To our customers,

---

**Old Company Name in Catalogs and Other Documents**

On April 1\textsuperscript{st}, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: [http://www.renesas.com](http://www.renesas.com)

---

April 1\textsuperscript{st}, 2010
Renesas Electronics Corporation

---

Issued by: Renesas Electronics Corporation ([http://www.renesas.com](http://www.renesas.com))

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.

2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.

3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.

4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.

5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.

6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.

7. Renesas Electronics products are classified according to the following three quality grades: “Standard”, “High Quality”, and “Specific”. The recommended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as “Specific” without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as “Specific” or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is “Standard” unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

- “Standard”: Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.
- “High Quality”: Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.
- “Specific”: Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.

8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.

9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.

10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.

11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.

12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

>Note 1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

>Note 2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.
Introduction

This application note explains an alternative implementation of the popular sprintf function that comes in compiler standard libraries. This alternative was intended to reduce ROM/RAM size usage compared to the default compiler library version.

Target Devices

R8C Family, M16C Family, H8 Family, H8S Family, SH Family

Contents

1. Overview ........................................................................................................................................... 2
2. Benefits ............................................................................................................................................. 2
   2.1 Formatting Options Compatible with Full Version................................................................. 2
   2.2 Smaller ROM/RAM sizes ............................................................................................................. 2
   2.3 Easier to Add to a Project ............................................................................................................. 2
   2.4 Uses Standard Include File ‘stdio.h’............................................................................................. 2
   2.5 Reentrant Capability...................................................................................................................... 2
3. Limitations ......................................................................................................................................... 3
   3.1 No Floats or Doubles......................................................................................................................... 3
   3.2 No fprintf support............................................................................................................................ 3
4. Format Specifications Fields ............................................................................................................. 4
   4.1 Conversion Specifications.............................................................................................................. 4
   4.2 Minimum Field Width ..................................................................................................................... 5
   4.3 Precision....................................................................................................................................... 5
   4.4 I, L or h Conversion Specifics ........................................................................................................ 6
5. Adding to an Existing Project ............................................................................................................ 6

Website and Support................................................................................................................................. 6
Revision Record........................................................................................................................................ 6
1. Overview

The sprintf function that comes with the standard Renesas compiler is a full ANSI compliant implementation. Unfortunately, this requires it to accept any type of formatting outlined by the sprintf specification. They result in more code and RAM usage than desired for simple formatting operations, especially in small ROM devices like the R8C and H8 families. For this reason, Renesas has developed a simpler version of the popular printf and sprintf utilities to be used as a “drop-in” replacement for the more traditional full implementation version contain in the Renesas compiler libraries.

It should be noted that the simple_printf.c file supports both printf and sprintf functions. However, the use of printf requires the setup of the standard library standard out (stdout) which is outside the scope of this appnote. Therefore this appnote and accompanying sample code only focuses on the usage of sprintf.

2. Benefits

Below is list of some of the benefit of using this utility over the one provided in the standard compiler library.

2.1 Formatting Options Compatible with Full Version

While not all formatting options are support with this simple version as compared to our compiler’s standard library’s version, the options that are supported match exactly. Therefore, if later you decided you need to move to the full standard library implementation, you will not have to modify any existing application code that has been using this simplified version.

2.2 Smaller ROM/RAM sizes

The most obvious benefits are smaller ROM and RAM sizes. Essentially, the ability of formatting floats and doubles are what make the standard printf and sprintf utilizes large. If you don’t need to format those data types, you can save a lot of resources by using this simplified version.

Below is a table showing the comparison between the M16C NC30 compiler standard library and the simple printf/sprintf version.

<table>
<thead>
<tr>
<th></th>
<th>NC30 Library</th>
<th>simple_printf.c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code size</td>
<td>8632</td>
<td>1320</td>
</tr>
<tr>
<td>Stack Usage</td>
<td>252</td>
<td>69</td>
</tr>
<tr>
<td>Static RAM Data Usage</td>
<td>886</td>
<td>0</td>
</tr>
<tr>
<td>Static ROM Data Usage</td>
<td>267</td>
<td>109</td>
</tr>
</tbody>
</table>

2.3 Easier to Add to a Project

Also, adding this utility to a project is easier. For the M16C series compiler, you also have to take care of setting up the complete standard I/O section of the library in order to use printf. Because it is a full featured standard I/O implementation, it adds a lot of complexity for you to do a simple task like formatting a string. Also, there is no detailed documentation on the process of setting up the standard I/O module within the Renesas M16C family compiler.

