```
!  This is a test program for the FM 1.4 multiple-precision rational arithmetic package.

!  All of the rational arithmetic routines are tested.

!  If all tests are completed successfully, this line is printed:

!  499 cases tested.  No errors were found.

   module sum_r

   interface sum_rat
      module procedure sum0
      module procedure sum1
      module procedure sum2
   end interface

   contains

      function sum0(a, b)     result (return_value)

!  Function that returns a rational result.

      use fm_rational_arithmetic
      implicit none
      type (fm_rational) :: a, b, return_value
      intent (in) :: a, b
      return_value = a + b
      end function sum0

      function sum1(a, b)     result (return_value)

!  Function that returns a rational vector result.

      use fm_rational_arithmetic
      implicit none
      type (fm_rational) :: a(3), b(3), return_value(3)
      intent (in) :: a, b
      integer :: j
      do j = 1, 3
         return_value(j) = a(j) + b(j)
      enddo
      end function sum1

      function sum2(a, b)     result (return_value)

!  Function that returns a rational matrix result.

      use fm_rational_arithmetic
      implicit none
      type (fm_rational) :: a(3, 3), b(3, 3), return_value(3, 3)
      intent (in) :: a, b
      integer :: j, k
      do j = 1, 3
         do k = 1, 3
            return_value(j, k) = a(j, k) + b(j, k)
         enddo
      enddo
```

```
      end function sum2

   end module sum_r

   module test_rational

      use fmvals
      use fmzm
      use fm_rational_arithmetic

      type (fm_rational), save ::  a, b, c, d, result, correct,         &
                           avec(3),    bvec(3),    cvec(3),    dvec(3),  &
                           amat(3, 3), bmat(3, 3), cmat(3, 3), dmat(3, 3)

!             Declare the derived type variables of type (fm), (im).
!             These are in the form that would be found in a user program.

      type (fm), save :: mfm1, mfm2, mfmvec(3), mfmmat(3, 3)
      type (im), save :: mim1, mim2, mim3, mimvec(3), mimmat(3, 3), amat_im(3, 6)

!             These are the variables that are not multiple precision.

      integer, save :: j1, jv(3), jv2(3, 3)
      real, save :: r1, rsmall, rv(3), rv2(3, 3)
      double precision, save :: d1, dsmall, dv(3), dv2(3, 3)
      complex, save :: c1, cv(3), cv2(3, 3)
      complex (kind(0.0d0)), save :: cd1, cdv(3), cdv2(3, 3)

      character(100), save :: st1, st2, stv2(3, 3)
      integer, save :: klog, kwsave, ml(2), ncase, nerror
      real, save :: time1, time2
      logical, external :: imcompare

      contains

      subroutine test1
      implicit none
      integer :: j, k

      write (kw, "(/' Testing input and output conversion for rationals.')")
      kwsave = kw

!             ncase is the number of cases tested.

      ncase = 1
      result = to_fm_rational( 2, 3 )
      correct = 0
      write (klog,*) ' '
      write (klog, "(a, i6)") ' ncase = ', ncase
      write (klog,*) ' to_fm_rational( 2, 3 ) '
      kw = klog
      call fm_print_rational(result)
      kw = kwsave
      write (klog,*) ' '
      mim1 = 2
      call imeq(mim1%mim, correct%numerator)
      mim1 = 3
      call imeq(mim1%mim, correct%denominator)
```

```
!             Use the .not. because fmcompare returns false for special cases like md = unknown,
!             and these should be treated as errors for these tests.

