# NAG Library Routine Document

# C09EYF

**Note:** before using this routine, please read the Users' Note for your implementation to check the interpretation of **bold italicised** terms and other implementation-dependent details.

## 1 Purpose

C09EYF extracts a selected set of discrete wavelet transform (DWT) coefficients from the full set of coefficients stored in compact form, as computed by C09ECF (two-dimensional DWT).

## 2 Specification

```
SUBROUTINE C09EYF (ILEV, CINDEX, LENC, C, D, LDD, ICOMM, IFAIL)

INTEGER            ILEV, CINDEX, LENC, LDD, ICOMM(180), IFAIL
REAL (KIND=nag_wp) C(LENC), D(LDD,*)
```

## 3 Description

C09EYF is intended to be used after a call to C09ECF (two-dimensional DWT), which in turn should be preceded by a call to C09ABF (two-dimensional wavelet filter initialization). Given an initial two-dimensional data set $A$, a prior call to C09ECF computes the approximation coefficients (at the highest requested level) and three sets of detail coeficients at all levels and stores these in compact form in a one-dimensional array C. C09EYF can then extract either the approximation coefficients or one of the sets of detail coefficients at one of the levels into a matrix $D$. The dimensions of $D$ depend on the level extracted and are available from the arrays DWTLVM and DWTLVN as returned by C09ECF which contain the first and second dimensions respectively. See Section 2.1 in the C09 Chapter Introduction for a discussion of the two-dimensional DWT.

## 4 References

None.

## 5 Parameters

**Note**: the following notation is used in this section:

$n_{cm}$ is the number of wavelet coefficients in the first dimension, which, at level ILEV, is equal to DWTLVM(NWL − ILEV + 1) as returned by a call to C09ECF transforming NWL levels.

$n_{cn}$ is the number of wavelet coefficients in the second dimension, which, at level ILEV, is equal to DWTLVN(NWL − ILEV + 1) as returned by a call to C09ECF transforming NWL levels..

1:     ILEV – INTEGER                                                                                     *Input*

*On entry*: the level at which coefficients are to be extracted.

*Constraints*:

      $1 \le$ ILEV $\le$ NWL, where NWL is as used in a preceding call to C09ECF;
      if CINDEX = 0, ILEV = NWL.

2:     CINDEX – INTEGER                                                          *Input*

On entry: identifies which coefficients to extract. The coefficients are identified as follows:

CINDEX = 0
     The approximation coefficients, produced by application of the low pass filter over columns
     and rows of the original matrix (LL). The approximation coefficients are available only for
     ILEV = NWL, where NWL is the value used in a preceding call to C09ECF.

CINDEX = 1
     The vertical detail coefficients produced by applying the low pass filter over columns of the
     original matrix and the high pass filter over rows (LH).

CINDEX = 2
     The horizontal detail coefficients produced by applying the high pass filter over columns of
     the original matrix and the low pass filter over rows (HL).

CINDEX = 3
     The diagonal detail coefficients produced by applying the high pass filter over columns and
     rows of the original matrix (HH).

*Constraint*:  $0 \le \text{CINDEX} \le 3$  when  ILEV = NWL  as  used  in  C09ECF,  otherwise
$1 \le \text{CINDEX} \le 3$.

3:     LENC – INTEGER                                                          *Input*

On entry: the dimension of the array C as declared in the (sub)program from which C09EYF is
called.

*Constraint*: LENC must be unchanged from the value used in the preceding call to C09ECF..

4:     C(LENC) – REAL (KIND=nag_wp) array                                       *Input*

On entry: DWT coefficients, as computed by a preceding call to C09ECF.

5:     D(LDD, ∗) – REAL (KIND=nag_wp) array                                    *Output*

**Note**: the second dimension of the array D must be at least $n_{\text{cn}}$.

*On exit*: the requested coefficients.

If ILEV = NWL (as used in C09ECF) and CINDEX = 0, the $n_{cm}$ by $n_{cn}$ approximation
coefficients $a_{ij}$ are stored in $D(i,j)$, for $i = 1, 2, \ldots, n_{cm}$ and $j = 1, 2, \ldots, n_{cn}$.

Otherwise the $n_{cm}$ by $n_{cn}$ level ILEV detail coefficients (of type specified by CINDEX) $d_{ij}$ are
stored in $D(i,j)$, for $i = 1, 2, \ldots, n_{cm}$ and $j = 1, 2, \ldots, n_{cn}$.

6:     LDD – INTEGER                                                           *Input*

On entry: the first dimension of the array D as declared in the (sub)program from which C09EYF
is called.

*Constraint*: $\text{LDD} \ge n_{\text{cm}}$.

7:     ICOMM(180) – INTEGER array                                   *Communication Array*

On entry: contains details of the discrete wavelet transform and the problem dimension as setup in
the call to the initialization routine C09ABF.

8:     IFAIL – INTEGER                                                   *Input/Output*

On entry: IFAIL must be set to 0, −1 or 1. If you are unfamiliar with this parameter you should
refer to Section 3.3 in the Essential Introduction 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 parameter, 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, ILEV = $\langle value \rangle$.
Constraint: ILEV ≥ 1.

On entry, ILEV = $\langle value \rangle$ and NWL = $\langle value \rangle$.
Constraint: ILEV ≤ NWL, where NWL is the number of levels used in the call to C09ECF.

IFAIL = 2

On entry, CINDEX = $\langle value \rangle$.
Constraint: CINDEX ≤ 3.

On entry, CINDEX = $\langle value \rangle$.
Constraint: CINDEX ≥ 0.

IFAIL = 3

On entry, LENC = $\langle value \rangle$ and $n_{ct}$ = $\langle value \rangle$.
Constraint: LENC ≥ $n_{ct}$, where $n_{ct}$ is the number of DWT coefficients computed in a previous call to C09ECF.

IFAIL = 4

On entry, LDD = $\langle value \rangle$ and $n_{cm}$ = $\langle value \rangle$.
Constraint: LDD ≥ $n_{cm}$, where $n_{cm}$ is the number of DWT coefficients in the first dimension at the selected level ILEV.

IFAIL = 5

On entry, ILEV = $\langle value \rangle$ and NWL = $\langle value \rangle$, but CINDEX = 0.
Constraint: CINDEX > 0 when ILEV < NWL in the preceding call to C09ECF.

IFAIL = 6

Either the initialization routine has not been called first or ICOMM has been corrupted.

Either the initialization routine was called with WTRANS = 'S' or ICOMM has been corrupted.

IFAIL = −99

An unexpected error has been triggered by this routine. Please contact NAG.

See Section 3.8 in the Essential Introduction for further information.

IFAIL = −399

Your licence key may have expired or may not have been installed correctly.

See Section 3.7 in the Essential Introduction for further information.

IFAIL $= -999$

Dynamic memory allocation failed.

See Section 3.6 in the Essential Introduction for further information.

## 7 Accuracy

Not applicable.

## 8 Parallelism and Performance

Not applicable.

## 9 Further Comments

None.

## 10 Example

See Section 10 in C09ABF, C09ECF and C09EZF.