e2 studio

Partner RTOS Aware Debugging for RA

Introduction

Renesas e² studio is a development environment based on the popular Eclipse CDT (C/C++ Development Tool). It includes a build (editor, compiler and linker control) functions as well as debug interface. It also supports integrating the Renesas GitHub FreeRTOS (with IoT libraries) demo applications and runs them on Renesas boards.

The Partner OS debugging plug-in provides a view in e² studio named RTOS Resources view. This view displays information on the usage of resources by the real-time OS. Items that can be displayed vary according to the real-time OS.

Objectives

This document introduces the usage of RTOS Resource view in e² studio as follows:

- How to create an RTOS project
- Introduction of RTOS Resource view
- Using the RTOS Resource view with FreeRTOS (Task, Queue, Timer, Stack)

Operating Environment

<table>
<thead>
<tr>
<th>IDE</th>
<th>e² studio v2020-10 + FSP v2.2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>e² studio v7.8 + FSP v1.0.0</td>
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<tr>
<td>Toolchains</td>
<td>GNU-ARM Embedded Toolchain version 9-2019-q4-major</td>
</tr>
<tr>
<td>Target devices</td>
<td>Renesas RA Family (EK-RA6M3)</td>
</tr>
<tr>
<td>Debuggers</td>
<td>SEGGER J-Link</td>
</tr>
<tr>
<td>Target OS</td>
<td>FreeRTOS</td>
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1. Creating the FreeRTOS project

The following steps show how to create a FreeRTOS project.

1. Launch e2 studio.
2. Select File → New → C/C++ Project from the menu.
   Select Renesas RA → Renesas RA C/C++ Project and click Next.

3. Name the project and click Next.
4. Specify the following information and click Next:
   — FSP Version: 2.2.0
   — Board: EK-RA6M3
   — Toolchain: 9.2.1.20191025
   — Debugger: J-Link ARM
5. Select the build artifact and RTOS, then click **Next**.

6. In the **Project Template Selection** dialog, select **FreeRTOS – Blinky – Static Allocation**. Click **Finish**.
7. After the project is created, click **Generate Project Content** in the RA Configuration window.

![Generate Project Content](image)

**Figure 1-5. Generate project content**

To use the RTOS Resources view, downloaded programs must have been compiled with the output of debugging information. For RA project, open project Properties > C/C++ Build > Settings > Tool Settings > Debugging and select at least Default (-g) for **Debug level** (do not select None). For further details, refer to the user manual of the GCC compiler.
Finally, build the project.

![Figure 1-6. Build program with output of debugging information](image)

2. **Introduction of RTOS Resources view**

The **RTOS Resources** view displays information about the resources (system information and task/thread information) used by the real-time OS.

2.1 **Opening the RTOS Resources view**

It can be opened during the debugging session. Select menu **Renesas Views > Partner OS > RTOS Resources**. The view has a **Select OS** box for selecting the real-time OS used in the project.
2.2 Selecting the OS

After opening the view, select the real-time OS to be used. Currently, only FreeRTOS is supported. Select FreeRTOS from the list box and click OK.

**Note:** Please do not select External as it is for real-time OS developers.

2.3 Context menu

The context menu is displayed by right-clicking on the resource information view.
Figure 2-3. Context menu

Explanation:

- **Real-time Refresh Column:**
  Allows real-time display for the displayed items.
  This is not valid while the program is running.

- **Real-time Refresh Interval:**
  Specifies interval time for updating of the real-time display. The specifiable range is 500 ms to 10000 ms.
  This is not valid while the program is running.

- **Stack Setting:**
  Enables/disables Stack Loading and stack threshold setting for stack alert function.
  This is not valid while a program is running.

- **Update information:**
  Updates the information.

- **Jump to source:**
  Opens an editor view in which the source code of the task/thread or handler is displayed. An editor view is also opened by double-clicking the task/thread or handler.
  This is not valid while the program is running.

- **Save File:**
  Saves the data of the current tab in the text file (*.txt).
  This is not valid while the program is running.

- **Select OS:**
  Opens the Select OS dialog box.
  This is not valid while the program is running.
2.4 Stack setting

2.4.1 Enable load stack data and set stack threshold

1. Open the context menu and select Stack Setting.
2. To load stack data to the RTOS Resource view, tick the Enable loading Stack data checkbox in the Stack Setting dialog. If this option is not enabled, stack data will not be loaded in the next debugging session.

3. The desired threshold value can be set in the Stack Threshold (%) textbox. Click OK to save the setting.

4. Run then suspend the target project to load stack data. The stack threshold warning will pop up if the threshold set is met.

There are two types of warning popup: Threshold Warning (list of threads which reached stack threshold value set as above) and Overflow Warning (reached 100%).
2.4.2 Save stack data
The stack data can be saved by selecting Save File from the context menu (or click the Save File button on the toolbar). A Save As dialog will be shown for user to enter the file name and location.

