

RX23W Group

Renesas Solution Starter Kit for RX23W
Tutorial Manual
For e² studio

RENESAS 32-Bit MCU
RX Family / RX200 Series

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

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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

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of 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.

Disclaimer

By using this Renesas Solution Starter Kit (RSSK), the user accepts the following terms:

The RSSK is not guaranteed to be error free, and the entire risk as to the results and performance of the RSSK is assumed by the User. The RSSK is provided by Renesas on an “as is” basis without warranty of any kind whether express or implied, including but not limited to the implied warranties of satisfactory quality, fitness for a particular purpose, title and non-infringement of intellectual property rights with regard to the RSSK. Renesas expressly disclaims all such warranties. Renesas or its affiliates shall in no event be liable for any loss of profit, loss of data, loss of contract, loss of business, damage to reputation or goodwill, any economic loss, any reprogramming or recall costs (whether the foregoing losses are direct or indirect) nor shall Renesas or its affiliates be liable for any other direct or indirect special, incidental or consequential damages arising out of or in relation to the use of this RSSK, even if Renesas or its affiliates have been advised of the possibility of such damages.

Precautions

The following precautions should be observed when operating any RSSK product:

This Renesas Solution Starter Kit is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and any sensitive equipment. Its use outside the laboratory, classroom, study area or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures;

- ensure attached cables do not lie across the equipment
- reorient the receiving antenna
- increase the distance between the equipment and the receiver
- connect the equipment into an outlet on a circuit different from that which the receiver is connected
- power down the equipment when not in use
- consult the dealer or an experienced radio/TV technician for help NOTE: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken;

- The user is advised that mobile phones should not be used within 10m of the product when in use.
- The user is advised to take ESD precautions when handling the equipment.

The Renesas Solution Starter Kit does not represent an ideal reference design for an end product and does not fulfil the regulatory standards for an end product.

How to Use This Manual

1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of how to use the e² studio IDE to develop and debug software for the RSSK platform. It is intended for users designing sample code on the RSSK platform, using the many different incorporated peripheral devices.

The manual comprises of step-by-step instructions to load and debug a project in e² studio, but does not intend to be a complete guide to software development on the RSSK platform. Further details regarding operating the RX23W microcontroller may be found in the RX23W Group Hardware Manual and within the provided sample code. The setup procedure for the RSSK Web installer is described in the Quick Start Guide.

Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

In this manual, the display may differ slightly from screen shots. There is no problem in reading this manual.

The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

The following documents apply to the RX23W Group. Make sure to refer to the latest versions of these documents. The newest versions of the documents listed may be obtained from the Renesas Electronics Web site.

Document Type	Description	Document Title	Document No.
User's Manual	Describes the technical details of the RSSK hardware.	Renesas Solution Starter Kit for RX23W User's Manual	R20UT4446EG
Tutorial Manual	Provides a guide to setting up RSSK environment, running sample code and debugging programs.	Renesas Solution Starter Kit for RX23W Tutorial Manual	R20UT4447EG
Quick Start Guide	Provides simple instructions to setup the RSSK and run the first sample, on a single A4 sheet.	Renesas Solution Starter Kit for RX23W Quick Start Guide	R20UT4448EG
Smart Configurator Tutorial	Provides a guide to code generation and importing into the e ² studio IDE.	Renesas Solution Starter Kit for RX23W Smart Configurator Tutorial Manual	R20UT4449EG
Schematics	Full detail circuit schematics of the RSSK.	Renesas Solution Starter Kit for RX23W Schematics	R20UT4445EG
Hardware Manual	Provides technical details of the RX23W microcontroller.	RX23W Group User's Manual: Hardware	R01UH0823EJ

2. List of Abbreviations and Acronyms

Abbreviation	Full Form
ADC	Analog-to-Digital Converter
API	Application Programming Interface
bps	bits per second
CMT	Compare Match Timer
COM	COMmunications port referring to PC serial port
CPU	Central Processing Unit
E1 / E2 Lite	Renesas On-chip Debugging Emulator
GUI	Graphical User Interface
IDE	Integrated Development Environment
IRQ	Interrupt Request
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LSB	Least Significant Bit
LVD	Low Voltage Detect
MCU	Micro-controller Unit
MSB	Most Significant Bit
PC	Personal Computer
PLL	Phase-locked Loop
Pmod™	This is a Digilent Pmod™ Compatible connector. Pmod™ is registered to Digilent Inc. Digilent-Pmod Interface Specification
PSU	Power Supply Unit
RAM	Random Access Memory
ROM	Read Only Memory
RSSK	Renesas Solution Starter Kit
RTC	Real Time Clock
SCI	Serial Communications Interface
SPI	Serial Peripheral Interface
TFT	Thin Film Transistor
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
WDT	Watchdog Timer

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1. Overview

1.1 Purpose

This RSSK is an evaluation tool for Renesas microcontrollers. This manual describes how to get the RSSK tutorial started, and basic debugging operations.