      if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
          call errprtrm(' to_fm_rational')
      endif

      ncase = 2
      result = to_fm_rational( -2, 3 )
      write (klog,*) ' '
      write (klog, "(a, i6)") ' ncase = ', ncase
      write (klog,*) ' to_fm_rational( -2, 3 ) '
      kw = klog
      call fm_print_rational(result)
      kw = kwsave
      write (klog,*) ' '
      mim1 = -2
      call imeq(mim1%mim, correct%numerator)
      mim1 = 3
      call imeq(mim1%mim, correct%denominator)
      if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
          call errprtrm(' to_fm_rational')
      endif

      ncase = 3
      result = to_fm_rational( 2, -3 )
      write (klog,*) ' '
      write (klog, "(a, i6)") ' ncase = ', ncase
      write (klog,*) ' to_fm_rational( 2, -3 ) '
      kw = klog
      call fm_print_rational(result)
      kw = kwsave
      write (klog,*) ' '
      mim1 = -2
      call imeq(mim1%mim, correct%numerator)
      mim1 = 3
      call imeq(mim1%mim, correct%denominator)
      if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
          call errprtrm(' to_fm_rational')
      endif

      ncase = 4
      result = to_fm_rational( -2, -3 )
      write (klog,*) ' '
      write (klog, "(a, i6)") ' ncase = ', ncase
      write (klog,*) ' to_fm_rational( -2, -3 ) '
      kw = klog
      call fm_print_rational(result)
      kw = kwsave
      write (klog,*) ' '
      mim1 = 2
      call imeq(mim1%mim, correct%numerator)
      mim1 = 3
      call imeq(mim1%mim, correct%denominator)
```

```
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' to_fm_rational')
endif

ncase = 5
result = to_fm_rational( 12, 36 )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) ' to_fm_rational( 12, 36 ) '
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
mim1 = 1
call imeq(mim1%mim, correct%numerator)
mim1 = 3
call imeq(mim1%mim, correct%denominator)
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' to_fm_rational')
endif

ncase = 6
result = to_fm_rational( 84, 36 )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) ' to_fm_rational( 84, 36 ) '
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( 7, 3 )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' to_fm_rational')
endif

ncase = 7
result = to_fm_rational( to_im('3141592653589776'), to_im('271828182829') )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " to_fm_rational( to_im('3141592653589776'), to_im('271828182829') ) "
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('101341698502896'), to_im('8768651059') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' to_fm_rational')
endif

ncase = 8
a = to_fm_rational( to_im('3141592653589776'), to_im('271828182829') )
result = a
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
```

```
write (klog,*) " result = a "
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('1013416985028896'), to_im('8768651059') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' = assignment')
endif

ncase = 9
a = to_fm_rational( '3141592653589776' ) / to_im('271828182829')
result = a
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a = to_fm_rational( '3141592653589776' ) / to_im('271828182829') "
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('1013416985028896'), to_im('8768651059') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' = assignment')
endif

ncase = 10
a = to_fm_rational( '3141592653589776 / 271828182829' )
result = a
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a = to_fm_rational( '3141592653589776 / 271828182829' ) "
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('1013416985028896'), to_im('8768651059') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' = assignment')
endif

ncase = 11
a = to_fm_rational( '3141592653589776', '271828182829' )
result = a
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a = to_fm_rational( '3141592653589776', '271828182829' ) "
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('1013416985028896'), to_im('8768651059') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' = assignment')
endif
```

```
ncase = 12
result = 314159
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = 314159 "
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('314159'), to_im('1') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' = assignment')
endif

ncase = 13
result = -314159
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = -314159 "
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('-314159'), to_im('1') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' = assignment')
endif

ncase = 14
result = to_im('3141592653589793')
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = to_im('3141592653589793') "
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('3141592653589793'), to_im('1') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' = assignment')
endif

ncase = 15
result = to_im('-3141592653589793')
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = to_im('-3141592653589793') "
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('-3141592653589793'), to_im('1') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
```

```
    call errprtrm(' = assignment')
endif

ncase = 16
result = to_fm_rational( 31, 47 )
mim1 = rational_numerator( result )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " mim1 = rational_numerator( result ) "
kw = klog
call im_print(mim1)
kw = kwsave
write (klog,*) ' '
mim2 = 31
if ( (.not. imcompare(mim1%mim, '==', mim2%mim)) ) then
