

4.1.6 gm2-libs/Builtins

```

DEFINITION MODULE Builtins ;

FROM SYSTEM IMPORT ADDRESS ;

(* Floating point intrinsic procedure functions. *)

PROCEDURE __BUILTIN__ isnanf (x: SHORTREAL) : INTEGER ;
PROCEDURE __BUILTIN__ isnan (x: REAL) : INTEGER ;
PROCEDURE __BUILTIN__ isnanl (x: LONGREAL) : INTEGER ;

PROCEDURE __BUILTIN__ isfinitef (x: SHORTREAL) : INTEGER ;
PROCEDURE __BUILTIN__ isfinite (x: REAL) : INTEGER ;
PROCEDURE __BUILTIN__ isfinitel (x: LONGREAL) : INTEGER ;

PROCEDURE __BUILTIN__ sinf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ sin (x: REAL) : REAL ;
PROCEDURE __BUILTIN__ sinl (x: LONGREAL) : LONGREAL ;

PROCEDURE __BUILTIN__ cosf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ cos (x: REAL) : REAL ;
PROCEDURE __BUILTIN__ cosl (x: LONGREAL) : LONGREAL ;

PROCEDURE __BUILTIN__ sqrtf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ sqrt (x: REAL) : REAL ;
PROCEDURE __BUILTIN__ sqrtl (x: LONGREAL) : LONGREAL ;

PROCEDURE __BUILTIN__ atan2f (x, y: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ atan2 (x, y: REAL) : REAL ;
PROCEDURE __BUILTIN__ atan2l (x, y: LONGREAL) : LONGREAL ;

PROCEDURE __BUILTIN__ fabsf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ fabs (x: REAL) : REAL ;
PROCEDURE __BUILTIN__ fabsl (x: LONGREAL) : LONGREAL ;

PROCEDURE __BUILTIN__ logf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ log (x: REAL) : REAL ;
PROCEDURE __BUILTIN__ logl (x: LONGREAL) : LONGREAL ;

PROCEDURE __BUILTIN__ expf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ exp (x: REAL) : REAL ;
PROCEDURE __BUILTIN__ expl (x: LONGREAL) : LONGREAL ;

PROCEDURE __BUILTIN__ log10f (x: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ log10 (x: REAL) : REAL ;
PROCEDURE __BUILTIN__ log10l (x: LONGREAL) : LONGREAL ;

```


[illegible]

[illegible]


```
    return_address - returns the return address of function.
                    The current function return address is
                    obtained if level is 0,
                    the next level up if level is 1 etc.
*)

PROCEDURE __BUILTIN__ return_address (level: CARDINAL) : ADDRESS ;

(*
    alloca_trace - this is a no-op which is used for internal debugging.
*)

PROCEDURE alloca_trace (returned: ADDRESS; nBytes: CARDINAL) : ADDRESS ;

END Builtins.
```

4.1.7 gm2-libs/CFileSysOp

```

DEFINITION MODULE CFileSysOp ;

FROM SYSTEM IMPORT ADDRESS ;

(*
  Description: provides access to filesystem operations.
               The implementation module is written in C
               and the parameters behave as their C
               counterparts.
*)

TYPE
  AccessMode = SET OF AccessStatus ;
  AccessStatus = (F_OK, R_OK, W_OK, X_OK, A_FAIL) ;

PROCEDURE Unlink (filename: ADDRESS) : INTEGER ;

(*
  Access - test access to a path or file. The behavior is
           the same as defined in access(2). Except that
           on A_FAIL is only used during the return result
           indicating the underlying C access has returned
           -1 (and errno can be checked).
*)

PROCEDURE Access (pathname: ADDRESS; mode: AccessMode) : AccessMode ;

(* Return TRUE if the caller can see the existence of the file or
   directory on the filesystem. *)

(*
  IsDir - return true if filename is a regular directory.
*)

PROCEDURE IsDir (dirname: ADDRESS) : BOOLEAN ;

(*
  IsFile - return true if filename is a regular file.
*)

```

```
PROCEDURE IsFile (filename: ADDRESS) : BOOLEAN ;

(*
  Exists - return true if pathname exists.
*)

PROCEDURE Exists (pathname: ADDRESS) : BOOLEAN ;

END CFileSysOp.
```

4.1.8 gm2-libs/CHAR

```
DEFINITION MODULE CHAR ;

FROM FIO IMPORT File ;

(*
   Write a single character ch to file f.
*)

PROCEDURE Write (f: File; ch: CHAR) ;
PROCEDURE WriteLn (f: File) ;

END CHAR.
```

