

# NAG Library Function Document

## nag\_bessel\_k1\_scaled (s18cdc)

### 1 Purpose

nag\_bessel\_k1\_scaled (s18cdc) returns a value of the scaled modified Bessel function  $e^x K_1(x)$ .

### 2 Specification

```
#include <nag.h>
#include <nags.h>
double nag_bessel_k1_scaled (double x, NagError *fail)
```

### 3 Description

nag\_bessel\_k1\_scaled (s18cdc) evaluates an approximation to  $e^x K_1(x)$ , where  $K_1$  is a modified Bessel function of the second kind. The scaling factor  $e^x$  removes most of the variation in  $K_1(x)$ .

The function uses the same Chebyshev expansions as nag\_bessel\_k1 (s18adc), which returns the unscaled value of  $K_1(x)$ .

### 4 References

Abramowitz M and Stegun I A (1972) *Handbook of Mathematical Functions* (3rd Edition) Dover Publications

### 5 Arguments

- 1: **x** – double *Input*  
*On entry:* the argument  $x$  of the function.  
*Constraint:*  $x > 0.0$ .
- 2: **fail** – NagError \* *Input/Output*  
 The NAG error argument (see Section 3.6 in the Essential Introduction).

### 6 Error Indicators and Warnings

#### NE\_INTERNAL\_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

#### NE\_REAL\_ARG\_LE

On entry,  $x = \langle value \rangle$ .  
 Constraint:  $x > 0.0$ .  
 $K_1$  is undefined and the function returns zero.

#### NE\_REAL\_ARG\_TOO\_SMALL

On entry,  $x = \langle value \rangle$ .  
 Constraint:  $x > \langle value \rangle$ .  
 The function returns the value of the function at the smallest permitted value of the argument.

## 7 Accuracy

Relative errors in the argument are attenuated when propagated into the function value. When the accuracy of the argument is essentially limited by the *machine precision*, the accuracy of the function value will be similarly limited by at most a small multiple of the *machine precision*.

## 8 Parallelism and Performance

Not applicable.

## 9 Further Comments

None.

## 10 Example

This example reads values of the argument  $x$  from a file, evaluates the function at each value of  $x$  and prints the results.

### 10.1 Program Text

```

/* nag_bessel_k1_scaled (s18cdc) Example Program.
 *
 * Copyright 1991 Numerical Algorithms Group.
 *
 * Mark 2 revised, 1992.
 */

#include <nag.h>
#include <stdio.h>
#include <nag_stdlib.h>
#include <nags.h>

int main(void)
{
    Integer  exit_status = 0;
    double   x, y;
    NagError fail;

    INIT_FAIL(fail);

    /* Skip heading in data file */
    scanf("%*[\n]");
    printf("nag_bessel_k1_scaled (s18cdc) Example Program Results\n");
    printf("      x          y\n");
    while (scanf("%lf", &x) != EOF)
    {
        /* nag_bessel_k1_scaled (s18cdc).
         * Scaled modified Bessel function exp(x) K_1(x)
         */
        y = nag_bessel_k1_scaled(x, &fail);
        if (fail.code != NE_NOERROR)
        {
            printf("Error from nag_bessel_k1_scaled (s18cdc).\n%s\n",
                   fail.message);
            exit_status = 1;
            goto END;
        }
        printf("%12.3e%12.3e\n", x, y);
    }

    END:
    return exit_status;
}

```

## **10.2 Program Data**

```
nag_bessel_k1_scaled (s18cdc) Example Program Data
      0.4
      0.6
      1.4
      2.5
     10.0
    1000.0
```

## **10.3 Program Results**

```
nag_bessel_k1_scaled (s18cdc) Example Program Results
      x              y
  4.000e-01    3.259e+00
  6.000e-01    2.374e+00
  1.400e+00    1.301e+00
  2.500e+00    9.002e-01
  1.000e+01    4.108e-01
  1.000e+03    3.965e-02
```

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