    call errprtrm(' = assignment')
endif

ncase = 17
result = to_fm_rational( 31, 47 )
mim1 = rational_denominator( to_fm_rational( 31, 47 ) )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " mim1 = rational_denominator( to_fm_rational( 31, 47 ) ) "
kw = klog
call im_print(mim1)
kw = kwsave
write (klog,*) ' '
mim2 = 47
if ( (.not. imcompare(mim1%mim, '==', mim2%mim)) ) then
    call errprtrm(' = assignment')
endif

ncase = 18
avec = 31
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = 31"
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
   write (klog,*) ' '
   correct = to_fm_rational( 31 )
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 19
avec = to_fm_rational( to_im('101341698502896'), to_im('8768651059') )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = to_fm_rational( to_im('101341698502896'), to_im('8768651059') )"
do j = 1, 3
   kw = klog
```

```
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
   write (klog,*) ' '
   correct = to_fm_rational( to_im('101341698502896'), to_im('8768651059') )
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 20
avec = to_im('101341698502896')
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = to_im('101341698502896')"
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
   write (klog,*) ' '
   correct = to_im('101341698502896')
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 21
jv(1:3) = (/ 31, -41, 59 /)
avec = (/ 31, -41, 59 /)
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = (/ 31, -41, 59 /)"
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
   write (klog,*) ' '
   correct = to_fm_rational( jv(j) )
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 22
jv(1:3) = (/ 31, -41, 59 /)
avec = to_fm_rational( (/ 31, -41, 59 /) )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = to_fm_rational( (/ 31, -41, 59 /) )"
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
```

```
   kw = kwsave
   write (klog,*) ' '
   correct = to_fm_rational( jv(j) )
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 23
jv(1:3) = (/ 31, -41, 59 /)
avec = jv
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = jv(1:3)"
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
   write (klog,*) ' '
   correct = to_fm_rational( jv(j) )
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 24
mimvec(1:3) = (/ 31, -41, 59 /)
avec = to_fm_rational( to_im( (/ 31, -41, 59 /) ) )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = to_im( (/ 31, -41, 59 /) )"
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
   write (klog,*) ' '
   correct = to_fm_rational( mimvec(j) )
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 25
mimvec(1:3) = (/ 31, -41, 59 /)
avec = to_im( (/ 31, -41, 59 /) )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = to_im( (/ 31, -41, 59 /) )"
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
```

```
   write (klog,*) ' '
   correct = to_fm_rational( mimvec(j) )
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 26
mimvec(1:3) = (/ 31, -41, 59 /)
avec = mimvec
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = mimvec(1:3)"
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
   write (klog,*) ' '
   correct = to_fm_rational( mimvec(j) )
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 27
bvec(1:3) = (/ to_fm_rational( to_im('101341698502896'), to_im('8768651059') ),  &
               to_fm_rational( -41, 43 ),                                        &
               to_fm_rational( 314, 159 )   /)
avec = (/ to_fm_rational( to_im('101341698502896'), to_im('8768651059') ),  &
               to_fm_rational( -41, 43 ),                                  &
               to_fm_rational( 314, 159 )   /)
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = (/ to_fm_rational( to_im('101341698502896'), ..."
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
   write (klog,*) ' '
   correct = bvec(j)
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 28
bvec(1:3) = (/ to_fm_rational( to_im('101341698502896'), to_im('8768651059') ),  &
               to_fm_rational( -41, 43 ),                                        &
               to_fm_rational( 314, 159 )   /)
avec = bvec
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " avec = bvec"
```

```
do j = 1, 3
   kw = klog
   write (klog, "(a, i1, a)") " avec(", j, ") = "
   call fm_print_rational(avec(j))
   kw = kwsave
   write (klog,*) ' '
   correct = bvec(j)
   if ( (.not. imcompare(avec(j)%numerator, '==', correct%numerator)) .or.  &
        (.not. imcompare(avec(j)%denominator, '==', correct%denominator)) ) then
       call errprtrm(' = assignment')
   endif
enddo

ncase = 29
jv2 = 314
amat = 314
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " amat = 314"
do j = 1, 3
   do k = 1, 3
      kw = klog
      write (klog, "(a, i1, a, i1, a)") " amat(", j, ", ", k, ") = "
      call fm_print_rational(amat(j, k))
      kw = kwsave
      write (klog,*) ' '
      correct = to_fm_rational( jv2(j, k) )
      if ( (.not. imcompare(amat(j, k)%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(amat(j, k)%denominator, '==', correct%denominator)) ) then
          call errprtrm(' = assignment')
      endif
   enddo
enddo

ncase = 30
jv2(1, 1:3) = (/ 1, 2, 3 /)
jv2(2, 1:3) = (/ 4, 5, 6 /)
jv2(3, 1:3) = (/ 7, 8, 9 /)
amat = reshape(  (/ 1, 4, 7,    &
                    2, 5, 8,    &
                    3, 6, 9 /)  &
     , (/ 3, 3 /)  )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " amat = reshape(  (/ 1, 4, 7, ..."