1.2 Features

This RSSK provides an evaluation of the following features:

- Renesas microcontroller programming
 - User code debugging
 - User circuitry such as switches, LEDs and a potentiometer
- Through the provided set of sample applications.

The RSSK board contains all the circuitry required for microcontroller operation.

2. Introduction

This manual is designed to answer, in tutorial form, the most common questions asked about using a Renesas Solution Starter Kit (RSSK). The tutorials help explain the following:

- How do I compile, link, download and run a simple program on the RSSK?
- How do I build an embedded application?
- How do I use Renesas' tools?

Files referred to in this manual are installed using the project generator as you work through the tutorials. The tutorial examples in this manual assume that installation procedures described in the RSSK Quick Start Guide have been completed. Please refer to the Quick Start Guide for details of preparing the configuration.

Due to the project generator, it is possible that line numbers for source code illustrated in this document do not match exactly with that in the actual source files. It is also possible that the source address of instructions illustrated in this manual differ from those in user code compiled from the same source. These differences are minor, and do not affect the functionality of the sample code nor the validity of this manual.

These tutorials are designed to show you how to use the RSSK and are not intended as a comprehensive introduction to e² studio, the compiler toolchains or the E2 emulator Lite. Please refer to the relevant user manuals for more in-depth information.

2.1 Smart Configurator Plugin

The Smart Configurator plugin for the RX23W has been used to generate the sample code discussed in this document. Smart Configurator for e² studio is a plugin tool for generating template 'C' source code and project settings for the RX23W. When using Smart Configurator, it supports the user with a visual way of configuring the target device, clocks, software components, hardware resources and interrupts for the project; thereby bypassing the need, in most cases, to refer to sections of the Hardware Manual.

Once the user has configured the project, the 'Smart Configurator' function is used to generate three code modules for each specific MCU feature selected. These code modules are name 'Config_xxx.h', 'Config_xxx.c', and 'Config_xxx_user.c', where 'xxx' is an acronym for the relevant MCU feature, for example 'CMT'. Within these code modules, the user is then free to add custom code to meet their specific requirement. However, these files require custom code to be added between the following comment delimiters:

```
/* Start user code for adding. Do not edit comment generated here */
/* End user code. Do not edit comment generated here */
```

Smart Configurator will locate these comment delimiters, and preserve any custom code inside the delimiters on subsequent code generation operations. This is useful if, after adding custom code, the user needs to re-visit Smart Configurator to change any MCU operating parameters.

Note: If code is added outside the above user code area, it will be lost if code generation is executed again with Smart Configurator.

In this RSSK sample project, only some functions are used.

For other useful features, refer to the <https://www.renesas.com/smart-configurator>.

3. Tutorial Project Workspace

3.1 Introduction

e² studio is an open source integrated development tool that allows the user to write, compile, program and debug a software product on many of the Renesas microcontrollers.

3.2 Connecting the Debugger

For this tutorial, the E2 Lite debugger will provide power to the RSSK, no external power supply is required.

The Quick Start Guide provided with the Renesas Solution Starter Kit board gives detailed instructions on how to connect the E2 Lite to the host computer. The following assumes that the steps in the Quick Start Guide have been followed and the E2 Lite drivers have been installed.

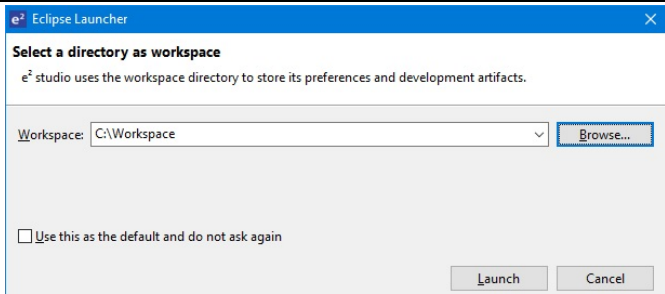
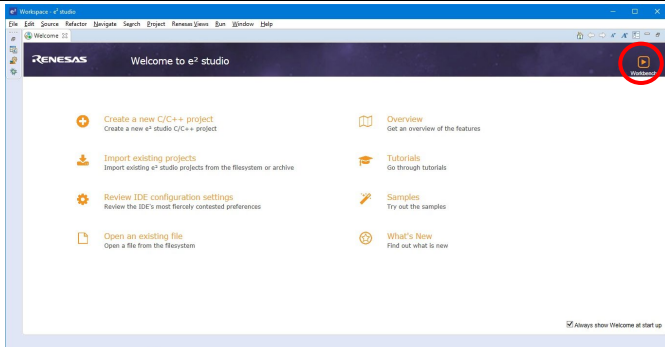
- Fit the PMOD LCD display to the PMOD2 connector on the board. Ensure all the pins of the connector are correctly inserted in the socket.
- Connect the E2 Lite Debugger to a free USB port on your computer.
- Connect the E2 Lite Debugger to the target hardware ensuring that it is plugged into the connector marked 'E1/E2 Lite'.