If you are using the Renesas H8 Family compiler, setting up the standard I/O is only most convenient at the time you create the project. If after you’ve created a project and decided that you would like to take advantage of string formatting, re-configuring your build settings is a bit more difficult.

2.4 Uses Standard Include File ‘stdio.h’

This utility still uses the same stdio.h file that comes with the compliers. You are simply replacing the implementation of the utility, not the standard definition or prototype of the ANSI compliant version.

2.5 Reentrant Capability

This code is also reentrant capable where as the Standard library routines for string formatting are not.
3. Limitations

Below is list of some of the limitations or comparisons against using this utility over the one provided in the standard compiler library.

3.1 No Floats or Doubles

The major limitation for this implementation is that “float” or “double” data types cannot be formatted. As an alternative, you could cast the floats to “int”s and do some math to covert the data in different pieces representing whole and factional values. Regardless, this code was purposely not designed to handle those data types.

3.2 No fprintf support

This code was not designed to support the fprintf (Function-printf) utility that the standard libraries support. Although, it could be suggested to this functionality could be emulated by using the simple_printf.c file and redefining the output function (_putc() routine) to be more versatile.
4. Format Specifications Fields

Below are tables showing what standard format specification fields and features are and are-not supported by this implementation.

### 4.1 Conversion Specifications

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>d, l</td>
<td>Converts the integer in the parameter to a signed decimal.</td>
<td>✓</td>
</tr>
<tr>
<td>u</td>
<td>Converts the integer in the parameter to an unsigned decimal.</td>
<td>✓</td>
</tr>
<tr>
<td>o</td>
<td>Converts the integer in the parameter to an unsigned octal.</td>
<td>✓</td>
</tr>
<tr>
<td>x</td>
<td>Converts the integer in the parameter to an unsigned hexadecimal. Lowercase &quot;abcdef&quot; are equivalent to 0AH to 0FH.</td>
<td>✓</td>
</tr>
<tr>
<td>X</td>
<td>Converts the integer in the parameter to an unsigned hexadecimal. Uppercase &quot;ABCDEF&quot; are equivalent to 0AH to 0FH.</td>
<td>✓</td>
</tr>
<tr>
<td>c</td>
<td>Outputs the parameter as an ASCII character.</td>
<td>✓</td>
</tr>
<tr>
<td>s</td>
<td>Converts the parameter after the string far pointer (char *) (and up to a null character '/0' or the precision) to a character string.</td>
<td>✓</td>
</tr>
<tr>
<td>p</td>
<td>Outputs the parameter pointer (all types) in the format 24 bits address.</td>
<td>✓</td>
</tr>
<tr>
<td>n</td>
<td>Stores the number of characters output in the integer pointer of the parameter. The parameter is not converted.</td>
<td>✓</td>
</tr>
<tr>
<td>e</td>
<td>Converts a double-type parameter to the exponent format. The format is [-]d.dddde±dd.</td>
<td>✓</td>
</tr>
<tr>
<td>E</td>
<td>Same as e, except that E is used in place of e for the exponent.</td>
<td>✓</td>
</tr>
<tr>
<td>f</td>
<td>Converts double parameters to [-]d.ddd format.</td>
<td>✓</td>
</tr>
<tr>
<td>g</td>
<td>Converts double parameters to the format specified in e or f. Normally, f conversion, but conversion to e type when the exponent is -4 or less or the precision is less than the value of the exponent.</td>
<td>✓</td>
</tr>
<tr>
<td>G</td>
<td>Same as g except that E is used in place of e for the exponent.</td>
<td>✓</td>
</tr>
<tr>
<td>-</td>
<td>Left-aligns the result of conversion in the minimum field width. The default is right alignment. default is right alignment.</td>
<td>✓</td>
</tr>
<tr>
<td>+</td>
<td>Adds + or – to the result of signed conversion. By default, only the - is added to negative numbers.</td>
<td>✓</td>
</tr>
<tr>
<td>Blank' '</td>
<td>By default, a blank is added before the value if the result of signed conversion has no sign.</td>
<td>✓</td>
</tr>
<tr>
<td>#</td>
<td>Adds 0 to the beginning of o conversion. Adds 0x or 0X to the beginning when other than 0 in x or X conversion. Always adds the decimal point in e, E, and f conversion. Always adds the decimal point in g and G conversion and also outputs any 0s in the decimal place.</td>
<td>✓</td>
</tr>
</tbody>
</table>
### 4.2 Minimum Field Width