do j = 1, 3
   do k = 1, 3
      kw = klog
      write (klog, "(a, i1, a, i1, a)") " amat(", j, ", ", k, ") = "
      call fm_print_rational(amat(j, k))
      kw = kwsave
      write (klog,*) ' '
      correct = to_fm_rational( jv2(j, k) )
      if ( (.not. imcompare(amat(j, k)%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(amat(j, k)%denominator, '==', correct%denominator)) ) then
          call errprtrm(' = assignment')
      endif
   enddo
```

```
enddo

ncase = 31
mimmat = 159
amat = to_im( 159 )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " amat = to_im( 159 )"
do j = 1, 3
   do k = 1, 3
      kw = klog
      write (klog, "(a, i1, a, i1, a)") " amat(", j, ", ", k, ") = "
      call fm_print_rational(amat(j, k))
      kw = kwsave
      write (klog,*) ' '
      correct = to_fm_rational( mimmat(j, k) )
      if ( (.not. imcompare(amat(j, k)%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(amat(j, k)%denominator, '==', correct%denominator)) ) then
          call errprtrm(' = assignment')
      endif
   enddo
enddo

ncase = 32
mimmat(1, 1:3) = (/ 1, 2, 3 /)
mimmat(2, 1:3) = (/ 4, 5, 6 /)
mimmat(3, 1:3) = (/ 7, 8, 9 /)
amat = to_im(  reshape(  (/ 1, 4, 7,    &
                            2, 5, 8,    &
                            3, 6, 9 /)  &
             , (/ 3, 3 /)  )            &
            )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " amat = to_im(  reshape(  (/ 1, 4, 7, ..."
do j = 1, 3
   do k = 1, 3
      kw = klog
      write (klog, "(a, i1, a, i1, a)") " amat(", j, ", ", k, ") = "
      call fm_print_rational(amat(j, k))
      kw = kwsave
      write (klog,*) ' '
      correct = to_fm_rational( mimmat(j, k) )
      if ( (.not. imcompare(amat(j, k)%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(amat(j, k)%denominator, '==', correct%denominator)) ) then
          call errprtrm(' = assignment')
      endif
   enddo
enddo

ncase = 33
mimmat(1, 1:3) = (/ 1, 2, 3 /)
mimmat(2, 1:3) = (/ 4, 5, 6 /)
mimmat(3, 1:3) = (/ 7, 8, 9 /)
amat = to_fm_rational( to_im(  reshape(  (/ 1, 4, 7,    &
                                           2, 5, 8,    &
                                           3, 6, 9 /)  &
                             , (/ 3, 3 /)  )           &
```

```
                    ) )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " amat = to_im(  reshape(  (/ 1, 4, 7, ..."
do j = 1, 3
   do k = 1, 3
      kw = klog
      write (klog, "(a, i1, a, i1, a)") " amat(", j, ", ", k, ") = "
      call fm_print_rational(amat(j, k))
      kw = kwsave
      write (klog,*) ' '
      correct = to_fm_rational( mimmat(j, k) )
      if ( (.not. imcompare(amat(j, k)%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(amat(j, k)%denominator, '==', correct%denominator)) ) then
          call errprtrm(' = assignment')
      endif
   enddo
enddo

ncase = 34
a = to_fm_rational( -314, 159 )
amat = to_fm_rational( -314, 159 )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " amat = to_fm_rational( -314, 159 )"
do j = 1, 3
   do k = 1, 3
      kw = klog
      write (klog, "(a, i1, a, i1, a)") " amat(", j, ", ", k, ") = "
      call fm_print_rational(amat(j, k))
      kw = kwsave
      write (klog,*) ' '
      correct = a
      if ( (.not. imcompare(amat(j, k)%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(amat(j, k)%denominator, '==', correct%denominator)) ) then
          call errprtrm(' = assignment')
      endif
   enddo
enddo

ncase = 35
bmat(1, 1:3) = (/ 1, 2, 3 /)
bmat(2, 1:3) = (/ 4, 5, 6 /)
bmat(3, 1:3) = (/ 7, 8, 9 /)
amat = to_fm_rational(  reshape(  (/ 1, 4, 7,    &
                                     2, 5, 8,    &
                                     3, 6, 9 /)  &
                      , (/ 3, 3 /)  )            &
                     )
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " amat = to_fm_rational(  reshape(  (/ 1, 4, 7, ..."
do j = 1, 3
   do k = 1, 3
      kw = klog
      write (klog, "(a, i1, a, i1, a)") " amat(", j, ", ", k, ") = "
      call fm_print_rational(amat(j, k))
      kw = kwsave
```

```
      write (klog,*) ' '
      correct = bmat(j, k)
      if ( (.not. imcompare(amat(j, k)%numerator, '==', correct%numerator)) .or.  &
           (.not. imcompare(amat(j, k)%denominator, '==', correct%denominator)) ) then
          call errprtrm(' = assignment')
      endif
   enddo
enddo

return
end subroutine test1



subroutine test2
implicit none
integer :: k

write (kw, "(/' Testing addition of rationals.')")