4.1.9 gm2-libs/COROUTINES

```
DEFINITION MODULE FOR "C" COROUTINES ;

CONST
    UnassignedPriority = 0 ;

TYPE
    INTERRUPTSOURCE = CARDINAL ;
    PROTECTION = [UnassignedPriority..7] ;

END COROUTINES.
```

4.1.10 gm2-libs/CmdArgs

```
DEFINITION MODULE CmdArgs ;

EXPORT QUALIFIED GetArg, Narg ;

(*
  GetArg - returns the nth argument from the command line, CmdLine
           the success of the operation is returned.
*)

PROCEDURE GetArg (CmdLine: ARRAY OF CHAR;
                  n: CARDINAL; VAR Argi: ARRAY OF CHAR) : BOOLEAN ;

(*
  Narg - returns the number of arguments available from
         command line, CmdLine.
*)

PROCEDURE Narg (CmdLine: ARRAY OF CHAR) : CARDINAL ;

END CmdArgs.
```

4.1.11 gm2-libs/Debug

```
DEFINITION MODULE Debug ;

  (*
    Description: provides some simple debugging routines.
  *)

  EXPORT QUALIFIED Halt, DebugString ;

  (*
    Halt - writes a message in the format:
           Module:Function:Line:Message

           It then terminates by calling HALT.
  *)

  PROCEDURE Halt (Message,
                  Module,
                  Function: ARRAY OF CHAR ;
                  LineNo  : CARDINAL) ;

  (*
    DebugString - writes a string to the debugging device (Scn.Write).
                  It interprets \n as carriage return, linefeed.
  *)

  PROCEDURE DebugString (a: ARRAY OF CHAR) ;

END Debug.
```

4.1.12 gm2-libs/DynamicStrings

```

DEFINITION MODULE DynamicStrings ;

FROM SYSTEM IMPORT ADDRESS ;
EXPORT QUALIFIED String,
    InitString, KillString, Fin, InitStringCharStar,
    InitStringChar, Index, RIndex, ReverseIndex,
    Mark, Length, ConCat, ConCatChar, Assign, Dup, Add,
    Equal, EqualCharStar, EqualArray, ToUpper, ToLower,
    CopyOut, Mult, Slice, ReplaceChar,
    RemoveWhitePrefix, RemoveWhitePostfix, RemoveComment,
    char, string,
    InitStringDB, InitStringCharStarDB, InitStringCharDB,
    MultDB, DupDB, SliceDB,
    PushAllocation, PopAllocation, PopAllocationExemption ;

TYPE
    String ;

(*
    InitString - creates and returns a String type object.
                 Initial contents are, a.
*)

PROCEDURE InitString (a: ARRAY OF CHAR) : String ;

(*
    KillString - frees String, s, and its contents.
                 NIL is returned.
*)

PROCEDURE KillString (s: String) : String ;

(*
    Fin - finishes with a string, it calls KillString with, s.
          The purpose of the procedure is to provide a short cut
          to calling KillString and then testing the return result.
*)

PROCEDURE Fin (s: String) ;

(*

```

```
    InitStringCharStar - initializes and returns a String to contain
                        the C string.
*)

PROCEDURE InitStringCharStar (a: ADDRESS) : String ;

(*
    InitStringChar - initializes and returns a String to contain the
                    single character, ch.
*)

PROCEDURE InitStringChar (ch: CHAR) : String ;

(*
    Mark - marks String, s, ready for garbage collection.
*)

PROCEDURE Mark (s: String) : String ;

(*
    Length - returns the length of the String, s.
*)

PROCEDURE Length (s: String) : CARDINAL ;

(*
    ConCat - returns String, a, after the contents of, b,
            have been appended.
*)

PROCEDURE ConCat (a, b: String) : String ;

(*
    ConCatChar - returns String, a, after character, ch,
                has been appended.
*)

PROCEDURE ConCatChar (a: String; ch: CHAR) : String ;

(*
    Assign - assigns the contents of, b, into, a.
```

```
String, a, is returned.
*)

PROCEDURE Assign (a, b: String) : String ;

(*
  ReplaceChar - returns string s after it has changed all
                occurrences of from to to.
*)

PROCEDURE ReplaceChar (s: String; from, to: CHAR) : String ;

(*
  Dup - duplicate a String, s, returning the copy of s.
*)

PROCEDURE Dup (s: String) : String ;

(*
  Add - returns a new String which contains the contents of a and b.
*)

PROCEDURE Add (a, b: String) : String ;

(*
  Equal - returns TRUE if String, a, and, b, are equal.
*)

PROCEDURE Equal (a, b: String) : BOOLEAN ;

(*
  EqualCharStar - returns TRUE if contents of String, s, is
                  the same as the string, a.
*)

PROCEDURE EqualCharStar (s: String; a: ADDRESS) : BOOLEAN ;

(*
  EqualArray - returns TRUE if contents of String, s, is the
               same as the string, a.
*)
```



```

(*)
    ToLower - returns string, s, after it has had its upper case
              characters replaced by lower case characters.
              The string, s, is not duplicated.
*)

PROCEDURE ToLower (s: String) : String ;

(*)
    CopyOut - copies string, s, to a.
*)

PROCEDURE CopyOut (VAR a: ARRAY OF CHAR; s: String) ;

(*)
    char - returns the character, ch, at position, i, in String, s.
           As Slice the index can be negative so:

           char(s, 0) will return the first character
           char(s, 1) will return the second character
           char(s, -1) will return the last character
           char(s, -2) will return the penultimate character

           a nul character is returned if the index is out of range.
*)

PROCEDURE char (s: String; i: INTEGER) : CHAR ;

(*)
    string - returns the C style char * of String, s.
*)

PROCEDURE string (s: String) : ADDRESS ;

(*)
    to easily debug an application using this library one could use
    use the following macro processing defines:

    #define InitString(X) InitStringDB(X, __FILE__, __LINE__)
    #define InitStringCharStar(X) InitStringCharStarDB(X, \
        __FILE__, __LINE__)

