

kdiv user manual



Title	kdiv (Constant division routine generator)
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v0.1.1	2014-11-29 Added project logo in README.
v0.1.0	2014-10-16 Documentation updates and fixes.
v0.0.9	2014-06-13 Renamed README to README.rst.
v0.0.8	2014-06-12 Updated contact information. Replaced COPYING.BSD by LICENSE.
v0.0.7	2013-04-28 Converted documentation to RestructuredText.
v0.0.6	2012-03-17 Split build-and-test scripts to <code>build</code> and <code>test</code> .
v0.0.5	2011-12-03 Minor README updates regarding multiple releases, tutorial usage.
v0.0.4	2011-11-20 Minor README, Makefile updates.
v0.0.3	2011-11-09 Added omitted constant value for M in C routines.
v0.0.2	2011-09-16 Small fixes, avoids emitting redundant shift.
v0.0.1	2011-05-21 Initial release.

1. Introduction

`kdiv` is a generator for routines for optimized division by an integer constant. It can be used for calculating an integer division with the routines presented in Henry S. Warren's "Hacker's Delight" book. `kdiv` can also be used for emitting a NAC (generic assembly language) or ANSI C implementation of the division.

2. File listing

The `kdiv` distribution includes the following files:

<code>/kdiv</code>	Top-level directory
<code>LICENSE</code>	Description of the Modified BSD license.
<code>Makefile</code>	Makefile for generating the <code>kdiv</code> executable.
<code>README.html</code>	HTML version of <code>README.rst</code> .
<code>README.pdf</code>	PDF version of <code>README.rst</code> .
<code>README.rst</code>	This file.
<code>build.sh</code>	Build script for <code>kdiv</code> .
<code>kdiv.c</code>	The source code for the application.
<code>kdiv.png</code>	PNG image for the <code>kdiv</code> project logo.
<code>rst2docs.sh</code>	Bash script for generating the HTML and PDF versions.
<code>test.c</code>	Sample test file.
<code>test.opt.c</code>	Expected optimized version of <code>test.c</code> .
<code>test.sh</code>	Perform some sample runs.

3. Installation

There exists a quite portable Makefile (`Makefile` in the current directory). Running `make` from the command prompt should compile `kdiv`.

4. Prerequisites

- [mandatory for building] Standard UNIX-based tools
- `gcc` (tested with `gcc-3.4.4` on `cygwin/x86`)
- `make`
- `bash`

5. `kdiv` usage

The `kdiv` program can be invoked with several options (see complete option listing below). The usual tasks that can be accomplished with `kdiv` are:

- test signed/unsigned division by constant

- generate a NAC optimized software routine for the division
- generate an ANSI C optimized software routine for the division.

ANSI C routines have been tested only for a width of 32-bits (see option below).
`kdiv` can be invoked as:

```
$ ./kdiv [options]
```

The complete `kdiv` options listing:

- h** Print this help.
- d** Enable debug/diagnostic output.
- errors** Report only inconsistencies to the expected division results.
- div <num>** Set the value of the divisor (an integer except zero). Default: 1.
- width <num>** Set the bitwidth of all operands: dividend, divisor and quotient. Default: 32.
- lo <num>** Set the lower integer bound for dividend testing. Debug output (`-d`) must be enabled. Default: 0.
- hi <num>** Set the higher integer bound for dividend testing. Debug output (`-d`) must be enabled. Default: 65535.
- signed** Construct optimized routine for signed division.
- unsigned** Construct optimized routine for unsigned division (default).
- nac** Emit software routine in the NAC general assembly language (default).
- ansic** Emit software routine in ANSI C (only for `width=32`).

Here follow some simple usage examples of `kdiv`.

1. Generate the ANSI C implementation of `n/11` optimized routine.

```
$ ./kdiv -div 11 -width 32 -unsigned -ansic
```

2. Generate the NAC implementation of `n/(-7)` optimized routine.

```
$ ./kdiv -div -7 -width 32 -signed -ansic
```

3. Generate the ANSI C implementation of `n/23` optimized routine. Also run some tests with an internal generator for the dividend range [0..1024].

```
$ ./kdiv -div 23 -width 32 -unsigned -ansic -d -lo 0 -hi 1024
```

6. Quick tutorial

`kdiv` can be used for arithmetic optimizations in user programs. Assume the following user program (`test.c`):

```
// test.c
#include <stdio.h>
#include <stdlib.h>
int main(int argc, char *argv[]) {
    int a, b;
    a = atoi(argv[1]);
    b = a / 23;
    printf("b = %d\n", b);
    return b;
}
```

This file is compiled and run as follows with one additional argument:

```
$ gcc -Wall -O2 -o test.exe test.c
$ ./test.exe 155
```

and the expected result is:

```
$ b = 6
```

The user can apply `kdiv` for generating a constant division routine for $a/23$:

```
$ ./kdiv -div 23 -width 32 -signed -ansic
```

and the corresponding routine is produced. Then, the user should edit a new file, let's say `test.opt.c` and include the produced routine. The resulting optimized source file should be as follows:

```
// test.opt.c
#include <stdio.h>
#include <stdlib.h>
inline signed int kdiv_s32_p_23 (signed int n)
{
    signed int q, M=-1307163959, c;
    signed long long int t, u, v;
    t = (signed long long int)M * (signed long long int)n;
    q = t >> 32;
    q = q + n;
    q = q >> 4;
    c = n >> 31;
    q = q + c;
    return (q);
}

int main(int argc, char *argv[]) {
    int a, b;
```

```
    a = atoi(argv[1]);  
    b = kdiv_s32_p_23(a);  
    printf("b = %d\n", b);  
    return b;  
}
```

This file is compiled and run as follows with one additional argument:

```
$ gcc -Wall -O2 -o test.opt.exe test.opt.c  
$ ./test.opt.exe 155
```

The target platform compiler (e.g. gcc or llvm) is expected to inline the `kdiv_s32_p_23` function at its call site.

7. Running tests

In order to build and run a series of sample tests do the following:

```
$ ./build.sh  
$ ./test.sh
```