<table>
<thead>
<tr>
<th>Description</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specifies the minimum field width of positive decimal integer (Ex: <code>%5d = &quot;   1&quot;)</code></td>
<td>✓</td>
</tr>
<tr>
<td>When the result of conversion has fewer characters than the specified field width, the left of the field is padded.</td>
<td>✓</td>
</tr>
<tr>
<td>The default padding character is the blank. However, ‘0’ is the padding character if you specified the field with using an integer preceded by ‘0’.</td>
<td>✓</td>
</tr>
<tr>
<td>If you specified the – flag, the result of conversion is left aligned and padding characters (always blanks) inserted to the right.</td>
<td>✓</td>
</tr>
<tr>
<td>If you specified the asterisk (*) for the minimum field width, the integer in the parameter specifies the field width. If the value of the parameter is negative, the value after the –flag is the positive field width.</td>
<td>✓</td>
</tr>
</tbody>
</table>

### 4.3 Precision

<table>
<thead>
<tr>
<th>Description</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specify a positive integer after ‘.’. If you specify only ‘.’ with no value, it is interpreted as zero. The function and default value differs according to the conversion type.</td>
<td>✓</td>
</tr>
<tr>
<td>Floating point type data is output with a precision of 6 by default. However, no decimal places are output if you specify a precision of 0.</td>
<td>✓</td>
</tr>
<tr>
<td>d, i, o, u, x, and X conversion (1) If the number of columns in the result of conversion is less than the specified number, the beginning is padded with zeros. (2) If the specified number of columns exceeds the minimum field width, the specified number of columns takes precedence. (3) If the number of columns in the specified precision is less than the minimum field width the field width is processed after the minimum number of columns have been processed. (4) The default is 1 (5) Nothing is output if zero with converted by zero minimum columns.</td>
<td>✓</td>
</tr>
<tr>
<td>s conversion (1) Represents the maximum number of characters. (2) If the result of conversion exceeds the specified number of characters, the remainder is discarded. (3) There is no limit to the number of characters in the default. (4) If you specify an asterisk (*) for the precision, the integer of the parameter specifies the precision. (5) If the parameter is a negative value, specification of the precision is invalid.</td>
<td>✓</td>
</tr>
<tr>
<td>e, E, and f conversion n (where n is the precision) numerals are output after the decimal point.</td>
<td>✓</td>
</tr>
<tr>
<td>g and G conversion Valid characters in excess of n (where n is the precision) are not output.</td>
<td>✓</td>
</tr>
</tbody>
</table>
4.4 I, L or h Conversion Specifics

<table>
<thead>
<tr>
<th>Description</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>l</td>
<td>✓</td>
</tr>
<tr>
<td>d, i, o, u, x, X, and n conversion is performed on long int and unsigned long int parameters.</td>
<td>✓</td>
</tr>
<tr>
<td>h</td>
<td>✓</td>
</tr>
<tr>
<td>d, i, o, u, x, and X conversion is performed on short int and unsigned short int parameters.</td>
<td>✓</td>
</tr>
<tr>
<td>If I or h are specified in other than d, i, o, u, x, X, or n conversion, they are ignored.</td>
<td>✓</td>
</tr>
<tr>
<td>L</td>
<td></td>
</tr>
<tr>
<td>e, E, f, g, and G conversion is performed on double parameters.</td>
<td>✓</td>
</tr>
</tbody>
</table>

5. Adding to an Existing Project

Adding simple `sprintf` support to an existing file is quite easy. Please note that you will use the standard `stdio.h` file that comes with your compiler.

**Step 1:** First, add the file `simple_printf.c` to your project environment.

**Step 2:** You need to add a dummy standard out function to your application code in order to satisfy the `printf` output calls within `simple_printf.c` file. This will prevent pulling unnecessary function calls from the standard library that you will not be using anyway.

