NAG Toolbox for MATLAB

s10ac

1 Purpose

s10ac returns the value of the hyperbolic cosine, $\cosh x$, via the function name.

2 Syntax

```
[result, ifail] = s10ac(x)
```

3 Description

s10ac calculates an approximate value for the hyperbolic cosine, $\cosh x$.

For $|x| \leq E_1$, $\quad \cosh x = \frac{1}{2}(e^x + e^{-x})$.

For $|x| > E_1$, the function fails owing to danger of setting overflow in calculating e^x. The result returned for such calls is $\cosh E_1$, i.e., it returns the result for the nearest valid argument.

4 References

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

5 Parameters

5.1 Compulsory Input Parameters

1: **x – double scalar**

The argument x of the function.

5.2 Optional Input Parameters

None.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **result – double scalar**

The result of the function.

2: **ifail – int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail $= 1$

The function has been called with an argument too large in absolute magnitude. There is a danger of overflow. The result returned is the value of $\cosh x$ at the nearest valid argument.

7 Accuracy

If δ and ϵ are the relative errors in the argument and result, respectively, then in principle

$$\epsilon \simeq x \tanh x \times \delta.$$

That is, the relative error in the argument, x, is amplified by a factor, at least $x \tanh x$. The equality should hold if δ is greater than the ***machine precision*** (δ is due to data errors etc.) but if δ is simply a result of round-off in the machine representation of x then it is possible that an extra figure may be lost in internal calculation round-off.

The behaviour of the error amplification factor is shown by the following graph:

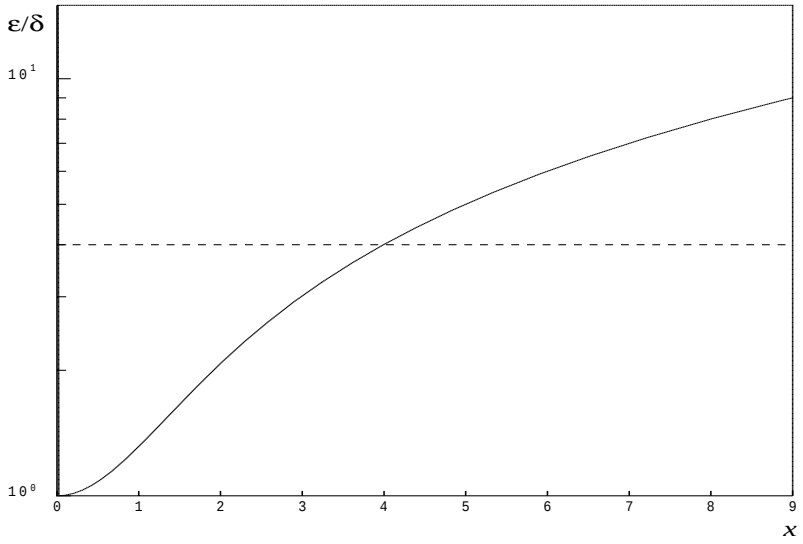

Figure 1

It should be noted that near $x = 0$ where this amplification factor tends to zero the accuracy will be limited eventually by the ***machine precision***. Also for $|x| \geq 2$

$$\epsilon \sim x\delta = \Delta$$

where Δ is the absolute error in the argument x.

8 Further Comments

None.

9 Example

```
x = -10;
[result, ifail] = s10ac(x)
```

```
result =
   1.1013e+04
ifail =
           0
```