```

```

#define InitStringChar(X) InitStringCharDB(X, __FILE__, __LINE__)
#define Mult(X,Y) MultDB(X, Y, __FILE__, __LINE__)
#define Dup(X) DupDB(X, __FILE__, __LINE__)
#define Slice(X,Y,Z) SliceDB(X, Y, Z, __FILE__, __LINE__)

    and then invoke gm2 with the -fcpp flag.
*)

(*
    InitStringDB - the debug version of InitString.
*)

PROCEDURE InitStringDB (a: ARRAY OF CHAR;
                        file: ARRAY OF CHAR; line: CARDINAL) : String ;

(*
    InitStringCharStarDB - the debug version of InitStringCharStar.
*)

PROCEDURE InitStringCharStarDB (a: ADDRESS;
                                file: ARRAY OF CHAR;
                                line: CARDINAL) : String ;

(*
    InitStringCharDB - the debug version of InitStringChar.
*)

PROCEDURE InitStringCharDB (ch: CHAR;
                            file: ARRAY OF CHAR;
                            line: CARDINAL) : String ;

(*
    MultDB - the debug version of MultDB.
*)

PROCEDURE MultDB (s: String; n: CARDINAL;
                  file: ARRAY OF CHAR; line: CARDINAL) : String ;

(*
    DupDB - the debug version of Dup.
*)

```

```

PROCEDURE DupDB (s: String;
                 file: ARRAY OF CHAR; line: CARDINAL) : String ;

(*
  SliceDB - debug version of Slice.
*)

PROCEDURE SliceDB (s: String; low, high: INTEGER;
                  file: ARRAY OF CHAR; line: CARDINAL) : String ;

(*
  PushAllocation - pushes the current allocation/deallocation lists.
*)

PROCEDURE PushAllocation ;

(*
  PopAllocation - test to see that all strings are deallocated since
                  the last push. Then it pops to the previous
                  allocation/deallocation lists.

                  If halt is true then the application terminates
                  with an exit code of 1.
*)

PROCEDURE PopAllocation (halt: BOOLEAN) ;

(*
  PopAllocationExemption - test to see that all strings are
                          deallocated, except string e since
                          the last push.
                          Post-condition: it pops to the previous
                          allocation/deallocation lists.

                          If halt is true then the application
                          terminates with an exit code of 1.

                          The string, e, is returned unmodified,
*)

PROCEDURE PopAllocationExemption (halt: BOOLEAN; e: String) : String ;

END DynamicStrings.

```

4.1.13 gm2-libs/Environment

```
DEFINITION MODULE Environment ;

EXPORT QUALIFIED GetEnvironment, PutEnvironment ;

(*
  GetEnvironment - gets the environment variable Env and places
                  a copy of its value into string, dest.
                  It returns TRUE if the string Env was found in
                  the processes environment.
*)

PROCEDURE GetEnvironment (Env: ARRAY OF CHAR;
                        VAR dest: ARRAY OF CHAR) : BOOLEAN ;

(*
  PutEnvironment - change or add an environment variable definition
                  EnvDef.
                  TRUE is returned if the environment variable was
                  set or changed successfully.
*)

PROCEDURE PutEnvironment (EnvDef: ARRAY OF CHAR) : BOOLEAN ;

END Environment.
```

