```
MODULE FM_QUAD_INT

!  FM_quadint 1.4                    David M. Smith                    Quadruple Length Integer Support

!  This module extends the definition of basic FM types (FM), (IM), and (ZM) so they can interact
!  with quad length integer variables.

!  Warning:  This module is needed only when the user's program explicitly declares quad length
!            integer variables.  If quad length integers are obtained by using a compiler switch
!            to change the default integer size for the entire program (such as with gfortran's
!            -fdefault-integer-8 option), then compiling the basic FM package with the same option
!            means this module is not needed.

!  Not all compilers might support quad length integers, but for those that do, variables can be
!  declared via the SELECTED_REAL_KIND function.

!  For example, when this module was first written, typical computer hardware supported 32-bit
!  integers as default precision and 64-bits as double precision.  Some compilers offered 128-bit
!  quad integers implemented in software, giving values up to 2**127 - 1, with 39 decimal digits.

!  So SELECTED_INT_KIND(30) could be used to select this 128-bit format.

!  The routines in this interface extend basic functions like TO_FM, TO_IM, TO_ZM so they can be
!  used with quad integer arguments.  New conversion function TO_QUAD_INT will take FM, IM, or ZM
!  inputs and convert to quad integers.

!  Other mixed-mode operations, such as assignment ( a = b ), logical comparisons, and arithmetic
!  are also provided.  As with the basic FMZM module, assignments and arithmetic may also involve
!  1 or 2-dimensional arrays.

    USE FMZM

    INTEGER, PARAMETER :: QUAD_INT = SELECTED_INT_KIND(30)

    INTERFACE TO_FM
       MODULE PROCEDURE FM_QI
       MODULE PROCEDURE FM_QI1
       MODULE PROCEDURE FM_QI2
    END INTERFACE

    INTERFACE TO_IM
       MODULE PROCEDURE IM_QI
       MODULE PROCEDURE IM_QI1
       MODULE PROCEDURE IM_QI2
    END INTERFACE

    INTERFACE TO_ZM
       MODULE PROCEDURE ZM_QI
       MODULE PROCEDURE ZM2_QI
       MODULE PROCEDURE ZM_QI1
       MODULE PROCEDURE ZM_QI2
    END INTERFACE

    INTERFACE TO_QUAD_INT
       MODULE PROCEDURE FM_2QI
       MODULE PROCEDURE IM_2QI
       MODULE PROCEDURE ZM_2QI
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   MODULE PROCEDURE FM_2QI1
   MODULE PROCEDURE IM_2QI1
   MODULE PROCEDURE ZM_2QI1
   MODULE PROCEDURE FM_2QI2
   MODULE PROCEDURE IM_2QI2
   MODULE PROCEDURE ZM_2QI2
END INTERFACE

INTERFACE ASSIGNMENT (=)
   MODULE PROCEDURE FMEQ_QIFM
   MODULE PROCEDURE FMEQ_QIIM
   MODULE PROCEDURE FMEQ_QIZM
   MODULE PROCEDURE FMEQ_FMQI
   MODULE PROCEDURE FMEQ_IMQI
   MODULE PROCEDURE FMEQ_ZMQI
   MODULE PROCEDURE FMEQ_FM1QI
   MODULE PROCEDURE FMEQ_QI1FM
   MODULE PROCEDURE FMEQ_FM1QI1
   MODULE PROCEDURE FMEQ_QI1FM1
   MODULE PROCEDURE FMEQ_IM1QI
   MODULE PROCEDURE FMEQ_QI1IM
   MODULE PROCEDURE FMEQ_IM1QI1
   MODULE PROCEDURE FMEQ_QI1IM1
   MODULE PROCEDURE FMEQ_ZM1QI
   MODULE PROCEDURE FMEQ_QI1ZM
   MODULE PROCEDURE FMEQ_ZM1QI1
   MODULE PROCEDURE FMEQ_QI1ZM1
   MODULE PROCEDURE FMEQ_FM2QI
   MODULE PROCEDURE FMEQ_QI2FM
   MODULE PROCEDURE FMEQ_FM2QI2
   MODULE PROCEDURE FMEQ_QI2FM2
   MODULE PROCEDURE FMEQ_IM2QI
   MODULE PROCEDURE FMEQ_QI2IM
   MODULE PROCEDURE FMEQ_IM2QI2
   MODULE PROCEDURE FMEQ_QI2IM2
   MODULE PROCEDURE FMEQ_ZM2QI
   MODULE PROCEDURE FMEQ_QI2ZM
   MODULE PROCEDURE FMEQ_ZM2QI2
   MODULE PROCEDURE FMEQ_QI2ZM2
END INTERFACE

INTERFACE OPERATOR (==)
   MODULE PROCEDURE FMLEQ_QIFM
   MODULE PROCEDURE FMLEQ_QIIM
   MODULE PROCEDURE FMLEQ_QIZM