ncase = 36
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = +to_fm_rational(7, 9) "
result = +to_fm_rational(7, 9)
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('7'), to_im('9') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 37
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a + b   (= to_fm_rational(5, 6) + to_fm_rational(7, 9) ) "
a = to_fm_rational(5, 6)
b = to_fm_rational(7, 9)
result = a + b
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('29'), to_im('18') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 38
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = to_fm_rational(5, 6) + to_fm_rational(7, 9) "
```

```
result = to_fm_rational(5, 6) + to_fm_rational(7, 9)
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('29'), to_im('18') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 39
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = to_fm_rational(-5, 6) + to_fm_rational(7, 9) "
result = to_fm_rational(-5, 6) + to_fm_rational(7, 9)
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational( to_im('-1'), to_im('18') )
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 40
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = to_fm_rational(to_im('55555555555555555555555555123'), "
write (klog,*) "                         to_im('28933333333333333213632'))       + "
write (klog,*) "          to_fm_rational(to_im('44444444444444444444444444789'), "
write (klog,*) "                         to_im('37199999999999999999632464')) "
result = to_fm_rational(to_im('55555555555555555555555555123'),          &
                        to_im('28933333333333333213632'))         +     &
         to_fm_rational(to_im('44444444444444444444444444789'),          &
                        to_im('37199999999999999999632464'))
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('491769547325102880600777774396471193415637860346O5'),  &
                         to_im('24111111111111111098753822222222222232077632'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 41
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a + k  ( = to_fm_rational(51234, 62345) + 3141) "
a = to_fm_rational(51234, 62345)
k = 3141
result = a + k
kw = klog
call fm_print_rational(result)
kw = kwsave
```

```
write (klog,*) ' '
correct = to_fm_rational(to_im('195876879'),  &
                         to_im('62345'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 42
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a + k  ( =  "
write (klog,*) "          to_fm_rational(to_im('8917602794770965746052376207314'), "
write (klog,*) "                         to_im('667842001245372344865067761168 3')) + 41 "
a = to_fm_rational(to_im('8917602794770965746052376207314'),  &
                   to_im('667842001245372344865067761168 3'))
k = 41
result = a + k
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('9424427443512454238024338609543 9'),  &
                         to_im('22261400041512411495502258705 61'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 43
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a + k  ( =  "
write (klog,*) "          to_fm_rational(to_im('-8917602794770965746052376207314'), "
write (klog,*) "                         to_im('667842001245372344865067761168 3')) + 41 "
a = to_fm_rational(to_im('-8917602794770965746052376207314'),  &
                   to_im('667842001245372344865067761168 3'))
k = 41
result = a + k
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('8829920590527723188287513529056 3'),  &
                         to_im('22261400041512411495502258705 61'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 44
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a + k  ( =  "
write (klog,*) "          to_fm_rational(to_im('-8917602794770965746052376207314'), "
write (klog,*) "                         to_im('667842001245372344865067761168 3')) - 41 "
a = to_fm_rational(to_im('-8917602794770965746052376207314'),  &
                   to_im('667842001245372344865067761168 3'))
```

```
k = -41
result = a + k
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('-942442744351245423802433860954 39'),  &
                         to_im('22261400041512411495502258705 61'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 45
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = k + a  ( = 3141 + to_fm_rational(51234, 62345) ) "
a = to_fm_rational(51234, 62345)
k = 3141
result = k + a
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('195876879'),  &
                         to_im('62345'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 46
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = k + a  ( = 41 + "
write (klog,*) "          to_fm_rational(to_im('8917602794770965746052376207314'), "
write (klog,*) "                         to_im('667842001245372344865067761 1683')) "
a = to_fm_rational(to_im('8917602794770965746052376207314'),  &
                   to_im('667842001245372344865067761 1683'))
k = 41
result = k + a
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('942442744351245423802433860954 39'),  &
                         to_im('22261400041512411495502258705 61'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 47
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = k + a  ( = 41 + "
write (klog,*) "          to_fm_rational(to_im('-8917602794770965746052376207314'), "
write (klog,*) "                         to_im('667842001245372344865067761 1683'))  "
```

```
a = to_fm_rational(to_im('-8917602794770965746052376207314'),  &
                   to_im('667842001245372344865067761168 3'))
k = 41
result = k + a