4.1.14 gm2-libs/FIO

```

DEFINITION MODULE FIO ;

(* Provides a simple buffered file input/output library. *)

FROM SYSTEM IMPORT ADDRESS, BYTE ;

EXPORT QUALIFIED (* types *)
  File,
  (* procedures *)
  OpenToRead, OpenToWrite, OpenForRandom, Close,
  EOF, EOLN, WasEOLN, IsNoError, Exists, IsActive,
  exists, openToRead, openToWrite, openForRandom,
  SetPositionFromBeginning,
  SetPositionFromEnd,
  FindPosition,
  ReadChar, ReadString,
  WriteChar, WriteString, WriteLine,
  WriteCardinal, ReadCardinal,
  UnReadChar,
  WriteNBytes, ReadNBytes,
  FlushBuffer,
  GetUnixFileDescriptor,
  GetFileName, getFileName, getFileNameLength,
  FlushOutErr,
  (* variables *)
  StdIn, StdOut, StdErr ;

TYPE
  File = CARDINAL ;

(* the following variables are initialized to their UNIX equivalents *)
VAR
  StdIn, StdOut, StdErr: File ;

(*
  IsNoError - returns a TRUE if no error has occurred on file, f.
*)

PROCEDURE IsNoError (f: File) : BOOLEAN ;

(*

```

```
    IsActive - returns TRUE if the file, f, is still active.
*)

PROCEDURE IsActive (f: File) : BOOLEAN ;

(*
    Exists - returns TRUE if a file named, fname exists for reading.
*)

PROCEDURE Exists (fname: ARRAY OF CHAR) : BOOLEAN ;

(*
    OpenToRead - attempts to open a file, fname, for reading and
                  it returns this file.
                  The success of this operation can be checked by
                  calling IsNoError.
*)

PROCEDURE OpenToRead (fname: ARRAY OF CHAR) : File ;

(*
    OpenToWrite - attempts to open a file, fname, for write and
                  it returns this file.
                  The success of this operation can be checked by
                  calling IsNoError.
*)

PROCEDURE OpenToWrite (fname: ARRAY OF CHAR) : File ;

(*
    OpenForRandom - attempts to open a file, fname, for random access
                    read or write and it returns this file.
                    The success of this operation can be checked by
                    calling IsNoError.
                    towrite, determines whether the file should be
                    opened for writing or reading.
                    newfile, determines whether a file should be
                    created if towrite is TRUE or whether the
                    previous file should be left alone,
                    allowing this descriptor to seek
                    and modify an existing file.
*)
```

```

PROCEDURE OpenForRandom (fname: ARRAY OF CHAR;
                        towrite, newfile: BOOLEAN) : File ;

(*
  Close - close a file which has been previously opened using:
          OpenToRead, OpenToWrite, OpenForRandom.
          It is correct to close a file which has an error status.
*)

PROCEDURE Close (f: File) ;

(* the following functions are functionally equivalent to the above
   except they allow C style names.
*)

PROCEDURE exists      (fname: ADDRESS; flength: CARDINAL) : BOOLEAN ;
PROCEDURE openToRead  (fname: ADDRESS; flength: CARDINAL) : File ;
PROCEDURE openToWrite (fname: ADDRESS; flength: CARDINAL) : File ;
PROCEDURE openForRandom (fname: ADDRESS; flength: CARDINAL;
                        towrite, newfile: BOOLEAN) : File ;

(*
  FlushBuffer - flush contents of the FIO file, f, to libc.
*)

PROCEDURE FlushBuffer (f: File) ;

(*
  ReadNBytes - reads nBytes of a file into memory area, dest, returning
               the number of bytes actually read.
               This function will consume from the buffer and then
               perform direct libc reads. It is ideal for large reads.
*)

PROCEDURE ReadNBytes (f: File; nBytes: CARDINAL;
                     dest: ADDRESS) : CARDINAL ;

(*
  ReadAny - reads HIGH (a) + 1 bytes into, a. All input
            is fully buffered, unlike ReadNBytes and thus is more
            suited to small reads.
*)

