

# Package ‘bitops’

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**Title** Bitwise Operations

**Description** Functions for bitwise operations on integer vectors.

**License** GPL (>= 2)

**URL** <https://github.com/mmaechler/R-bitops>

**BugReports** <https://github.com/mmaechler/R-bitops/issues>

**NeedsCompilation** yes

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`bitAnd`*Bitwise And, Or and Xor Operations*

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**Description**

Bitwise operations, ‘and’ (`&`), ‘or’ (`|`), and ‘Xor’ (`xor`).

**Usage**

```
bitAnd(a, b)
a %% b
bitOr (a, b)
a %|% b
bitXor(a, b)
a %^% b
```

**Arguments**

a, b                    numeric vectors of compatible length, each treated as 32 bit “strings”.

**Details**

The bitwise operations are applied to the arguments cast as 32 bit (unsigned long) integers. NA is returned wherever the magnitude of the arguments is not less than  $2^31$ , or, where either of the arguments is not finite.

For bitwise ‘not’ (`!` in R), use `bitFlip()`.

**Value**

non-negative integer valued numeric vector of maximum length of a or b.

**Author(s)**

Steve Dutky; idea for operators: Dan L Robertson

**See Also**

`bitFlip`, `bitShiftL`; further, `cksum`.

**Examples**

```
bitAnd(15,7) == 7 ; identical(15 %% 7, bitAnd(15, 7))
bitOr(15,7) == 15 ; identical(15 %|% 7, bitOr (15, 7))
bitXor(15,7) == 8 ; identical(15 %^% 7, bitXor(15,7))
bitOr(-1,0) == 4294967295 ; identical(-1 %|% 0, bitOr(-1,0))
```

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bitFlip	<i>Binary Flip (Not) Operator</i>
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**Description**

The binary flip (‘not’, R’s !) operator, `bitFlip(a, w)`, “flips every bit” of `a` up to the `w`-th bit.

**Usage**

```
bitFlip(a, bitWidth = 32)
```

**Arguments**

<code>a</code>	numeric vector.
<code>bitWidth</code>	scalar integer between 0 and 32.

**Value**

(“binary”) numeric vector of the same length as `a` masked with  $(2^{\text{bitWidth}}-1)$ . `NA` is returned for any value of `a` that is not finite or whose magnitude is greater or equal to  $2^{32}$ .

**Note**

`bitFlip(a, w)` is an “involution”, i.e. it is its own inverse – *when* `a` is in  $\{0, 1, \dots, 2^{32}-1\}$ . Notably, negative values `a` are equivalent to their values in the above range, see also `bitUnique()` in the ‘Examples’.

**Author(s)**

Steve Dutky

**See Also**

[bitShiftL](#), [bitXor](#), etc.

**Examples**

```
bitFlip(0:5)
##
bitUnique <- function(x) bitFlip(bitFlip(x)) # "identity" when x in 0:(2^32-1)
bitUnique( 0:16 ) # identical (well, double precision)
bitUnique(-(1:16)) # 4294967295 ...
stopifnot(
  identical(bitUnique(-(1:16)), 2^32 -(1:16)),
  bitFlip(-1) == 0,
  bitFlip(0 ) == 2^32 - 1,
  bitFlip(0, bitWidth=8) == 255
)
```

bitShiftL

*Bitwise Shift Operator (to the Left or Right)***Description**

These functions shift integers bitwise to the left or to the right, returning *unsigned integers*, i.e., values in  $0, 1, \dots, 2^{32} - 1$ .

**Usage**

```
bitShiftL(a, b)
a %<<% b
bitShiftR(a, b)
a %>>% b
```

**Arguments**

**a** numeric vector (integer valued), to be shifted.

**b** integer (valued) vector. Internally, only `b %% 32` is used, e.g, `b = 32` is equivalent to `b = 0`, i.e., *no* shift. This corresponds to *cyclic* rotation (to the left or right).

**Value**

non-negative integer valued numeric vector of maximum length of `a` or `b` containing the value of `a` shifted to the left or right by `b` bits. `NA` is returned wherever the value of `a` or `b` is not finite, or, wherever the magnitude of `a` is greater than or equal to  $2^{32}$ .

**See Also**

[bitFlip](#), [bitXor](#), etc.

**Examples**

```
bitShiftL(0:4, 1) # 0 2 4 6 8
bitShiftL(0:3, 2) # 0 4 8 12

stopifnot(exprs = {
  identical(bitShiftL(0:4, 1), 0:4 %<<% 1)
  identical(bitShiftR(0:3, 2), 0:3 %>>% 2)
})

bitShiftR(0:7, 1) # 0 0 1 1 2 2 3 3 <==> N %/% 2
bitShiftR(0:7, 2) # 0 0 0 0 1 1 1 1 <==> N %/% 4
## all outputs are "unsigned integer" :
stopifnot( bitShiftL(-1, 0) == 2^32 - 1 ,
           bitShiftL(-7, 0) == 4294967289 ,
           bitShiftL(-7, 0) == bitShiftR(-7, 0))
```

```

bitShiftR(-1,1) == 2147483647
bitShiftL(2147483647,1) == 4294967294 # <==> * 2
bitShiftL( -1,      1) == 4294967294

bitShiftL(47, 32) # is 47

## 5 Christmas trees ( bitShiftL *rotates* to the left)
t(outer(1:5, 0:40, bitShiftL))

N <- as.numeric( rpois(1000, 100) )
stopifnot(identical(bitShiftL(N,0),  N),
           identical(bitShiftL(N,1), 2*N),
           identical(bitShiftL(N,2), 4*N),
           ## right shift:
           identical(bitShiftR(N,2), N %% 4),
           identical(bitShiftR(N,4), N %% 16))

```

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cksum

*Compute Check Sum*


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## Description

Return a cyclic redundancy checksum for each element in the argument.

## Usage

```
cksum(a)
```

## Arguments

a                    coerced to character vector

## Details

NA's appearing in the argument are returned as NA's.

The default calculation is identical to that given in pseudo-code in the ACM article (in the References).

## Value

numeric vector of the same length as a.

## Author(s)

Steve Dutky <sdutky@terpalum.umd.edu>

## References

Fashioned from cksum(1) UNIX command line utility, i.e., man cksum.

Dilip V. Sarwate (1988) Computation of Cyclic Redundancy Checks Via Table Lookup, *Communications of the ACM* **31**, 8, 1008–1013.

## See Also

[bitShiftL](#), [bitAnd](#), etc.

## Examples

```
b <- "I would rather have a bottle in front of me than frontal lobotomy\n"
stopifnot(cksum(b) == 1342168430)
(bv <- strsplit(b, " ")[[1]])
cksum(bv) # now a vector of length 13
```

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