (TPU) – a number of timer channels are used to drive the display and audio playback

D/A Converter – The DAC is used to drive the speaker for audio output.

4. Application Overview

A simple floating-point calculation is performed to determine the current position of two balls bouncing around the RX-Stick's LED display. One ball is moved using calculations performed by the FPU, while the other is moved using the software floating-point library. An identical formula is used to compute the location of both balls:

X position = X position + X velocity

Y position = Y position + Y velocity

4.1 Position Calculations

Each ball is given a three millisecond (0.003 seconds) time slice to compute as many position updates as it can. The display is then updated to show the new positions of the balls. The more calculations completed during the 3 ms time slice, the farther the ball travels on each display update, providing a visual contrast between the speed of the native FPU hardware and software floating point. The number of position updates for each ball is recorded during each time slice, and these counts can be viewed in the Watch Window in the debugger.

Connect the RX-Stick to your PC, open the HEW workspace, and select Build | Build All from the menu. Once the program builds it is downloaded to the RX-Stick and ready for execution. Press the Reset Go button on the toolbar to run the program. After a few seconds, the ball demo starts. The faster ball is being moved by the FPU; the slower one by the software floating point library.

A number of variables can be watched in the watch window to observe the performance of the demo:

> ***fpuOps*** shows the number of position updates calculated in the 3 ms time slice using the hardware FPU.
>
> ***swOps*** shows the number of position updates calculated in the 3 ms time slice using software emulation.
>
> The ***fpuBall*** and ***theBall*** structures show the current X and Y position and velocity of the balls.
>
> ***totalSpeedup*** is computed after each ball has been given 1,000 time slices and shows the relative performance of the FPU over of the software floating point library. It is updated roughly every 6 seconds.

Try setting a breakpoint on the line of code that calculates ***totalSpeedup*** to periodically stop the program and update the watch window.

The position calculations are identical for both balls, but the module Ball.c is compiled with the "-nofpu" switch, which disables hardware floating-point support. By contrast, Ball_FPU.c moves the faster ball and is compiled with native floating-point enabled.

4.2 LED Display

The LED display is used to show the positions of the balls. At start up the "RX" logo is displayed for a few seconds while the intro sound plays. The demo program maintains a screen buffer where it plots the bouncing balls. A TPU timer channel triggers DMA transfers from the LED screen buffer to the port pins that drive the LED's, updating the display without taking any processing time away from the CPU.

4.3 ADPCM Audio Playback

When the demo starts, and introduction sound is played by decoding ADPCM audio data stored in the RX's flash memory and copying it to the DAC using interrupts triggered by a TPU timer. The timer fires at 11 kHz, and during each interrupt a single audio sample is decoded using the ADPCM decoder and written to the DAC to drive the speaker through an op-amp. For a more complete explanation of audio decoding possibilities on the RX, see the ADPCM RX-Stick Quick Demo.

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Revision Record

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		Page	Summary
1.0	Jan.11.2011	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of an MPU or MCU in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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