   MODULE PROCEDURE FMLEQ_FMQI
   MODULE PROCEDURE FMLEQ_IMQI
   MODULE PROCEDURE FMLEQ_ZMQI
END INTERFACE

INTERFACE OPERATOR (/=)
   MODULE PROCEDURE FMLNE_QIFM
   MODULE PROCEDURE FMLNE_QIIM
   MODULE PROCEDURE FMLNE_QIZM
   MODULE PROCEDURE FMLNE_FMQI
   MODULE PROCEDURE FMLNE_IMQI
   MODULE PROCEDURE FMLNE_ZMQI
END INTERFACE
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INTERFACE OPERATOR (>)
   MODULE PROCEDURE FMLGT_QIFM
   MODULE PROCEDURE FMLGT_QIIM
   MODULE PROCEDURE FMLGT_FMQI
   MODULE PROCEDURE FMLGT_IMQI
END INTERFACE

INTERFACE OPERATOR (>=)
   MODULE PROCEDURE FMLGE_QIFM
   MODULE PROCEDURE FMLGE_QIIM
   MODULE PROCEDURE FMLGE_FMQI
   MODULE PROCEDURE FMLGE_IMQI
END INTERFACE

INTERFACE OPERATOR (<)
   MODULE PROCEDURE FMLLT_QIFM
   MODULE PROCEDURE FMLLT_QIIM
   MODULE PROCEDURE FMLLT_FMQI
   MODULE PROCEDURE FMLLT_IMQI
END INTERFACE

INTERFACE OPERATOR (<=)
   MODULE PROCEDURE FMLLE_QIFM
   MODULE PROCEDURE FMLLE_QIIM
   MODULE PROCEDURE FMLLE_FMQI
   MODULE PROCEDURE FMLLE_IMQI
END INTERFACE

INTERFACE OPERATOR (+)
   MODULE PROCEDURE FMADD_QIFM
   MODULE PROCEDURE FMADD_QIIM
   MODULE PROCEDURE FMADD_QIZM
   MODULE PROCEDURE FMADD_FMQI
   MODULE PROCEDURE FMADD_IMQI
   MODULE PROCEDURE FMADD_ZMQI
   MODULE PROCEDURE FMADD_QIFM1
   MODULE PROCEDURE FMADD_QIIM1
   MODULE PROCEDURE FMADD_FMQI1
   MODULE PROCEDURE FMADD_FM1QI
   MODULE PROCEDURE FMADD_QI1FM
   MODULE PROCEDURE FMADD_QI1FM1
   MODULE PROCEDURE FMADD_FM1QI1
   MODULE PROCEDURE FMADD_IMQI1
   MODULE PROCEDURE FMADD_IM1QI
   MODULE PROCEDURE FMADD_QI1IM
   MODULE PROCEDURE FMADD_QI1IM1
   MODULE PROCEDURE FMADD_IM1QI1
   MODULE PROCEDURE FMADD_QIZM1
   MODULE PROCEDURE FMADD_ZMQI1
   MODULE PROCEDURE FMADD_ZM1QI
   MODULE PROCEDURE FMADD_QI1ZM
   MODULE PROCEDURE FMADD_QI1ZM1
   MODULE PROCEDURE FMADD_ZM1QI1
   MODULE PROCEDURE FMADD_QIFM2
   MODULE PROCEDURE FMADD_QIIM2
   MODULE PROCEDURE FMADD_FMQI2
   MODULE PROCEDURE FMADD_FM2QI
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   MODULE PROCEDURE FMADD_QI2FM
   MODULE PROCEDURE FMADD_QI2FM2
   MODULE PROCEDURE FMADD_FM2QI2
   MODULE PROCEDURE FMADD_IMQI2
   MODULE PROCEDURE FMADD_IM2QI
   MODULE PROCEDURE FMADD_QI2IM
   MODULE PROCEDURE FMADD_QI2IM2
   MODULE PROCEDURE FMADD_IM2QI2
   MODULE PROCEDURE FMADD_QIZM2
   MODULE PROCEDURE FMADD_ZMQI2
   MODULE PROCEDURE FMADD_ZM2QI
   MODULE PROCEDURE FMADD_QI2ZM
   MODULE PROCEDURE FMADD_QI2ZM2
   MODULE PROCEDURE FMADD_ZM2QI2
END INTERFACE

INTERFACE OPERATOR (-)
   MODULE PROCEDURE FMSUB_QIFM
   MODULE PROCEDURE FMSUB_QIIM
   MODULE PROCEDURE FMSUB_QIZM
   MODULE PROCEDURE FMSUB_FMQI
   MODULE PROCEDURE FMSUB_IMQI
   MODULE PROCEDURE FMSUB_ZMQI
   MODULE PROCEDURE FMSUB_QIFM1
   MODULE PROCEDURE FMSUB_QIIM1
   MODULE PROCEDURE FMSUB_FMQI1
   MODULE PROCEDURE FMSUB_FM1QI
   MODULE PROCEDURE FMSUB_QI1FM
   MODULE PROCEDURE FMSUB_QI1FM1
   MODULE PROCEDURE FMSUB_FM1QI1
   MODULE PROCEDURE FMSUB_IMQI1
   MODULE PROCEDURE FMSUB_IM1QI
   MODULE PROCEDURE FMSUB_QI1IM
   MODULE PROCEDURE FMSUB_QI1IM1
   MODULE PROCEDURE FMSUB_IM1QI1
   MODULE PROCEDURE FMSUB_QIZM1
   MODULE PROCEDURE FMSUB_ZMQI1
   MODULE PROCEDURE FMSUB_ZM1QI
   MODULE PROCEDURE FMSUB_QI1ZM
   MODULE PROCEDURE FMSUB_QI1ZM1
   MODULE PROCEDURE FMSUB_ZM1QI1
   MODULE PROCEDURE FMSUB_QIFM2
   MODULE PROCEDURE FMSUB_QIIM2
   MODULE PROCEDURE FMSUB_FMQI2
   MODULE PROCEDURE FMSUB_FM2QI
   MODULE PROCEDURE FMSUB_QI2FM
   MODULE PROCEDURE FMSUB_QI2FM2
   MODULE PROCEDURE FMSUB_FM2QI2
   MODULE PROCEDURE FMSUB_IMQI2
   MODULE PROCEDURE FMSUB_IM2QI
   MODULE PROCEDURE FMSUB_QI2IM