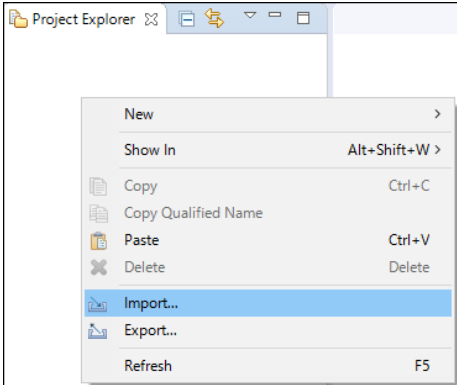
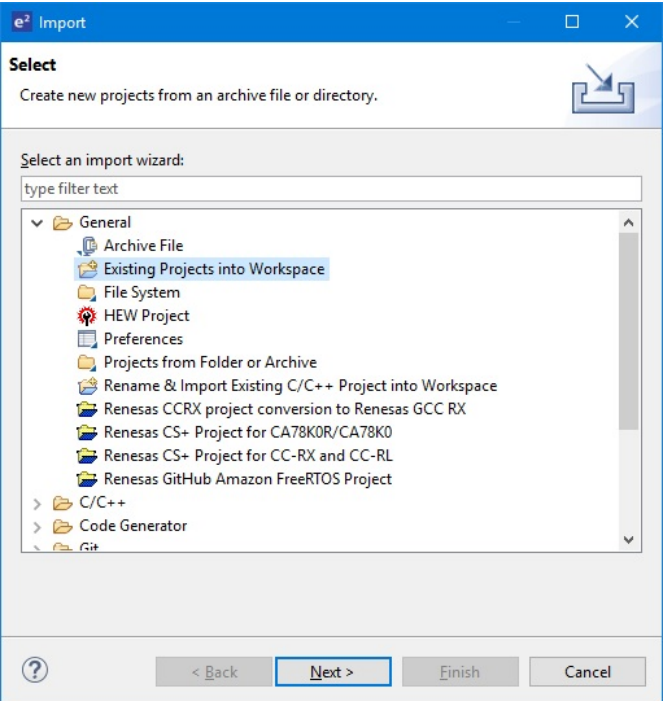
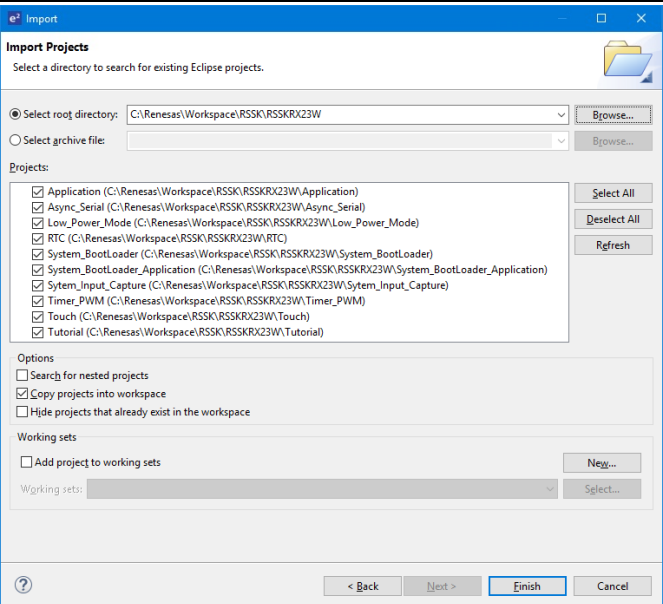
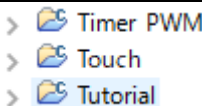
3.3 Starting e² studio and Importing Sample Code

To use the program, start e²studio:

Windows™ 8.1: From Apps View , click 'Renesas Electronics e2studio > e2 studio icon

Windows™ 10: Start Menu > All Apps > Renesas Electronics e2studio > e2 studio

• Start e² studio by selecting it from the Windows™ Start Menu. The first dialog box to appear will be the Workspace Launcher. • Click 'Browse' and select a suitable location to store your workspace, using the 'Make New Folder' option as necessary. Click 'Launch'.	
• The e² studio Welcome splash screen will appear. Click the 'Workbench' arrow button on the far right (circled in the screenshot opposite).	

Once the environment has initialized, right click in the 'Project Explorer' window and select 'Import...'	
The Import dialog box will be shown. Expand the 'General' folder icon, and select 'Existing Projects into Workspace', then click 'Next'.	
- The Import dialog box will allow you to specify a project to import. Click the 'Browse' button and locate the following directory: C:\Renesas\Workspace\RSSK\RSSKRX23W - Ensure that the 'Copy projects into workspace' option is ticked, and then click 'Finish'.	
Click on Tutorial from the list of projects in the 'Project Explorer' on the left-hand side.	