```



```
(*
  WasEOLN - tests to see whether a file, f, has just read a newline
            character.
*)
```

```
PROCEDURE WasEOLN (f: File) : BOOLEAN ;
```

```
(*
  ReadChar - returns a character read from file, f.
             Sensible to check with IsNoError or EOF after calling
             this function.
*)
```

```
PROCEDURE ReadChar (f: File) : CHAR ;
```

```
(*
  UnReadChar - replaces a character, ch, back into file, f.
               This character must have been read by ReadChar
               and it does not allow successive calls. It may
               only be called if the previous read was successful,
               end of file or end of line seen.
*)
```

```
PROCEDURE UnReadChar (f: File ; ch: CHAR) ;
```

```
(*
  WriteLine - writes out a linefeed to file, f.
*)
```

```
PROCEDURE WriteLine (f: File) ;
```

```
(*
  WriteString - writes a string to file, f.
*)
```

```
PROCEDURE WriteString (f: File; a: ARRAY OF CHAR) ;
```

```
(*
  ReadString - reads a string from file, f, into string, a.
               It terminates the string if HIGH is reached or
               if a newline is seen or an error occurs.
*)
```

```
*)

PROCEDURE ReadString (f: File; VAR a: ARRAY OF CHAR) ;

(*
  WriteCardinal - writes a CARDINAL to file, f.
                  It writes the binary image of the CARDINAL.
                  to file, f.
*)

PROCEDURE WriteCardinal (f: File; c: CARDINAL) ;

(*
  ReadCardinal - reads a CARDINAL from file, f.
                 It reads a bit image of a CARDINAL
                 from file, f.
*)

PROCEDURE ReadCardinal (f: File) : CARDINAL ;

(*
  GetUnixFileDescriptor - returns the UNIX file descriptor of a file.
                        Useful when combining FIO.mod with select
                        (in Selective.def - but note the comments in
                        Selective about using read/write primitives)
*)

PROCEDURE GetUnixFileDescriptor (f: File) : INTEGER ;

(*
  SetPositionFromBeginning - sets the position from the beginning
                           of the file.
*)

PROCEDURE SetPositionFromBeginning (f: File; pos: LONGINT) ;

(*
  SetPositionFromEnd - sets the position from the end of the file.
*)

PROCEDURE SetPositionFromEnd (f: File; pos: LONGINT) ;
```

```
(*
  FindPosition - returns the current absolute position in file, f.
*)

PROCEDURE FindPosition (f: File) : LONGINT ;

(*
  GetFileName - assigns, a, with the filename associated with, f.
*)

PROCEDURE GetFileName (f: File; VAR a: ARRAY OF CHAR) ;

(*
  getFileName - returns the address of the filename associated with, f.
*)

PROCEDURE getFileName (f: File) : ADDRESS ;

(*
  getFileNameLength - returns the number of characters associated with
                      filename, f.
*)

PROCEDURE getFileNameLength (f: File) : CARDINAL ;

(*
  FlushOutErr - flushes, StdOut, and, StdErr.
*)

PROCEDURE FlushOutErr ;

END FIO.
```

4.1.15 gm2-libs/FileSysOp

```
DEFINITION MODULE FileSysOp ;

FROM CFileSysOp IMPORT AccessMode ;

(*
  Description: provides access to filesystem operations using
               Modula-2 base types.
*)

PROCEDURE Exists (filename: ARRAY OF CHAR) : BOOLEAN ;
PROCEDURE IsDir (dirname: ARRAY OF CHAR) : BOOLEAN ;
PROCEDURE IsFile (filename: ARRAY OF CHAR) : BOOLEAN ;
PROCEDURE Unlink (filename: ARRAY OF CHAR) : BOOLEAN ;
PROCEDURE Access (pathname: ARRAY OF CHAR; mode: AccessMode) : AccessMode ;

END FileSysOp.
```

4.1.16 gm2-libs/FormatStrings

```
DEFINITION MODULE FormatStrings ;

FROM SYSTEM IMPORT BYTE ;
FROM DynamicStrings IMPORT String ;
EXPORT QUALIFIED Sprintf0, Sprintf1, Sprintf2, Sprintf3, Sprintf4,
    HandleEscape ;

(*
    Sprintf0 - returns a String containing, fmt, after it has had its
               escape sequences translated.
*)

PROCEDURE Sprintf0 (fmt: String) : String ;

(*
    Sprintf1 - returns a String containing, fmt, together with
               encapsulated entity, w. It only formats the
               first %s or %d with n.
*)

PROCEDURE Sprintf1 (fmt: String; w: ARRAY OF BYTE) : String ;

(*
    Sprintf2 - returns a string, fmt, which has been formatted.
*)

PROCEDURE Sprintf2 (fmt: String; w1, w2: ARRAY OF BYTE) : String ;

(*
    Sprintf3 - returns a string, fmt, which has been formatted.
*)

PROCEDURE Sprintf3 (fmt: String; w1, w2, w3: ARRAY OF BYTE) : String ;

(*
    Sprintf4 - returns a string, fmt, which has been formatted.
*)

PROCEDURE Sprintf4 (fmt: String;
    w1, w2, w3, w4: ARRAY OF BYTE) : String ;
```

```
(*
  HandleEscape - translates \a, \b, \e, \f, \n, \r, \x[hex] \[octal]
                  into their respective ascii codes. It also converts
                  \[any] into a single [any] character.
*)

PROCEDURE HandleEscape (s: String) : String ;

END FormatStrings.
```