   MODULE PROCEDURE FMSUB_QI2IM2
   MODULE PROCEDURE FMSUB_IM2QI2
   MODULE PROCEDURE FMSUB_QIZM2
   MODULE PROCEDURE FMSUB_ZMQI2
   MODULE PROCEDURE FMSUB_ZM2QI
   MODULE PROCEDURE FMSUB_QI2ZM
   MODULE PROCEDURE FMSUB_QI2ZM2
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   MODULE PROCEDURE FMSUB_ZM2QI2
END INTERFACE

INTERFACE OPERATOR (*)
   MODULE PROCEDURE FMMPY_QIFM
   MODULE PROCEDURE FMMPY_QIIM
   MODULE PROCEDURE FMMPY_QIZM
   MODULE PROCEDURE FMMPY_FMQI
   MODULE PROCEDURE FMMPY_IMQI
   MODULE PROCEDURE FMMPY_ZMQI
   MODULE PROCEDURE FMMPY_QIFM1
   MODULE PROCEDURE FMMPY_QIIM1
   MODULE PROCEDURE FMMPY_FMQI1
   MODULE PROCEDURE FMMPY_FM1QI
   MODULE PROCEDURE FMMPY_QI1FM
   MODULE PROCEDURE FMMPY_QI1FM1
   MODULE PROCEDURE FMMPY_FM1QI1
   MODULE PROCEDURE FMMPY_IMQI1
   MODULE PROCEDURE FMMPY_IM1QI
   MODULE PROCEDURE FMMPY_QI1IM
   MODULE PROCEDURE FMMPY_QI1IM1
   MODULE PROCEDURE FMMPY_IM1QI1
   MODULE PROCEDURE FMMPY_QIZM1
   MODULE PROCEDURE FMMPY_ZMQI1
   MODULE PROCEDURE FMMPY_ZM1QI
   MODULE PROCEDURE FMMPY_QI1ZM
   MODULE PROCEDURE FMMPY_QI1ZM1
   MODULE PROCEDURE FMMPY_ZM1QI1
   MODULE PROCEDURE FMMPY_QIFM2
   MODULE PROCEDURE FMMPY_QIIM2
   MODULE PROCEDURE FMMPY_FMQI2
   MODULE PROCEDURE FMMPY_FM2QI
   MODULE PROCEDURE FMMPY_QI2FM
   MODULE PROCEDURE FMMPY_QI2FM2
   MODULE PROCEDURE FMMPY_FM2QI2
   MODULE PROCEDURE FMMPY_IMQI2
   MODULE PROCEDURE FMMPY_IM2QI
   MODULE PROCEDURE FMMPY_QI2IM
   MODULE PROCEDURE FMMPY_QI2IM2
   MODULE PROCEDURE FMMPY_IM2QI2
   MODULE PROCEDURE FMMPY_QIZM2
   MODULE PROCEDURE FMMPY_ZMQI2
   MODULE PROCEDURE FMMPY_ZM2QI
   MODULE PROCEDURE FMMPY_QI2ZM
   MODULE PROCEDURE FMMPY_QI2ZM2
   MODULE PROCEDURE FMMPY_ZM2QI2
END INTERFACE

INTERFACE OPERATOR (/)
   MODULE PROCEDURE FMDIV_QIFM
   MODULE PROCEDURE FMDIV_QIIM
   MODULE PROCEDURE FMDIV_QIZM
   MODULE PROCEDURE FMDIV_FMQI
   MODULE PROCEDURE FMDIV_IMQI
   MODULE PROCEDURE FMDIV_ZMQI
   MODULE PROCEDURE FMDIV_QIFM1
   MODULE PROCEDURE FMDIV_QIIM1
   MODULE PROCEDURE FMDIV_FMQI1
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      MODULE PROCEDURE FMDIV_FM1QI
      MODULE PROCEDURE FMDIV_QI1FM
      MODULE PROCEDURE FMDIV_QI1FM1
      MODULE PROCEDURE FMDIV_FM1QI1
      MODULE PROCEDURE FMDIV_IMQI1
      MODULE PROCEDURE FMDIV_IM1QI
      MODULE PROCEDURE FMDIV_QI1IM
      MODULE PROCEDURE FMDIV_QI1IM1
      MODULE PROCEDURE FMDIV_IM1QI1
      MODULE PROCEDURE FMDIV_QIZM1
      MODULE PROCEDURE FMDIV_ZMQI1
      MODULE PROCEDURE FMDIV_ZM1QI
      MODULE PROCEDURE FMDIV_QI1ZM
      MODULE PROCEDURE FMDIV_QI1ZM1
      MODULE PROCEDURE FMDIV_ZM1QI1
      MODULE PROCEDURE FMDIV_QIFM2
      MODULE PROCEDURE FMDIV_QIIM2
      MODULE PROCEDURE FMDIV_FMQI2
      MODULE PROCEDURE FMDIV_FM2QI
      MODULE PROCEDURE FMDIV_QI2FM
      MODULE PROCEDURE FMDIV_QI2FM2
      MODULE PROCEDURE FMDIV_FM2QI2
      MODULE PROCEDURE FMDIV_IMQI2
      MODULE PROCEDURE FMDIV_IM2QI
      MODULE PROCEDURE FMDIV_QI2IM
      MODULE PROCEDURE FMDIV_QI2IM2
      MODULE PROCEDURE FMDIV_IM2QI2
      MODULE PROCEDURE FMDIV_QIZM2
      MODULE PROCEDURE FMDIV_ZMQI2
      MODULE PROCEDURE FMDIV_ZM2QI
      MODULE PROCEDURE FMDIV_QI2ZM
      MODULE PROCEDURE FMDIV_QI2ZM2
      MODULE PROCEDURE FMDIV_ZM2QI2
   END INTERFACE

   INTERFACE OPERATOR (**)
      MODULE PROCEDURE FMPWR_QIFM
      MODULE PROCEDURE FMPWR_QIIM
      MODULE PROCEDURE FMPWR_QIZM
      MODULE PROCEDURE FMPWR_FMQI
      MODULE PROCEDURE FMPWR_IMQI
      MODULE PROCEDURE FMPWR_ZMQI
   END INTERFACE

 CONTAINS

      SUBROUTINE FMQI2M(IVAL,MA)

!  Convert quad length integer IVAL to multiple precision MA.