3.4 Build Configurations and Debug Sessions

3.4.1 Build Configuration

The e² studio workspace will be created with two build configurations: 'HardwareDebug' and 'Release'.

Release

This Build Mode has optimisation turned on, and provides little debug information. The C code execution may appear to be out of order, due to the way the compiler optimises the code. This build configuration is intended for final ROM-programmable code.

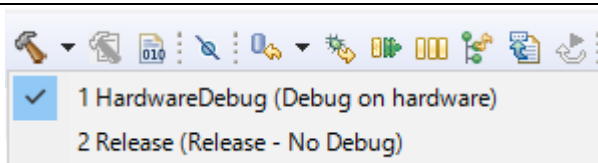
HardwareDebug

This Build Mode has all optimisation turned off, and provides full debug information. This is the best configuration to use whilst developing code as C code execution will be linear.

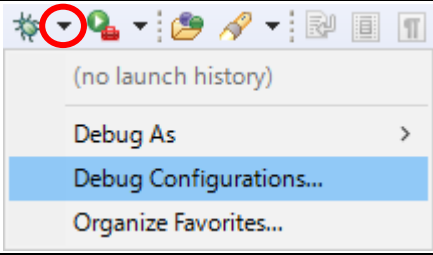
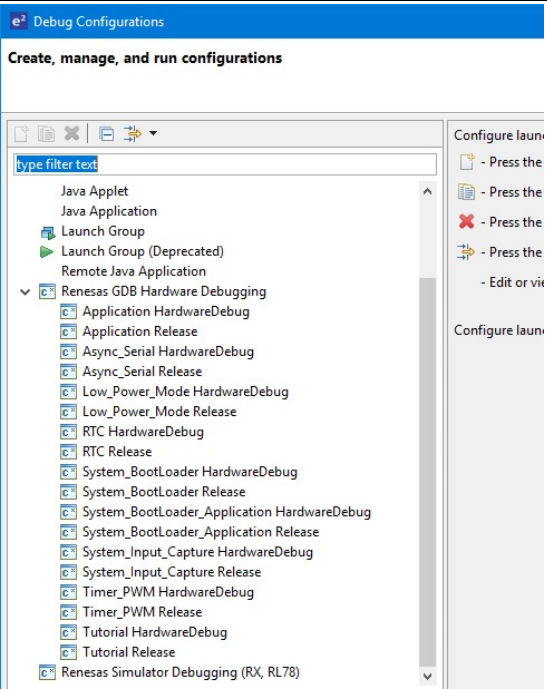
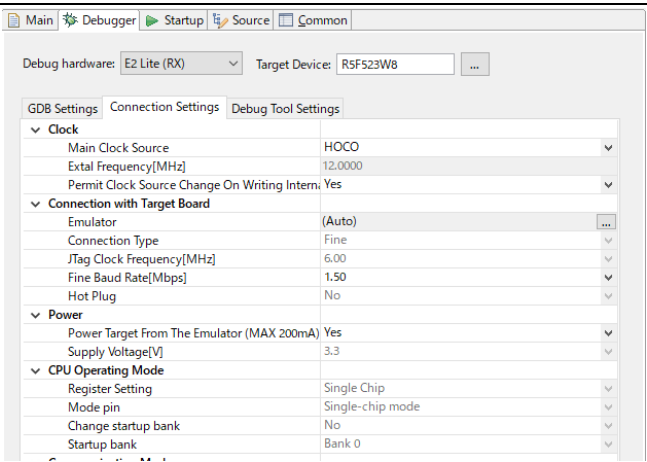
- Click the top level 'Tutorial' folder again, and then the arrow next to the build button (hammer icon) and select the 'HardwareDebug' option.

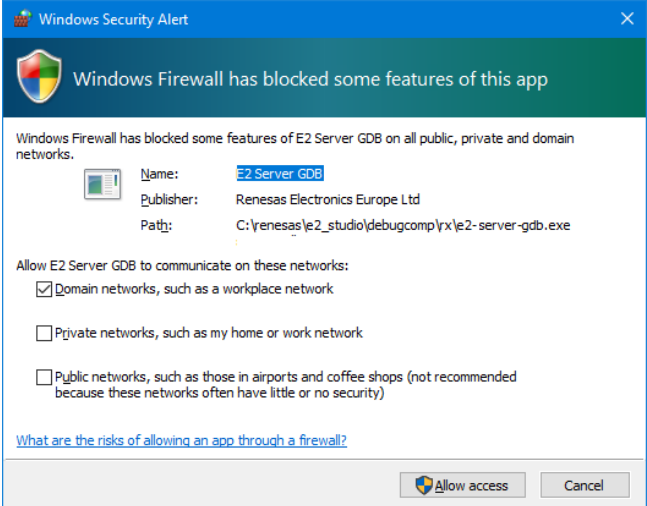
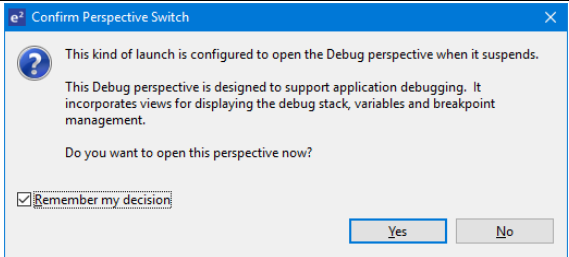
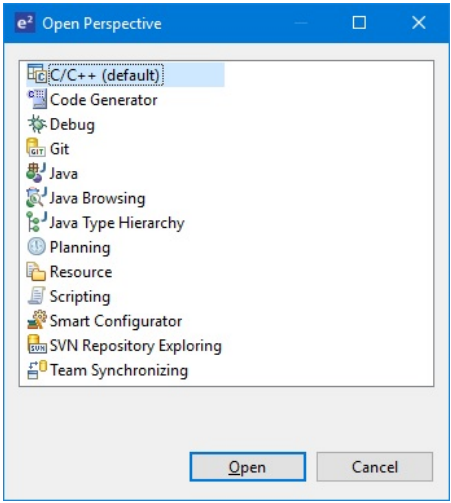