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('882992059052772318828751352905 63'),  &
                         to_im('22261400041512411495502258705 61'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 48
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = k + a  ( = -41 + "
write (klog,*) "          to_fm_rational(to_im('-8917602794770965746052376207314'), "
write (klog,*) "                         to_im('667842001245372344865067761168 3'))  "
a = to_fm_rational(to_im('-8917602794770965746052376207314'),  &
                   to_im('667842001245372344865067761168 3'))
k = -41
result = k + a
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('-94244274435124542380243386095439'),  &
                         to_im('22261400041512411495502258705 61'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 49
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = mim1 + a  ( = 314159 + to_fm_rational(7654321, 8234567) ) "
a = to_fm_rational(7654321, 8234567)
mim1 = 314159
result = mim1 + a
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('2586970988474'),  &
                         to_im('8234567'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 50
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = mim1 + a  ( = to_im('26512976791589443022171590148 8988') + "
```

```
write (klog,*) "          to_fm_rational(to_im('61260361136430393310447233718951 2'), "
write (klog,*) "                         to_im('878773830101413992948550377979617')) "
a = to_fm_rational(to_im('61260361136430393310447233718951 2'),  &
                   to_im('878773830101413992948550377979617'))
mim1 = to_im('265129767915894430221715901488988')
result = mim1 + a
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(                                                                  &
             to_im('776630338751165115784927826376669162610006491396033998299170490 36'),  &
             to_im('29292461003380466431616345932653 9'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 51
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = mim1 + a  ( = to_im('265129767915894430221715901488988') + "
write (klog,*) "          to_fm_rational(to_im('-61260361136430393310447233718951 2'), "
write (klog,*) "                         to_im('878773830101413992948550377979617')) "
a = to_fm_rational(to_im('-61260361136430393310447233718951 2'),  &
                   to_im('878773830101413992948550377979617'))
mim1 = to_im('265129767915894430221715901488988')
result = mim1 + a
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(                                                                  &
             to_im('776630338751165115784927826376665078585930729369813301816922560 28'),  &
             to_im('29292461003380466431616345932653 9'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 52
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = mim1 + a  ( = to_im('-265129767915894430221715901488988') + "
write (klog,*) "          to_fm_rational(to_im('-61260361136430393310447233718951 2'), "
write (klog,*) "                         to_im('878773830101413992948550377979617')) "
a = to_fm_rational(to_im('-61260361136430393310447233718951 2'),  &
                   to_im('878773830101413992948550377979617'))
mim1 = to_im('-265129767915894430221715901488988')
result = mim1 + a
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(                                                                   &
             to_im('-776630338751165115784927826376669162610006491396033998299170490 36'),  &
             to_im('29292461003380466431616345932653 9'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
```

```
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 53
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a + mim1  ( = to_fm_rational(7654321, 8234567) + 314159 ) "
a = to_fm_rational(7654321, 8234567)
mim1 = 314159
result = a + mim1
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(to_im('2586970988474'),  &
                         to_im('8234567'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 54
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a + mim1  ( =  "
write (klog,*) "          to_fm_rational(to_im('61260361136430393310447233718951 2'), "
write (klog,*) "                         to_im('8787738301014139929485503779796 17')) +  "
write (klog,*) "          to_im('2651297679158944302217159014889 88')  "

a = to_fm_rational(to_im('61260361136430393310447233718951 2'),  &
                   to_im('8787738301014139929485503779796 17'))
mim1 = to_im('2651297679158944302217159014889 88')
result = a + mim1
kw = klog
call fm_print_rational(result)
kw = kwsave
write (klog,*) ' '
correct = to_fm_rational(                                                                  &
             to_im('7766303387511651157849278263766691626100064913960339982991704 9036'),  &
             to_im('2929246100338046643161834593265 39'))
if ( (.not. imcompare(result%numerator, '==', correct%numerator)) .or.  &
     (.not. imcompare(result%denominator, '==', correct%denominator)) ) then
    call errprtrm(' addition of rationals')
endif

ncase = 55
write (klog,*) ' '
write (klog, "(a, i6)") ' ncase = ', ncase
write (klog,*) " result = a + mim1  ( =  "
write (klog,*) "          to_fm_rational(to_im('-61260361136430393310447233718951 2'), "
write (klog,*) "                         to_im('8787738301014139929485503779796 17')) +  "
write (klog,*) "          to_im('2651297679158944302217159014889 88')  "
a = to_fm_rational(to_im('-61260361136430393310447233718951 2'),  &
                   to_im('8787738301014139929485503779796 17'))
mim1 = to_im('2651297679158944302217159014889 88')
result = a + mim1
kw = klog
```