      USE FMVALS
      IMPLICIT NONE

      TYPE(MULTI) :: MA
      INTEGER (QUAD_INT) :: IVAL

      REAL (KIND(1.0D0)) :: MK,ML,MVAL
      INTEGER (QUAD_INT) :: J,JM2,KB,KB1,N1,NMVAL,NV2
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```
      CHARACTER(50) :: STR
      INTENT (IN) :: IVAL
      INTENT (INOUT) :: MA

      IF (.NOT. ALLOCATED(MA%MP)) THEN
          ALLOCATE(MA%MP(NDIG+2),STAT=K_STAT)
          IF (K_STAT /= 0) CALL FMDEFINE_ERROR
      ELSE IF (SIZE(MA%MP) < NDIG+2) THEN
          DEALLOCATE(MA%MP)
          ALLOCATE(MA%MP(NDIG+2),STAT=K_STAT)
          IF (K_STAT /= 0) CALL FMDEFINE_ERROR
      ENDIF

      IF (MBLOGS /= MBASE) CALL FMCONS
      KFLAG = 0
      N1 = NDIG + 1

      IF (ABS(IVAL) > MXBASE) THEN
          WRITE (STR,"(I50)") IVAL
          CALL FMST2M(STR,MA)
          GO TO 150
      ELSE
          MVAL = ABS(IVAL)
          NMVAL = MVAL
          NV2 = NMVAL - 1
          IF (NMVAL /= ABS(IVAL) .OR. NV2 /= ABS(IVAL)-1) THEN
              WRITE (STR,"(I50)") IVAL
              CALL FMST2M(STR,MA)
              GO TO 150
          ENDIF
      ENDIF

!             Check for small IVAL.

      IF (MVAL < MBASE) THEN
          DO J = 3, N1
             MA%MP(J+1) = 0
          ENDDO
          IF (IVAL >= 0) THEN
              MA%MP(3) = IVAL
              MA%MP(1) = 1
          ELSE
              MA%MP(3) = -IVAL
              MA%MP(1) = -1
          ENDIF
          IF (IVAL == 0) THEN
              MA%MP(2) = 0
          ELSE
              MA%MP(2) = 1
          ENDIF
          GO TO 150
      ENDIF

!             Compute and store the digits, right to left.

      MA%MP(2) = 0
      J = NDIG + 1
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```
  120 MK = AINT (MVAL/MBASE)
      ML = MVAL - MK*MBASE
      MA%MP(2) = MA%MP(2) + 1
      MA%MP(J+1) = ML
      IF (MK > 0) THEN
          MVAL = MK
          J = J - 1
          IF (J >= 2) GO TO 120

!             Here IVAL cannot be expressed exactly.

          WRITE (STR,"(I50)") IVAL
          CALL FMST2M(STR,MA)
          RETURN
      ENDIF

!             Normalize MA.

      KB = N1 - J + 2
      JM2 = J - 2
      DO J = 2, KB
         MA%MP(J+1) = MA%MP(J+JM2+1)
      ENDDO
      KB1 = KB + 1
      IF (KB1 <= N1) THEN
          DO J = KB1, N1
             MA%MP(J+1) = 0
          ENDDO
      ENDIF

      MA%MP(1) = 1
      IF (IVAL < 0 .AND. MA%MP(2) /= MUNKNO .AND. MA%MP(3) /= 0) MA%MP(1) = -1

  150 RETURN
      END SUBROUTINE FMQI2M


      SUBROUTINE FMM2QI(MA,IVAL)

!  Convert multiple precision MA to quad length integer IVAL.

      USE FMVALS
      IMPLICIT NONE

      TYPE(MULTI) :: MA
      INTEGER (QUAD_INT) :: IVAL

      INTEGER (QUAD_INT) :: IBASE,J,KA,KB,LARGE,N1
      INTENT (IN) :: MA
      INTENT (INOUT) :: IVAL

      KFLAG = 0
      N1 = NDIG + 1
      LARGE = HUGE(IVAL)/MBASE
      IBASE = MBASE
      IVAL = 0
      IF (MA%MP(2) <= 0) THEN
          IF (MA%MP(3) /= 0) KFLAG = 2
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```
          RETURN
       ENDIF

       KB = MA%MP(2) + 1
       IVAL = ABS(MA%MP(3))
       IF (KB >= 3) THEN
           DO J = 3, KB
              IF (IVAL > LARGE) THEN
                  KFLAG = -4
                  IF (MA%MP(2) /= MUNKNO) CALL FMWARN
                  IVAL = IUNKNO
                  RETURN
              ENDIF
              IF (J <= N1) THEN
                  IVAL = IVAL*IBASE
                  IF (IVAL > HUGE(IVAL)-MA%MP(J+1)) THEN
                      KFLAG = -4
                      IF (MA%MP(2) /= MUNKNO) CALL FMWARN
                      IVAL = IUNKNO
                      RETURN
                  ELSE
                      IVAL = IVAL + INT(MA%MP(J+1))
                  ENDIF
              ELSE
                  IVAL = IVAL*IBASE
              ENDIF
           ENDDO
       ENDIF

       IF (MA%MP(1) < 0) IVAL = -IVAL

!             Check to see if MA is an integer.