4.1.17 gm2-libs/FpuIO

```

DEFINITION MODULE FpuIO ;

EXPORT QUALIFIED ReadReal, WriteReal, StrToReal, RealToStr,
                  ReadLongReal, WriteLongReal, StrToLongReal,
                  LongRealToStr,
                  ReadLongInt, WriteLongInt, StrToLongInt,
                  LongIntToStr ;

PROCEDURE ReadReal (VAR x: REAL) ;
PROCEDURE WriteReal (x: REAL; TotalWidth, FractionWidth: CARDINAL) ;
PROCEDURE StrToReal (a: ARRAY OF CHAR ; VAR x: REAL) ;
PROCEDURE RealToStr (x: REAL; TotalWidth, FractionWidth: CARDINAL;
                    VAR a: ARRAY OF CHAR) ;

PROCEDURE ReadLongReal (VAR x: LONGREAL) ;
PROCEDURE WriteLongReal (x: LONGREAL;
                        TotalWidth, FractionWidth: CARDINAL) ;
PROCEDURE StrToLongReal (a: ARRAY OF CHAR ; VAR x: LONGREAL) ;
PROCEDURE LongRealToStr (x: LONGREAL;
                        TotalWidth, FractionWidth: CARDINAL;
                        VAR a: ARRAY OF CHAR) ;

PROCEDURE ReadLongInt (VAR x: LONGINT) ;
PROCEDURE WriteLongInt (x: LONGINT; n: CARDINAL) ;
PROCEDURE StrToLongInt (a: ARRAY OF CHAR ; VAR x: LONGINT) ;
PROCEDURE LongIntToStr (x: LONGINT; n: CARDINAL; VAR a: ARRAY OF CHAR) ;

END FpuIO.

```

4.1.18 gm2-libs/GetOpt

```

DEFINITION MODULE GetOpt ;

FROM SYSTEM IMPORT ADDRESS ;
FROM DynamicStrings IMPORT String ;

CONST
    no_argument = 0 ;
    required_argument = 1 ;
    optional_argument = 2 ;

TYPE
    LongOptions ;
    PtrToInteger = POINTER TO INTEGER ;

(*
    GetOpt - call C getopt and fill in the parameters:
             optarg, optind, opterr and optopt.
*)

PROCEDURE GetOpt (argc: INTEGER; argv: ADDRESS; optstring: String;
                 VAR optarg: String;
                 VAR optind, opterr, optopt: INTEGER) : CHAR ;

(*
    InitLongOptions - creates and returns a LongOptions empty array.
*)

PROCEDURE InitLongOptions () : LongOptions ;

(*
    AddLongOption - appends long option {name, has_arg, flag, val} to the
                   array of options and new long options array is
                   returned.
                   The old array, lo, should no longer be used.

    (from man 3 getopt)
    The meanings of the different fields are:

    name    is the name of the long option.

    has_arg
    is: no_argument (or 0) if the option does not take an
        argument; required_argument (or 1) if the option

```



```
    optstring: String; longopts: LongOptions;  
    VAR longindex: INTEGER) : INTEGER ;
```

```
END GetOpt.
```


only really makes sence for a file descriptor opened
for terminal input or maybe some specific file descriptor
which is attached to a particular piece of hardware.

*)

PROCEDURE EchoOff (fd: INTEGER; input: BOOLEAN) ;

END IO.

4.1.20 gm2-libs/Indexing

```

DEFINITION MODULE Indexing ;

FROM SYSTEM IMPORT ADDRESS ;

TYPE
  Index ;
  IndexProcedure = PROCEDURE (ADDRESS) ;

(*
  InitIndexTuned - creates a dynamic array with low indice.
                  minsize is the initial number of elements the
                  array is allocated and growfactor determines how
                  it will be resized once it becomes full.
*)

PROCEDURE InitIndexTuned (low, minsize, growfactor: CARDINAL) : Index ;

(*
  InitIndex - creates and returns an Index.
*)

PROCEDURE InitIndex (low: CARDINAL) : Index ;

(*
  KillIndex - returns Index to free storage.
*)

PROCEDURE KillIndex (i: Index) : Index ;

(*
  DebugIndex - turns on debugging within an index.
*)

PROCEDURE DebugIndex (i: Index) : Index ;

(*
  InBounds - returns TRUE if indice, n, is within the bounds
             of the dynamic array.
*)