- e² studio will then build the code.



3.4.2 Debug Configuration

Click the arrow next to the debug button (bug icon), as highlighted by the red circle. Select 'Debug Configurations'.	
- The 'Debug Configurations' dialog box will appear. Click the small arrow next to the 'Renesas GDB Hardware Debugging' option. - The debug configurations for each project will appear. Select the entry for the 'Tutorial HardwareDebug'.	
- The debug configurations control page will then show for the Tutorial project. Change the main tab to 'Debugger' and then select 'Connection Settings' on the secondary tab bar that appears. - There is no need to change the debugger settings as they are preconfigured with the Tutorial project. Please check "Power Target From The Emulator (MAX 200mA)" is "Yes". - Refer to the RSSKRX23W User's Manual for details of power supply configuration. Note: e² studio will display a warning if you attempt to connect with an incorrect power supply setting. - Click the 'Debug' button to continue. e² studio will be connected to the debugger and download the code to the target.	

- A firewall warning may be displayed for 'e2-server-gdb.exe'. Check the 'Private networks, such as my home or work network' box and click 'Allow access'. - A user account control dialog may be displayed. Enter the administrator password and click 'Yes'.	
- After downloading the code a dialog box will appear asking if you would like to switch to the 'Debug perspective'. Click 'Remember my decision' to prevent this dialog box from appearing in future, then click 'Yes'. - e² studio will load the new perspective, which is optimised for debugging.	
- To change back to the default 'C/C++' perspective, from the menu bar select Window > Perspective > Open Perspective > Other or click the Open Perspective button.  - The 'Open Perspective' dialog box will appear. Click on the desired perspective to select it then 'OK'. - Perspectives can also be switched with the following shortcuts.  - The perspective should be 'Debug', as it will be needed in the next section.	

3.5 Running the Tutorial

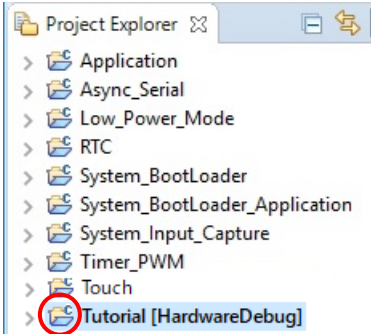
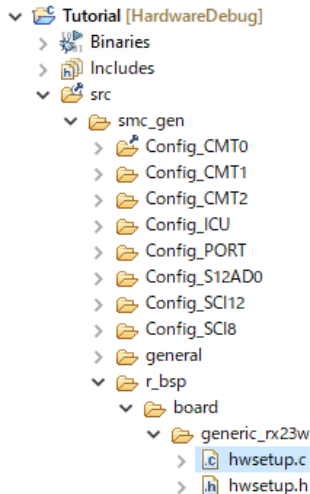
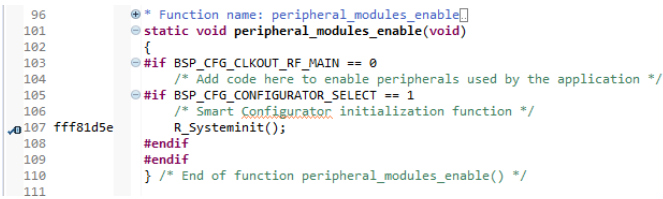
- Refer to the description.txt file in the doc folder of Tutorial project for instructions on how to configure the RSSK and run the sample code.
- Once the code has been downloaded, click 'Resume' button  to run the code to the main function. The main function is set as the program entry point by default. The program counter will stop on the first instruction in the main function.
- Click the 'Resume' button  in the 'Debug' perspective to run the rest of the code.
- It is recommended that you run the entire tutorial demo first, before continuing to debug it.

4. Reviewing the Tutorial Program

This section will look at each section of the tutorial code and basic debugging functionality in e² studio.