       KA = KB + 1
       IF (KA <= N1) THEN
           DO J = KA, N1
              IF (MA%MP(J+1) /= 0) THEN
                  KFLAG = 2
                  RETURN
              ENDIF
           ENDDO
       ENDIF

       RETURN
       END SUBROUTINE FMM2QI


       SUBROUTINE IMQI2M(IVAL,MA)

!  MA = IVAL

!  Convert a quad length integer to an IM number.

       USE FMVALS
       IMPLICIT NONE

       TYPE(MULTI) :: MA
       INTEGER (QUAD_INT) :: IVAL
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```
      INTEGER :: NDSAVE
      INTENT (IN) :: IVAL
      INTENT (INOUT) :: MA
      TYPE(MULTI), SAVE :: MVLVFM

      CALL FMQI2M(IVAL,MVLVFM)

      IF (INT(MVLVFM%MP(2)) > NDIG) THEN
          NDSAVE = NDIG
          NDIG = MAX(2,INT(MVLVFM%MP(2)))
          CALL FMQI2M(IVAL,MVLVFM)
          CALL IMFM2I(MVLVFM,MA)
          NDIG = NDSAVE
      ELSE
          CALL IMFM2I(MVLVFM,MA)
      ENDIF

      RETURN
      END SUBROUTINE IMQI2M


      SUBROUTINE IMM2QI(MA,IVAL)

!  IVAL = MA

!  Convert an IM number to quad length integer.

      USE FMVALS
      IMPLICIT NONE

      TYPE(MULTI) :: MA
      INTEGER (QUAD_INT) :: IVAL

      INTEGER :: NDSAVE
      INTENT (IN) :: MA
      INTENT (INOUT) :: IVAL
      TYPE(MULTI), SAVE :: MTLVFM

      NDSAVE = NDIG
      NDIG = MAX(2,INT(MA%MP(2)))

      CALL IMI2FM(MA,MTLVFM)
      CALL FMM2QI(MTLVFM,IVAL)

      NDIG = NDSAVE
      RETURN
      END SUBROUTINE IMM2QI


   FUNCTION FM_QI(D)     RESULT (RETURN_VALUE)
      USE FMVALS
      IMPLICIT NONE
      TYPE (FM) :: RETURN_VALUE
      INTEGER (QUAD_INT) :: D
      INTENT (IN) :: D
      CALL FMQI2M(D,RETURN_VALUE%MFM)
   END FUNCTION FM_QI
```

```
FUNCTION FM_QI1(D)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   INTEGER (QUAD_INT), DIMENSION(:) :: D
   TYPE (FM), DIMENSION(SIZE(D)) :: RETURN_VALUE
   INTEGER :: J,N
   INTENT (IN) :: D
   N = SIZE(D)
   DO J = 1, N
      CALL FMQI2M(D(J),RETURN_VALUE(J)%MFM)
   ENDDO
END FUNCTION FM_QI1

FUNCTION FM_QI2(D)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   INTEGER (QUAD_INT), DIMENSION(:,:) :: D
   TYPE (FM), DIMENSION(SIZE(D,DIM=1),SIZE(D,DIM=2)) :: RETURN_VALUE
   INTEGER :: J,K
   INTENT (IN) :: D
   DO J = 1, SIZE(D,DIM=1)
      DO K = 1, SIZE(D,DIM=2)
         CALL FMQI2M(D(J,K),RETURN_VALUE(J,K)%MFM)
      ENDDO
   ENDDO
END FUNCTION FM_QI2

FUNCTION IM_QI(D)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM) :: RETURN_VALUE
   INTEGER (QUAD_INT) :: D
   INTENT (IN) :: D
   CALL IMQI2M(D,RETURN_VALUE%MIM)
END FUNCTION IM_QI

FUNCTION IM_QI1(D)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   INTEGER (QUAD_INT), DIMENSION(:) :: D
   TYPE (IM), DIMENSION(SIZE(D)) :: RETURN_VALUE
   INTEGER :: J,N
   INTENT (IN) :: D
   N = SIZE(D)
   DO J = 1, N
      CALL IMQI2M(D(J),RETURN_VALUE(J)%MIM)
   ENDDO
END FUNCTION IM_QI1

FUNCTION IM_QI2(D)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   INTEGER (QUAD_INT), DIMENSION(:,:) :: D
   TYPE (IM), DIMENSION(SIZE(D,DIM=1),SIZE(D,DIM=2)) :: RETURN_VALUE
   INTEGER :: J,K
   INTENT (IN) :: D
   DO J = 1, SIZE(D,DIM=1)
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```
      DO K = 1, SIZE(D,DIM=2)
         CALL IMQI2M(D(J,K),RETURN_VALUE(J,K)%MIM)
      ENDDO
   ENDDO
END FUNCTION IM_QI2

FUNCTION ZM_QI(D)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (ZM) :: RETURN_VALUE
   INTEGER (QUAD_INT) :: D
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVFM,MULVFM
   CALL FMQI2M(D,MTLVFM)
   CALL FMI2M(0,MULVFM)
   CALL ZMCMPX(MTLVFM,MULVFM,RETURN_VALUE%MZM)
END FUNCTION ZM_QI

FUNCTION ZM2_QI(D1,D2)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (ZM) :: RETURN_VALUE
   INTEGER (QUAD_INT) :: D1,D2
   INTENT (IN) :: D1,D2
   TYPE(MULTI), SAVE :: MTLVFM,MULVFM
   CALL FMQI2M(D1,MTLVFM)
