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

A Sprintf Function Implementation for Smaller ROM/RAM

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

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 out side 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.

	NC30 Library	simple_printf.c
Code size	8632	1320
Stack Usage	252	69
Static RAM Data Usage	886	0
Static ROM Data Usage	267	109

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 fiel 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

Symbol	Description	Support
d, l	Converts the integer in the parameter to a signed decimal.	✓
u	Converts the integer in the parameter to an unsigned decimal.	✓
o	Converts the integer in the parameter to an unsigned octal.	✓
x	Converts the integer in the parameter to an unsigned hexadecimal. Lowercase "abcdef" are equivalent to 0AH to 0FH.	✓
X	Converts the integer in the parameter to an unsigned hexadecimal. Uppercase "ABCDEF" are equivalent to 0AH to 0FH.	✓
c	Outputs the parameter as an ASCII character.	✓
s	Converts the parameter after the string far pointer (char *) (and up to a null character '/0' or the precision) to a character string.	✓
p	Outputs the parameter pointer (all types) in the format 24 bits address.	
n	Stores the number of characters output in the integer pointer of the parameter. The parameter is not converted.	
e	Converts a double-type parameter to the exponent format. The format is [-]d.dddddde±dd.	
E	Same as e, except that E is used in place of e for the exponent.	
f	Converts double parameters to [-]d.dddddd format.	
g	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.	
G	Same as g except that E is used in place of e for the exponent.	
−	Left-aligns the result of conversion in the minimum field width. The default is right alignment. default is right alignment.	✓
+	Adds + or − to the result of signed conversion. By default, only the - is added to negative numbers.	✓
Blank' '	By default, a blank is added before the value if the result of signed conversion has no sign.	✓
#	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.	✓

4.2 Minimum Field Width

Description	Support
Specifies the minimum field width of positive decimal integer (Ex: %5d = " 1")	✓
When the result of conversion has fewer characters than the specified field width, the left of the field is padded.	✓
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'.	✓
If you specified the − flag, the result of conversion is left aligned and padding characters (always blanks) inserted to the right.	✓
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.	

4.3 Precision

Description	Support
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.	
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.	
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.	✓
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.	✓
e, E, and f conversion n (where n is the precision) numerals are output after the decimal point.	
g and G conversion Valid characters in excess of n (where n is the precision) are not output.	

4.4 I, L or h Conversion Specifics

Description	Support
l d, i, o, u, x, X, and n conversion is performed on long int and unsigned long int parameters.	✓
h d, i, o, u, x, and X conversion is performed on short int and unsigned short int parameters.	✓
If l or h are specified in other than d, i, o, u, x, X, or n conversion, they are ignored.	
L e, E, f, g, and G conversion is performed on double parameters.1	

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 sdtio.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:

```
#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:

```
#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, simple add `#include <stdio.h>` at the top of the file.

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Revision Record

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