4.1 Program Initialization

Before the main program can run, the microcontroller must be configured. The following parts of the tutorial program are used exclusively for initializing the RSSK device so that the main function can execute correctly. The initialization code is run every time the device is reset via the reset switch or from a power cycle.

- Build and download the code as shown in Section 3.4. - On the Project Explorer tab expand the 'Tutorial' folder by clicking on the arrow next to the folder icon, as highlighted by the red circle.	
- Click the arrow next to the 'src' folder to show the source files. - Expand the folder path 'smc_gen' -> 'r_bsp' -> 'board' -> 'generic_rx23w' as shown and double click on the file 'hwsetup.c'.	
Breakpoints can be set by double clicking at the left-hand edge of the source code window. On the line with instruction 'R_Systeminit();', double click next to the vertical line to set a breakpoint. Note: As an alternative, breakpoints may be set in the C/C++ perspective by selecting a line and using Run > Toggle Breakpoint.	 <pre> 96 101 102 103 104 105 106 107 fff81d5e 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 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814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050 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1851 1852 1853 1854 1855 1856 1857 1858 1859 1860 1861 1862 1863 1864 1865 1866 1867 1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563 2564 2565 2566 2567 2568 2569 2</pre>

- Click the 'Resume' button in the Debug perspective (or press [F8]) to run the code up to this breakpoint.



Note: The program counter is indicated by the blue arrow next to the breakpoint.

```

96      /* Function name: peripheral_modules_enable */
97      static void peripheral_modules_enable(void)
98      {
99          /* Add code here to enable peripherals used by the application */
100         /* Smart Configurator initialization function */
101         R_Systeminit();
102     }
103     /* End of function peripheral_modules_enable() */

```

- Click the 'Step Into' button (or press [F5]), to step into the 'R_Systeminit' function.



- The 'R_Systeminit' function calls several initialization functions which configure the MCU for normal operation. This includes input/output ports, and system clocks.
- The user can step through all the initialization code by clicking the 'Step Into' icon and reading the code however for the purpose of this manual, it will be skipped.
- Click the 'Resume' button, to run the code up to the main function.



```

78 void R_Systeminit(void)
79 {
80     /* Enable writing to registers related to operating modes, LPC, CGC, software reset and LVD */
81     SYSTEM.PRCR.WORD = 0xA50FU;
82
83     /* Enable writing to MPC pin function control registers */
84     MPC.PMPR.BIT.B0N1 = 0U;
85     MPC.PMPR.BIT.PFSNE = 1U;
86
87     /* Initialize clocks settings */
88     R_CGC_Create();
89
90     /* Set peripheral settings */
91     R_Config_PORT_Create();
92     R_Config_CMT0_Create();
93     R_Config_CMT1_Create();
94     R_Config_S12AD00_Create();
95     R_Config_ICU_Create();
96     R_Config_SC1B_Create();
97     R_Config_SC1I2_Create();
98     R_Config_CMT2_Create();
99
100    /* Register undefined interrupt */
101    R_BSP_InterruptWrite(BSP_INT_SRC_UNDEFINED_INTERRUPT, (bsp_int_cb_t)r_undefined_exception);
102
103    /* Disable writing to MPC pin function control registers */
104    MPC.PMPR.BIT.PFSNE = 0U;
105    MPC.PMPR.BIT.B0N1 = 1U;
106
107    /* Enable protection */
108    SYSTEM.PRCR.WORD = 0xA500U;

```

For further details regarding hardware configuration, please refer to 'Renesas Solution Starter Kit for RX23W User's Manual' and 'RX23W Group User's Manual: Hardware'.

4.2 Main Functions

This section will look at the program code called from within the main function, and how it works. It is necessary to connect the RSSK USB Serial Connector(USBCN0) to a PC USB port and open a terminal emulation program, such as Tera Term, with the settings:

Baud Rate: 19200,

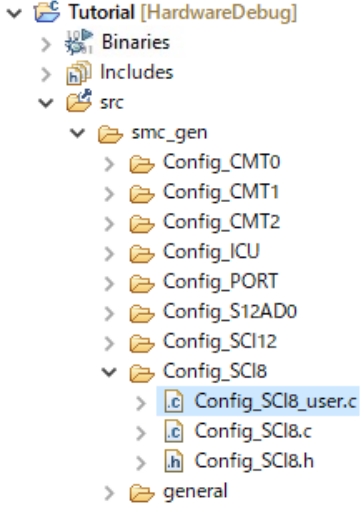
Data Length: 8, Parity Bit: None, Stop Bit: 1, Flow Control: None

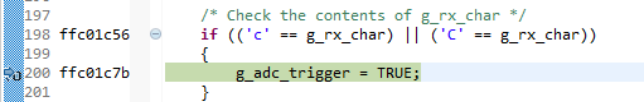
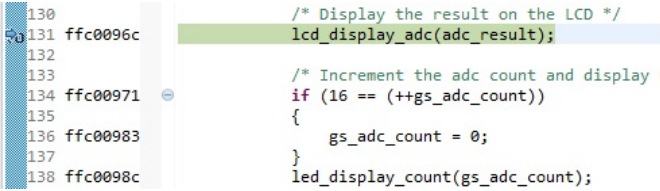
For information on installation of the RSSK virtual COM port driver, refer to the file 'description.txt' in the doc folder of the e² studio Tutorial project.