   CALL FMQI2M(D2,MULVFM)
   CALL ZMCMPX(MTLVFM,MULVFM,RETURN_VALUE%MZM)
END FUNCTION ZM2_QI

FUNCTION ZM_QI1(D)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   INTEGER (QUAD_INT), DIMENSION(:) :: D
   TYPE (ZM), DIMENSION(SIZE(D)) :: RETURN_VALUE
   INTEGER :: J,N
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVFM,MULVFM
   N = SIZE(D)
   CALL FMI2M(0,MULVFM)
   DO J = 1, N
      CALL FMQI2M(D(J),MTLVFM)
      CALL ZMCMPX(MTLVFM,MULVFM,RETURN_VALUE(J)%MZM)
   ENDDO
END FUNCTION ZM_QI1

FUNCTION ZM_QI2(D)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   INTEGER (QUAD_INT), DIMENSION(:,:) :: D
   TYPE (ZM), DIMENSION(SIZE(D,DIM=1),SIZE(D,DIM=2)) :: RETURN_VALUE
   INTEGER :: J,K
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVFM,MULVFM
   CALL FMI2M(0,MULVFM)
   DO J = 1, SIZE(D,DIM=1)
      DO K = 1, SIZE(D,DIM=2)
         CALL FMQI2M(D(J,K),MTLVFM)
```

```
         CALL ZMCMPX(MTLVFM,MULVFM,RETURN_VALUE(J,K)%MZM)
      ENDDO
   ENDDO
END FUNCTION ZM_QI2

FUNCTION FM_2QI(MA)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM) :: MA
   INTEGER (QUAD_INT) :: RETURN_VALUE
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   CALL FMM2QI(MA%MFM,RETURN_VALUE)
END FUNCTION FM_2QI

FUNCTION IM_2QI(MA)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM) :: MA
   INTEGER (QUAD_INT) :: RETURN_VALUE
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   CALL IMM2QI(MA%MIM,RETURN_VALUE)
END FUNCTION IM_2QI

FUNCTION ZM_2QI(MA)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (ZM) :: MA
   INTEGER (QUAD_INT) :: RETURN_VALUE
   INTENT (IN) :: MA
   TYPE(MULTI), SAVE :: MTLVFM
   CALL FM_UNDEF_INP(MA)
   CALL ZMREAL(MA%MZM,MTLVFM)
   CALL FMM2QI(MTLVFM,RETURN_VALUE)
END FUNCTION ZM_2QI

FUNCTION FM_2QI1(MA)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM), DIMENSION(:) :: MA
   INTEGER (QUAD_INT), DIMENSION(SIZE(MA)) :: RETURN_VALUE
   INTEGER :: J,N
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   N = SIZE(MA)
   DO J = 1, N
      CALL FMM2QI(MA(J)%MFM,RETURN_VALUE(J))
   ENDDO
END FUNCTION FM_2QI1

FUNCTION IM_2QI1(MA)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM), DIMENSION(:) :: MA
   INTEGER (QUAD_INT), DIMENSION(SIZE(MA)) :: RETURN_VALUE
   INTEGER :: J,N
   INTENT (IN) :: MA
```

```
   CALL FM_UNDEF_INP(MA)
   N = SIZE(MA)
   DO J = 1, N
      CALL IMM2QI(MA(J)%MIM,RETURN_VALUE(J))
   ENDDO
END FUNCTION IM_2QI1

FUNCTION ZM_2QI1(MA)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (ZM), DIMENSION(:) :: MA
   INTEGER (QUAD_INT), DIMENSION(SIZE(MA)) :: RETURN_VALUE
   INTEGER :: J,N
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   N = SIZE(MA)
   DO J = 1, N
      CALL FMM2QI(MA(J)%MZM(1),RETURN_VALUE(J))
   ENDDO
END FUNCTION ZM_2QI1

FUNCTION FM_2QI2(MA)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM), DIMENSION(:,:) :: MA
   INTEGER (QUAD_INT), DIMENSION(SIZE(MA,DIM=1),SIZE(MA,DIM=2)) :: RETURN_VALUE
   INTEGER :: J,K
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   DO J = 1, SIZE(MA,DIM=1)
      DO K = 1, SIZE(MA,DIM=2)
         CALL FMM2QI(MA(J,K)%MFM,RETURN_VALUE(J,K))
      ENDDO
   ENDDO
END FUNCTION FM_2QI2

FUNCTION IM_2QI2(MA)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM), DIMENSION(:,:) :: MA
   INTEGER (QUAD_INT), DIMENSION(SIZE(MA,DIM=1),SIZE(MA,DIM=2)) :: RETURN_VALUE
   INTEGER :: J,K
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   DO J = 1, SIZE(MA,DIM=1)
      DO K = 1, SIZE(MA,DIM=2)
         CALL IMM2QI(MA(J,K)%MIM,RETURN_VALUE(J,K))
      ENDDO
   ENDDO
END FUNCTION IM_2QI2

FUNCTION ZM_2QI2(MA)     RESULT (RETURN_VALUE)
   USE FMVALS
   IMPLICIT NONE
   TYPE (ZM), DIMENSION(:,:) :: MA
   INTEGER (QUAD_INT), DIMENSION(SIZE(MA,DIM=1),SIZE(MA,DIM=2)) :: RETURN_VALUE
   INTEGER :: J,K
   INTENT (IN) :: MA
```

```
   CALL FM_UNDEF_INP(MA)
