

NAG Library Routine Document

s18gdf

1 Purpose

s18gdf returns the value of $I_1(x) - L_1(x)$ where $I_1(x)$ is the modified Bessel function of the first kind of order 1, and $L_1(x)$ is the modified Struve function of order 1, via the function name.

2 Specification

```
Function s18gdf (x, ifail)
Real (Kind=nag_wp)          :: s18gdf
Integer, Intent (Inout)    :: ifail
Real (Kind=nag_wp), Intent (In) :: x
```

3 Description

s18gdf evaluates an approximation to $I_1(x) - L_1(x)$.

Please consult the NIST Digital Library of Mathematical Functions for a detailed discussion of the Struve function including special cases, transformations, relations and asymptotic approximations.

The approximation method used by this routine is based on Chebyshev expansions.

4 References

NIST Digital Library of Mathematical Functions

MacLeod A J (1996) MISCFUN, a software package to compute uncommon special functions *ACM Trans. Math. Software (TOMS)* **22(3)** 288–301

5 Arguments

1: **x** – Real (Kind=nag_wp) *Input*

On entry: the argument x of the function.

Constraint: $x \geq 0.0$.

2: **ifail** – Integer *Input/Output*

On entry: **ifail** must be set to 0, –1 or 1. If you are unfamiliar with this argument you should refer to Section 3.4 in How to Use the NAG Library and its Documentation for details.

For environments where it might be inappropriate to halt program execution when an error is detected, the value –1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, if you are not familiar with this argument, the recommended value is 0. **When the value –1 or 1 is used it is essential to test the value of ifail on exit.**

On exit: **ifail** = 0 unless the routine detects an error or a warning has been flagged (see Section 6).

6 Error Indicators and Warnings

If on entry `ifail` = 0 or -1, explanatory error messages are output on the current error message unit (as defined by `x04aaf`).

Errors or warnings detected by the routine:

`ifail` = 1

On entry, $x = \langle value \rangle$.
Constraint: $x \geq 0.0$.

`ifail` = -99

An unexpected error has been triggered by this routine. Please contact NAG.
See Section 3.9 in How to Use the NAG Library and its Documentation for further information.

`ifail` = -399

Your licence key may have expired or may not have been installed correctly.
See Section 3.8 in How to Use the NAG Library and its Documentation for further information.

`ifail` = -999

Dynamic memory allocation failed.
See Section 3.7 in How to Use the NAG Library and its Documentation for further information.

7 Accuracy

The Chebyshev coefficients used by this routine are internally represented to 20 digits of precision. Calling the number of digits of precision in the floating-point arithmetic being used t , then clearly the maximum number of correct digits in the results obtained is limited by $p = \min(t, 20)$.

Apart from this, rounding errors in internal arithmetic may result in a slight loss of accuracy, but it is reasonable to assume that the result is accurate to within a small multiple of the *machine precision*.

8 Parallelism and Performance

`s18gdf` is not threaded in any implementation.

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

```

Program s18gdfe
!      S18GDF Example Program Text
!
!      Mark 26.1 Release. NAG Copyright 2017.
!
!      .. Use Statements ..
!      Use nag_library, Only: nag_wp, s18gdf
!      .. Implicit None Statement ..
!      Implicit None

```

```

! .. Parameters ..
Integer, Parameter          :: nin = 5, nout = 6
! .. Local Scalars ..
Real (Kind=nag_wp)         :: x, y
Integer                    :: ifail, ioerr
! .. Executable Statements ..
Write (nout,*) 'S18GDF Example Program Results'

! Skip heading in data file
Read (nin,*)

Write (nout,*)
Write (nout,*) '      X      I1(X)-L1(X)'
Write (nout,*)

data: Do
  Read (nin,*,Iostat=ioerr) x

  If (ioerr<0) Then
    Exit data
  End If

  ifail = -1
  y = s18gdf(x,ifail)

  If (ifail<0) Then
    Exit data
  End If

  Write (nout,99999) x, y

End Do data

99999 Format (1X,1P,2E12.3)
End Program s18gdf

```

10.2 Program Data

```

S18GDF Example Program Data
0.5
0
1
3
6
8
10
100

```

10.3 Program Results

```

S18GDF Example Program Results

```

X	I1(X)-L1(X)
5.000E-01	2.040E-01
0.000E+00	0.000E+00
1.000E+00	3.384E-01
3.000E+00	5.568E-01
6.000E+00	6.169E-01
8.000E+00	6.260E-01
1.000E+01	6.300E-01
1.000E+02	6.366E-01