```

```
PROCEDURE InBounds (i: Index; n: CARDINAL) : BOOLEAN ;

(*
  HighIndice - returns the last legally accessible indice of this array.■
*)

PROCEDURE HighIndice (i: Index) : CARDINAL ;

(*
  LowIndice - returns the first legally accessible indice of this array.■
*)

PROCEDURE LowIndice (i: Index) : CARDINAL ;

(*
  PutIndice - places, a, into the dynamic array at position i[n]
*)

PROCEDURE PutIndice (i: Index; n: CARDINAL; a: ADDRESS) ;

(*
  GetIndice - retrieves, element i[n] from the dynamic array.
*)

PROCEDURE GetIndice (i: Index; n: CARDINAL) : ADDRESS ;

(*
  IsIndiceInIndex - returns TRUE if, a, is in the index, i.
*)

PROCEDURE IsIndiceInIndex (i: Index; a: ADDRESS) : BOOLEAN ;

(*
  RemoveIndiceFromIndex - removes, a, from Index, i.
*)

PROCEDURE RemoveIndiceFromIndex (i: Index; a: ADDRESS) ;

(*
```

```

    DeleteIndice - delete i[j] from the array.
*)

PROCEDURE DeleteIndice (i: Index; j: CARDINAL) ;

(*
    IncludeIndiceIntoIndex - if the indice is not in the index, then
                           add it at the end.
*)

PROCEDURE IncludeIndiceIntoIndex (i: Index; a: ADDRESS) ;

(*
    ForeachIndiceInIndexDo - for each j indice of i, call procedure p(i[j])
*)

PROCEDURE ForeachIndiceInIndexDo (i: Index; p: IndexProcedure) ;

(*
    IsEmpty - return TRUE if the array has no entries it.
*)

PROCEDURE IsEmpty (i: Index) : BOOLEAN ;

(*
    FindIndice - returns the indice containing a.
                It returns zero if a is not found in array i.
*)

PROCEDURE FindIndice (i: Index; a: ADDRESS) : CARDINAL ;

END Indexing.
```

4.1.21 gm2-libs/LMathLib0

```
DEFINITION MODULE LMathLib0 ;

CONST
  pi    = 3.1415926535897932384626433832795028841972;
  exp1  = 2.7182818284590452353602874713526624977572;

PROCEDURE __BUILTIN__ sqrt (x: LONGREAL) : LONGREAL ;
PROCEDURE exp (x: LONGREAL) : LONGREAL ;
PROCEDURE ln (x: LONGREAL) : LONGREAL ;
PROCEDURE __BUILTIN__ sin (x: LONGREAL) : LONGREAL ;
PROCEDURE __BUILTIN__ cos (x: LONGREAL) : LONGREAL ;
PROCEDURE tan (x: LONGREAL) : LONGREAL ;
PROCEDURE arctan (x: LONGREAL) : LONGREAL ;
PROCEDURE entier (x: LONGREAL) : INTEGER ;

END LMathLib0.
```

4.1.22 gm2-libs/LegacyReal

```
DEFINITION MODULE LegacyReal ;
```

```
TYPE
```

```
  REAL = SHORTREAL ;
```

```
END LegacyReal.
```



```
PROCEDURE InstallTerminationProcedure (p: PROC) : BOOLEAN ;

(*
  ExecuteInitialProcedures - executes the initial procedures installed
                           by InstallInitialProcedure.
*)

PROCEDURE ExecuteInitialProcedures ;

(*
  InstallInitialProcedure - installs a procedure to be executed just
                           before the BEGIN code section of the main
                           program module.
*)

PROCEDURE InstallInitialProcedure (p: PROC) : BOOLEAN ;

(*
  ExecuteTerminationProcedures - calls each installed termination procedure
                               in reverse order.
*)

PROCEDURE ExecuteTerminationProcedures ;

END M2Dependent.
```