   DO J = 1, SIZE(MA,DIM=1)
      DO K = 1, SIZE(MA,DIM=2)
         CALL FMM2QI(MA(J,K)%MZM(1),RETURN_VALUE(J,K))
      ENDDO
   ENDDO
END FUNCTION ZM_2QI2


SUBROUTINE FMEQ_QIFM(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM) :: MA
   INTEGER (QUAD_INT) :: D
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   CALL FMM2QI(MA%MFM,D)
END SUBROUTINE FMEQ_QIFM

SUBROUTINE FMEQ_QIIM(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM) :: MA
   INTEGER (QUAD_INT) :: D
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   CALL IMM2QI(MA%MIM,D)
END SUBROUTINE FMEQ_QIIM

SUBROUTINE FMEQ_QIZM(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (ZM) :: MA
   INTEGER (QUAD_INT) :: D
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   TYPE(MULTI), SAVE :: MTLVFM
   CALL FM_UNDEF_INP(MA)
   CALL ZMREAL(MA%MZM,MTLVFM)
   CALL FMM2QI(MTLVFM,D)
END SUBROUTINE FMEQ_QIZM

SUBROUTINE FMEQ_FMQI(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM) :: MA
   INTEGER (QUAD_INT) :: D
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   CALL FMQI2M(D,MA%MFM)
END SUBROUTINE FMEQ_FMQI

SUBROUTINE FMEQ_IMQI(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM) :: MA
```

```
   INTEGER :: IVAL
   INTEGER (QUAD_INT) :: D
   CHARACTER(50) :: ST
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   IF (ABS(D) < HUGE(1)) THEN
       IVAL = INT(D)
       CALL IMI2M(IVAL,MA%MIM)
   ELSE
       WRITE (ST,'(I50)') D
       CALL IMST2M(ST,MA%MIM)
   ENDIF
END SUBROUTINE FMEQ_IMQI

SUBROUTINE FMEQ_ZMQI(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (ZM) :: MA
   INTEGER (QUAD_INT) :: D
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVFM,MULVFM
   CALL FMQI2M(D,MTLVFM)
   CALL FMI2M(0,MULVFM)
   CALL ZMCMPX(MTLVFM,MULVFM,MA%MZM)
END SUBROUTINE FMEQ_ZMQI

SUBROUTINE FMEQ_FM1QI(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM), DIMENSION(:) :: MA
   INTEGER :: J,N
   INTEGER (QUAD_INT) :: D
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVFM
   N = SIZE(MA)
   CALL FMQI2M(D,MTLVFM)
   DO J = 1, N
      CALL FMEQ(MTLVFM,MA(J)%MFM)
   ENDDO
END SUBROUTINE FMEQ_FM1QI

SUBROUTINE FMEQ_QI1FM(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM) :: MA
   INTEGER (QUAD_INT), DIMENSION(:) :: D
   INTEGER (QUAD_INT) :: D2
   INTEGER :: J,N
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   N = SIZE(D)
   CALL FMM2QI(MA%MFM,D2)
   DO J = 1, N
      D(J) = D2
   ENDDO
```

```
END SUBROUTINE FMEQ_QI1FM

SUBROUTINE FMEQ_FM1QI1(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM), DIMENSION(:) :: MA
   INTEGER :: J,N
   INTEGER (QUAD_INT), DIMENSION(:) :: D
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVFM
   IF (SIZE(MA) /= SIZE(D)) THEN
       CALL FMST2M(' UNKNOWN ',MTLVFM)
       DO J = 1, SIZE(MA)
          CALL FMEQ(MTLVFM,MA(J)%MFM)
       ENDDO
       RETURN
   ENDIF
   N = SIZE(MA)
   DO J = 1, N
      CALL FMQI2M(D(J),MA(J)%MFM)
   ENDDO
END SUBROUTINE FMEQ_FM1QI1

SUBROUTINE FMEQ_QI1FM1(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM), DIMENSION(:) :: MA
   INTEGER (QUAD_INT), DIMENSION(:) :: D
   INTEGER :: J,N
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   IF (SIZE(MA) /= SIZE(D)) THEN
       DO J = 1, SIZE(D)
          D(J) = RUNKNO
       ENDDO
       RETURN
   ENDIF
   N = SIZE(D)
   DO J = 1, N
      CALL FMM2QI(MA(J)%MFM,D(J))
   ENDDO
END SUBROUTINE FMEQ_QI1FM1

SUBROUTINE FMEQ_FM2QI(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM), DIMENSION(:,:) :: MA
   INTEGER :: J,K
   INTEGER (QUAD_INT) :: D
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVFM
   CALL FMQI2M(D,MTLVFM)
   DO J = 1, SIZE(MA,DIM=1)
      DO K = 1, SIZE(MA,DIM=2)
         CALL FMEQ(MTLVFM,MA(J,K)%MFM)
```

```
      ENDDO
   ENDDO
END SUBROUTINE FMEQ_FM2QI

SUBROUTINE FMEQ_QI2FM(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM) :: MA