![Figure 2-7. Save File button](image)

3. Using RTOS Resources view with FreeRTOS

3.1 Task tab
The Task tab lists all tasks that existed in the program with the following information:

![Figure 3-1. Task tab](image)

- **No.**: Row index.
- **TaskName**: The name assigned to the task upon creation.
- **Base/ActualPriority**: The base priority used by the priority inheritance mechanism/The actual priority used by the task.
- **State**: State of the task which includes RUNNING, READY, BLOCKED and SUSPENDED.
- **EventObject**: The name of the queue which causes the task to be blocked.
- **TotalTickCount**: The total number of tick count for the task to be active.
- **DeltaTickCount**: The number of tick count for the task to be active since previous suspend event.

**Note**: To display TotalTickCount and DeltaTickCount, define `configGENERATE_RUN_TIME_STATS` to 1 (in `<project>/ra_cfg/aws/FreeRTOSConfig.h`), and implement the macros `portCONFIGURE_TIMER_FOR_RUN_TIME_STATS()` and `portGET_RUN_TIME_COUNTER_VALUE()` (in `<project>/ra/aws/amazon-freertos/freertos_kernel/include/FreeRTOS.h`). To configure these parameters, please refer to FreeRTOS guidelines at: [https://www.freertos.org/rtos-run-time-stats.html](https://www.freertos.org/rtos-run-time-stats.html).
3.2 Queue tab

The Queue tab lists all queues/semmaphores/mutexes used in the program.

Note: To display queue information, specify configQUEUE_REGISTRY_SIZE with value greater than 0 (in <project>/ra_cfg/aws/FreeRTOSConfig.h), and call the function vQueueAddToRegisty(). Note that this function call is already implemented in the demo code.
Figure 3-4. Define configQUEUE_REGISTRY_SIZE in FreeRTOSConfig.h

This tab displays the following information:

- **No.**: Row index.
- **Name(Type)**: The name assigned to the queue upon registration and its type (Queue, Semaphore or Mutex).
- **Address**: The address of the queue handle.
- **MaxLength**: The maximum number of items that can be stored in the queue.
- **ItemSize**: Size per item in the queue (in bytes).
- **CurrentLength**: Number of items currently stored in the queue.
- **#WaitingTx**: Number of tasks blocked while waiting to send to the queue.
- **#WaitingRx**: Number of tasks blocked while waiting to receive from the queue.

Figure 3-5. Queue tab
3.3 Timer tab

The Timer tab lists all timers that existed in the program. The following information is displayed in the Timer tab:

- **No.**: Row index.
- **Name**: The name assigned to the software timer upon creation.
- **Period**: The current period of the timer in system ticks.
- **Reload**: Automatic reload Enable/Disable. On when auto reload is enabled which resets the timer each time it expires. Off when auto reload is disabled which does nothing when the timer expires.
- **CallbackFn**: Address and <Name> of the callback function which executes each time the timer ends.
- **TimerID**: The numeric ID of the timer assigned in hexadecimal format when it was created.

![Figure 3-6. Timer tab](image)

3.4 Stack tab

The Stack tab lists all stacks associated with tasks that existed in the program. The following information is displayed in the Stack tab:

- **No.**: Row index.
- **TaskName**: The name assigned to the task upon creation.
- **StartOfStack**: The address of the start of stack.
- **EndOfStack**: The address of the end of stack.
- **TopOfStack**: The address of the top of the stack where it is last written to when the context of the stack was saved.
- **StackSize**: Total stack size.
- **StackUsageSize**: Stack usage at high water mark.
- **StackUsageRatio**: Percentage of usage at high water mark relative to total stack size.

![Figure 3-7. Stack tab](image)
Note:

- To display `EndOfStack` and `StackSize`, define `configRECORD_STACK_HIGH_ADDRESS` as 1 in the `<project>/ra/aws/amazon-freertos/freertos_kernel/include/FreeRTOS.h` file.

![Figure 3-8. Define configRECORD_STACK_HIGH_ADDRESS in FreeRTOS.h](image)

- To display `StackUsageSize` and `StackUsageRatio`, define `configRECORD_STACK_HIGHADDRESS` as 1 in the `<project>/ra/aws/amazon-freertos/freertos_kernel/include/FreeRTOS.h` file, and `tskSTACK_FILL_BYTE` to 0xA5U in the `<project>/ra/aws/amazon-freertos/freertos_kernel/task.c` file.

  Only devices with `portSTACK_GROWTH` defined as -1 are supported (in `<project>/ra/fsp/src/rm_freertos_port/portmacro.h`).

![Figure 3-9. Define tskSTACK_FILL_BYTE in task.c](image)
Figure 3-10. Define portSTACK_GROWTH in portmacro.h
## Revision History

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
<th>Summary</th>
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</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Dec.24.20</td>
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General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit 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. Precaution against Electrostatic Discharge (ESD)
   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on
   The state of the product is undefined at the time 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 time 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 time 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 time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state
   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins
   Handle unused pins in accordance 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 the 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.

5. Clock signals
   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is 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. Additionally, 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.

6. Voltage application waveform at input pin
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between $V_{IL}$ (Max.) and $V_{IH}$ (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between $V_{IL}$ (Max.) and $V_{IH}$ (Min.).

7. Prohibition of access to reserved addresses
   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products
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