The USB serial driver made by FTDI is required for USB serial communication. Please download from the URL below. Please contact FTDI for installation method of USB serial driver and questions.

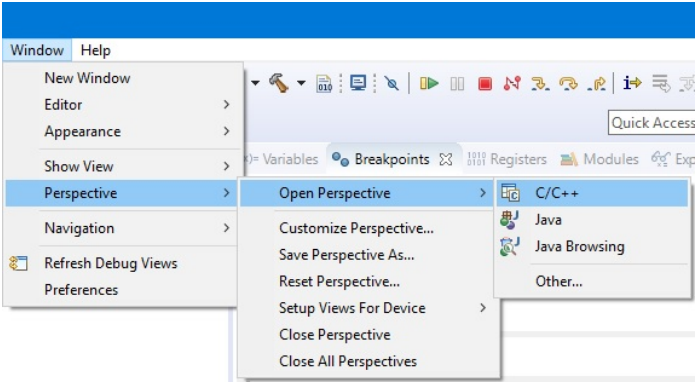
<https://www.ftdichip.com/Drivers/D2XX.htm>

Right click the 'R_Config_SCI8_Serial_Receive' function call and select 'Run to Line' to execute the program up to this line. The 'R_LCD_Init' function call enables and configures the LCD panel, and 'R_LCD_Display' will write "RSSKRX23W Tutorial Press Any Switch" onto the LCD.	<pre> 90 fff808f6 void main(void) 91 { 92 /* Initialize the switch module */ 93 fff808f8 R_SWITCH_Init(); 94 95 /* Set the call back function when SW1 or SW2 is pressed */ 96 fff808fc R_SWITCH_SetPressCallback(cb_switch_press); 97 98 /* Initialize the debug LCD */ 99 fff80906 R_LCD_Init(); 100 101 /* Displays the application name on the debug LCD. 102 * Casting for use as characters. */ 103 fff8090a R_LCD_Display(0, (uint8_t *) "RSSKRX23W"); 104 105 /* Casting for use as characters. */ 106 fff80916 R_LCD_Display(1, (uint8_t *) "Tutorial "); 107 108 /* Casting for use as characters. */ 109 fff80922 R_LCD_Display(2, (uint8_t *) "Press Any Switch "); 110 111 /* Start the A/D converter */ 112 fff8092e R_Config_S12AD0_Start(); 113 114 /* Set up SCI8 receive buffer and callback function */ 115 fff80934 R_Config_SCI8_Serial_Receive((uint8_t *)&g_rx_char, 1); </pre>
- Set a breakpoint on the 'R_Config_SCI8_Start' function call by double-clicking in the breakpoint column. - Click the 'Step Into' button to step into the 'R_Config_SCI8_Serial_Receive' function. 	<pre> 114 /* Set up SCI8 receive buffer and callback function */ 115 fff80934 R_Config_SCI8_Serial_Receive((uint8_t *)&g_rx_char, 1); 116 117 /* Enable SCI8 operations */ 118 fff8093e R_Config_SCI8_Start(); </pre>
- The program counter should now move into the 'R_Config_SCI8_Serial_Receive' function definition. This function is an API function provided by the Smart Configurator. It sets up the SCI interrupt handler code to receive a specified number of bytes into a receive buffer. Once the specified number of bytes has been received, the interrupt handler code calls a callback function as shown later on in this section. - For full details on how to configure a project using Smart Configurator refer to the Smart Configurator Tutorial Manual. - Click the 'Resume' button to resume program execution. 	<pre> 162 fff81ac3 MD_STATUS R_Config_SCI8_Serial_Receive(uint8_t * const rx_buf, uint16_t rx_num) 163 { 164 fff81ac9 MD_STATUS status = MD_OK; 165 166 fff81acc if (1U > rx_num) 167 { 168 fff81ad1 status = MD_ARGERROR; 169 } 170 else 171 { 172 fff81ad6 g_sci8_rx_count = 0U; 173 fff81adf g_sci8_rx_length = rx_num; 174 fff81ae8 gp_sci8_rx_address = rx_buf; 175 fff81af6 SCI8.SCR.BIT.RIE = 1U; 176 fff81afd SCI8.SCR.BIT.RE = 1U; 177 } 178 179 fff81aff return (status); 180 fff81b05 } </pre>