   INTEGER (QUAD_INT), DIMENSION(:,:) :: D
   INTEGER (QUAD_INT) :: D2
   INTEGER :: J,K
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   CALL FMM2QI(MA%MFM,D2)
   DO J = 1, SIZE(D,DIM=1)
      DO K = 1, SIZE(D,DIM=2)
         D(J,K) = D2
      ENDDO
   ENDDO
END SUBROUTINE FMEQ_QI2FM

SUBROUTINE FMEQ_FM2QI2(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM), DIMENSION(:,:) :: MA
   INTEGER :: J,K
   INTEGER (QUAD_INT), DIMENSION(:,:) :: D
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVFM
   IF (SIZE(MA,DIM=1) /= SIZE(D,DIM=1) .OR. SIZE(MA,DIM=2) /= SIZE(D,DIM=2)) THEN
       CALL FMST2M(' UNKNOWN ',MTLVFM)
       DO J = 1, SIZE(MA,DIM=1)
          DO K = 1, SIZE(MA,DIM=2)
             CALL FMEQ(MTLVFM,MA(J,K)%MFM)
          ENDDO
       ENDDO
       RETURN
   ENDIF
   DO J = 1, SIZE(MA,DIM=1)
      DO K = 1, SIZE(MA,DIM=2)
         CALL FMQI2M(D(J,K),MA(J,K)%MFM)
      ENDDO
   ENDDO
END SUBROUTINE FMEQ_FM2QI2

SUBROUTINE FMEQ_QI2FM2(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (FM), DIMENSION(:,:) :: MA
   INTEGER (QUAD_INT), DIMENSION(:,:) :: D
   INTEGER :: J,K
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   IF (SIZE(MA,DIM=1) /= SIZE(D,DIM=1) .OR. SIZE(MA,DIM=2) /= SIZE(D,DIM=2)) THEN
       DO J = 1, SIZE(D,DIM=1)
```

```
         DO K = 1, SIZE(D,DIM=2)
            D(J,K) = RUNKNO
         ENDDO
      ENDDO
      RETURN
   ENDIF
   DO J = 1, SIZE(MA,DIM=1)
      DO K = 1, SIZE(MA,DIM=2)
         CALL FMM2QI(MA(J,K)%MFM,D(J,K))
      ENDDO
   ENDDO
END SUBROUTINE FMEQ_QI2FM2

SUBROUTINE FMEQ_IM1QI(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM), DIMENSION(:) :: MA
   INTEGER :: J,N
   INTEGER (QUAD_INT) :: D
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVIM
   N = SIZE(MA)
   CALL IMQI2M(D,MTLVIM)
   DO J = 1, N
      CALL IMEQ(MTLVIM,MA(J)%MIM)
   ENDDO
END SUBROUTINE FMEQ_IM1QI

SUBROUTINE FMEQ_QI1IM(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM) :: MA
   INTEGER (QUAD_INT), DIMENSION(:) :: D
   INTEGER (QUAD_INT) :: D2
   INTEGER :: J,N
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   N = SIZE(D)
   CALL IMM2QI(MA%MIM,D2)
   DO J = 1, N
      D(J) = D2
   ENDDO
END SUBROUTINE FMEQ_QI1IM

SUBROUTINE FMEQ_IM1QI1(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM), DIMENSION(:) :: MA
   INTEGER :: J,N
   INTEGER (QUAD_INT), DIMENSION(:) :: D
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVIM
   IF (SIZE(MA) /= SIZE(D)) THEN
      CALL IMST2M(' UNKNOWN ',MTLVIM)
      DO J = 1, SIZE(MA)
```

```
         CALL IMEQ(MTLVIM,MA(J)%MIM)
       ENDDO
       RETURN
   ENDIF
   N = SIZE(MA)
   DO J = 1, N
      CALL IMQI2M(D(J),MA(J)%MIM)
   ENDDO
END SUBROUTINE FMEQ_IM1QI1

SUBROUTINE FMEQ_QI1IM1(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM), DIMENSION(:) :: MA
   INTEGER (QUAD_INT), DIMENSION(:) :: D
   INTEGER :: J,N
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
   IF (SIZE(MA) /= SIZE(D)) THEN
       DO J = 1, SIZE(MA)
          D(J) = RUNKNO
       ENDDO
       RETURN
   ENDIF
   N = SIZE(D)
   DO J = 1, N
      CALL IMM2QI(MA(J)%MIM,D(J))
   ENDDO
END SUBROUTINE FMEQ_QI1IM1

SUBROUTINE FMEQ_IM2QI(MA,D)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM), DIMENSION(:,:) :: MA
   INTEGER :: J,K
   INTEGER (QUAD_INT) :: D
   INTENT (INOUT) :: MA
   INTENT (IN) :: D
   TYPE(MULTI), SAVE :: MTLVIM
   CALL IMQI2M(D,MTLVIM)
   DO J = 1, SIZE(MA,DIM=1)
      DO K = 1, SIZE(MA,DIM=2)
         CALL IMEQ(MTLVIM,MA(J,K)%MIM)
      ENDDO
   ENDDO
END SUBROUTINE FMEQ_IM2QI

SUBROUTINE FMEQ_QI2IM(D,MA)
   USE FMVALS
   IMPLICIT NONE
   TYPE (IM) :: MA
   INTEGER (QUAD_INT), DIMENSION(:,:) :: D
   INTEGER (QUAD_INT) :: D2
   INTEGER :: J,K
   INTENT (INOUT) :: D
   INTENT (IN) :: MA
   CALL FM_UNDEF_INP(MA)
```