For **R8C, M16C** or **M32C** compilers, add the following code to one of your application files:

```c
#include <stdio.h>  /* Add to the top of your application source file */
FILE _iob[1];     /* Needed to keep from importing the entire stdio library */
int fputc(int c, FILE _far *st)  
{  
    return 1;    /* Dummy return value */
}
```

For **H8, H8S** or **SH** compilers, add the following code to one of your application files:

```c
#include <stdio.h>  /* Add to the top of your application source file */
FILE _iob[1];     /* Needed to keep from importing the entire stdio library */
int putc(int c, FILE *st)  
{  
    return 1;    /* Dummy return value */
}
```

**Step 3:** For any application source file that you would like to use `sprintf`, simply add `#include <stdio.h>` at the top of the file.

Website and Support

[http://www.renesas.com](http://www.renesas.com)

Inquiries

[http://www.renesas.com/inquiry](http://www.renesas.com/inquiry)
csc@renesas.com

Revision Record

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
<th>Page</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>April.1.2008</td>
<td></td>
<td>—</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>
1. This document is provided for reference purposes only so that Renesas customers may select the appropriate Renesas products for their use. Renesas neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of Renesas or any third party with respect to the information in this document.

2. Renesas shall have no liability for damages or infringement of any intellectual property or other rights arising out of the use of any information in this document, including, but not limited to, product data, diagrams, charts, programs, algorithms, and application circuit examples.

3. You should not use the products or the technology described in this document for the purpose of military applications such as the development of weapons of mass destruction or for the purpose of any other military use. When exporting the products or technology described herein, you should follow the applicable export control laws and regulations, and procedures required by such laws and regulations.

4. All information included in this document such as product data, diagrams, charts, programs, algorithms, and application circuit examples, is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas products listed in this document, please confirm the latest product information with a Renesas sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas such as that disclosed through our website. (http://www.renesas.com)

5. Renesas has used reasonable care in compiling the information included in this document, but Renesas assumes no liability whatsoever for any damages incurred as a result of errors or omissions in the information included in this document.

6. When using or otherwise relying on the information in this document, you should evaluate the information in light of the total system before deciding about the applicability of such information to the intended application. Renesas makes no representations, warranties or guaranties regarding the suitability of its products for any particular application and specifically disclaims any liability arising out of the application and use of the information in this document or Renesas products.

7. With the exception of products specified by Renesas as suitable for automobile applications, Renesas products are not designed, manufactured or tested for applications or otherwise in systems the failure of which may cause a direct threat to human life or create a risk of human injury or which require especially high quality and reliability such as safety systems, or equipment or systems for transportation and traffic, healthcare, combustion control, aerospace and aeronautics, nuclear power, or undersea communication transmission. If you are considering the use of our products for such purposes, please contact a Renesas sales office beforehand. Renesas shall have no liability for damages arising out of the uses set forth above.

8. Notwithstanding the preceding paragraph, you should not use Renesas products for the purposes listed below:
   1. artificial life support devices or systems
   2. surgical implantations
   3. healthcare intervention (e.g., excision, administration of medication, etc.)
   4. any other purposes that pose a direct threat to human life

     Renesas shall have no liability for damages arising out of the uses set forth in the above and purchasers who elect to use Renesas products in any of the foregoing applications shall indemnify and hold harmless Renesas Technology Corp., its affiliated companies and their officers, directors, and employees against any and all damages arising out of such applications.

9. You should use the products described herein within the range specified by Renesas, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas shall have no liability for malfunctions or damages arising out of the use of Renesas products beyond such specified ranges.

10. Although Renesas endeavors to improve the quality and reliability of its products, IC products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Please be sure to implement safety measures to guard against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other applicable measures. Among others, since the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.

11. In case Renesas products listed in this document are detached from the products to which the Renesas products are attached or affixed, the risk of accident such as swallowing by infants and small children is very high. You should implement safety measures so that Renesas products may not be easily detached from your products. Renesas shall have no liability for damages arising out of such detachment.

12. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written approval from Renesas.

13. Please contact a Renesas sales office if you have any questions regarding the information contained in this document, Renesas semiconductor products, or if you have any other inquiries.

© 2008. Renesas Technology Corp., All rights reserved.