- The program counter should come to a halt at the 'R_Config_SCI8_Start' function. - Step over the function by clicking the 'Step Over' button. Alternatively, press [F6].  The 'R_Config_SCI8_Start' function enables the UART interrupts. The program then proceeds to the main while(1U) loop. The code inside the loop waits for user input from either the SCI or RSSK switches, and then performs an A/D conversion.	<pre> 114 /* Set up SCI8 receive buffer and callback function */ 115 R_Config_SCI8_Serial_Receive((uint8_t *)&g_rx_char, 1); 116 117 /* Enable SCI8 operations */ 118 R_Config_SCI8_Start(); </pre>
- Locate the function call to 'lcd_display_adc' inside the while loop. - Set a breakpoint on the 'lcd_display_adc' function call by double-clicking in the breakpoint column.	<pre> 120 while (1U) 121 { 122 uint16_t adc_result; 123 124 /* Wait for user requested A/D conversion flag to 125 fff8098a if (TRUE == g_adc_trigger) 126 { 127 /* Call the function to perform an A/D conversion 128 fff80944 adc_result = get_adc(); 129 130 /* Display the result on the LCD */ 131 fff80949 lcd_display_adc(adc_result); </pre>
In the Project Explorer pane, locate the file 'Config_SCI8_user.c' and double-click to open the source file. Scroll down to the function 'r_Config_SCI8_callback_receiveend'.	
- Set a breakpoint on the line of code inside the 'r_Config_SCI8_callback_receiveend' function as shown opposite. - Continue to execute the program by clicking the 'Resume' button. 	<pre> 193 static void r_Config_SCI6_callback_receiveend(void) 194 { 195 /* Start user code for r_Config_SCI6_callback_receiveend. Do not 196 197 /* Check the contents of g_rx_char */ 198 ffc01c56 if (('c' == g_rx_char) ('C' == g_rx_char)) 199 { 200 ffc01c7b g_adc_trigger = TRUE; 201 } 202 203 /* Set up SCI6 receive buffer and callback function again */ 204 ffc01c86 R_Config_SCI6_Serial_Receive((uint8_t *)&g_rx_char, 1); 205 206 /* End user code. Do not edit comment generated here */ 207 } </pre>

- In the terminal emulation window, press the 'c' button on the keyboard. - The program will halt at the breakpoint in the 'r_Config_SCI8_callback_receiveend' function as shown opposite. Remove the breakpoint by double-clicking on the breakpoint column. - Continue to execute the program by clicking the 'Resume' button. 	 
--	--

The program proceeds to display the result of the A/D conversion on the LCD and in the terminal window. In addition, the running count of A/D conversions performed is displayed in binary form using LEDs 0-3 on the RSSK. Adjust the potentiometer and press SW1 or SW2 on the RSSK and an additional A/D conversion will be performed.

Press the 'Suspend' button to halt program execution.	
To change back to the default 'C/C++' perspective, from the menu bar select Window > Perspective > Open Perspective > 'C/C++'.	
Alternatively, click on the 'C/C++' button in the top right corner of the screen, as shown opposite.	
This is the extent of the tutorial code.	

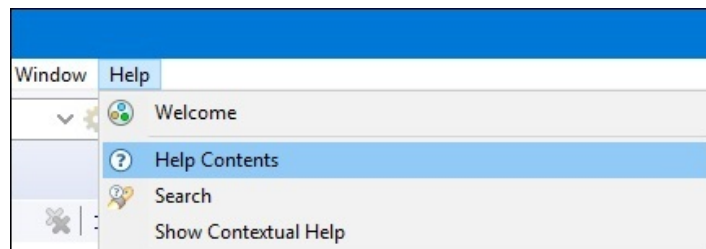
For further details regarding hardware configuration, please refer to 'Renesas Solution Starter Kit for RX23W User's Manual' and 'RX23W Group User's Manual: Hardware'.

The E2 emulator Lite features an advanced logic-based event point trigger system, and full instruction on its use is outside the scope of this tutorial. For further details, please refer to the E2 Emulator Lite User's Manual.

5. Additional Information

Technical Support

For details on how to use e² studio, refer to the help file by opening e² studio, then selecting Help > Help Contents from the menu bar.



Parts of the sample code provided with the RSSKRX23W can be reproduced using the Smart Configurator tool. Smart Configurator is included as a plug in with e² studio.

Source files and functions generated by Smart Configurator are prefixed with 'r_' and 'R_' or 'Config_', respectively.

For information about the RX23W Group microcontrollers refer to 'RX23W Group User's Manual: Hardware'.

For information about the RX assembly language, refer to 'RX Family User's Manual: Software'.

Technical Contact Details

Please refer to the contact details listed in section 9 of the “Quick Start Guide”

General information on Renesas Microcontrollers can be found on the Renesas website at:

<https://www.renesas.com/>

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REVISION HISTORY	RX23W Group Renesas Solution Starter Kit for RX23W Tutorial Manual For e ² studio
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Rev.	Date	Description	
		Page	Summary
1.00	Aug.30.19	—	First Edition issued
1.01	Mar.31.20	10	3.3 Removed the description of Windows™ 7 and 8 from start e ² studio.

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