4.1.24 gm2-libs/M2EXCEPTION

```
DEFINITION MODULE M2EXCEPTION;
```

```
(* This enumerated list of exceptions must match the exceptions in gm2-libs-iso to
   allow mixed module dialect projects. *)
```

```
TYPE
```

```
  M2Exceptions =
```

```
    (indexException,      rangeException,      caseSelectException,  invalidLocation
     functionException,   wholeValueException, wholeDivException,   realValueExcept
     realDivException,   complexValueException, complexDivException, protException,
     sysException,       coException,          exException
    );
```

```
(* If the program or coroutine is in the exception state then return the enumeration
   value representing the exception cause. If it is not in the exception state then
   raises and exception (exException). *)
```

```
PROCEDURE M2Exception () : M2Exceptions;
```

```
(* Returns TRUE if the program or coroutine is in the exception state.
   Returns FALSE if the program or coroutine is not in the exception state. *)
```

```
PROCEDURE IsM2Exception () : BOOLEAN;
```

```
END M2EXCEPTION.
```



```
PROCEDURE InstallTerminationProcedure (p: PROC) : BOOLEAN ;

(*
  ExecuteInitialProcedures - executes the initial procedures installed
                           by InstallInitialProcedure.
*)

PROCEDURE ExecuteInitialProcedures ;

(*
  InstallInitialProcedure - installs a procedure to be executed just
                           before the BEGIN code section of the main
                           program module.
*)

PROCEDURE InstallInitialProcedure (p: PROC) : BOOLEAN ;

(*
  ExecuteTerminationProcedures - calls each installed termination procedure
                               in reverse order.
*)

PROCEDURE ExecuteTerminationProcedures ;

(*
  Terminate - provides compatibility for pim. It call exit with
              the exitcode provided in a prior call to ExitOnHalt
              (or zero if ExitOnHalt was never called). It does
              not call ExecuteTerminationProcedures.
*)

PROCEDURE Terminate <* noreturn *> ;

(*
  HALT - terminate the current program. The procedure Terminate
         is called before the program is stopped. The parameter
         exitcode is optional. If the parameter is not supplied
         HALT will call libc 'abort', otherwise it will exit with
         the code supplied. Supplying a parameter to HALT has the
         same effect as calling ExitOnHalt with the same code and
         then calling HALT with no parameter.
*)
```

```

PROCEDURE HALT ([exitcode: INTEGER = -1]) <* noreturn *> ;

(*
  Halt - provides a more user friendly version of HALT, which takes
         four parameters to aid debugging.  It writes an error message
         to stderr and calls exit (1).
*)

PROCEDURE Halt (description, filename, function: ARRAY OF CHAR;
               line: CARDINAL) <* noreturn *> ;

(*
  HaltC - provides a more user friendly version of HALT, which takes
         four parameters to aid debugging.  It writes an error message
         to stderr and calls exit (1).
*)

PROCEDURE HaltC (description, filename, function: ADDRESS;
               line: CARDINAL) <* noreturn *> ;

(*
  ExitOnHalt - if HALT is executed then call exit with the exit code, e.
*)

PROCEDURE ExitOnHalt (e: INTEGER) ;

(*
  ErrorMessage - emits an error message to stderr and then calls exit (1).
*)

PROCEDURE ErrorMessage (message: ARRAY OF CHAR;
                      filename: ARRAY OF CHAR;
                      line: CARDINAL;
                      function: ARRAY OF CHAR) <* noreturn *> ;

(*
  Length - returns the length of a string, a. This is called whenever
         the user calls LENGTH and the parameter cannot be calculated
         at compile time.
*)

```

```
PROCEDURE Length (a: ARRAY OF CHAR) : CARDINAL ;
```

```
(*
  The following are the runtime exception handler routines.
*)
```

```
PROCEDURE AssignmentException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ReturnException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE IncException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE DecException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE InclException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ExclException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ShiftException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE RotateException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE StaticArraySubscriptException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE DynamicArraySubscriptException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ForLoopBeginException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ForLoopToException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ForLoopEndException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE PointerNilException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE NoReturnException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE CaseException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeNonPosDivException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeNonPosModException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeZeroDivException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeZeroRemException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeValueException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE RealValueException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ParameterException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE NoException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
```

```
END M2RTS.
```

4.1.26 gm2-libs/MathLib0

```
DEFINITION MODULE MathLib0 ;

CONST
  pi    = 3.1415926535897932384626433832795028841972;
  exp1  = 2.7182818284590452353602874713526624977572;

PROCEDURE __BUILTIN__ sqrt (x: REAL) : REAL ;
PROCEDURE exp (x: REAL) : REAL ;
PROCEDURE ln (x: REAL) : REAL ;
PROCEDURE __BUILTIN__ sin (x: REAL) : REAL ;
PROCEDURE __BUILTIN__ cos (x: REAL) : REAL ;
PROCEDURE tan (x: REAL) : REAL ;
PROCEDURE arctan (x: REAL) : REAL ;
PROCEDURE entier (x: REAL) : INTEGER ;

END MathLib0.
```

4.1.27 gm2-libs/MemUtils

```
DEFINITION MODULE MemUtils ;

FROM SYSTEM IMPORT ADDRESS ;
EXPORT QUALIFIED MemCopy, MemZero ;

(*
  MemCopy - copys a region of memory to the required destination.
*)

PROCEDURE MemCopy (from: ADDRESS; length: CARDINAL; to: ADDRESS) ;

(*
  MemZero - sets a region of memory: a..a+length to zero.
*)

PROCEDURE MemZero (a: ADDRESS; length: CARDINAL) ;

END MemUtils.
```

4.1.28 gm2-libs/NumberIO

```

DEFINITION MODULE NumberIO ;

EXPORT QUALIFIED ReadCard, WriteCard, ReadHex, WriteHex, ReadInt, WriteInt,
    CardToStr, StrToCard, StrToHex, HexToStr, StrToInt, IntToStr,
    ReadOct, WriteOct, OctToStr, StrToOct,
    ReadBin, WriteBin, BinToStr, StrToBin,
    StrToBinInt, StrToHexInt, StrToOctInt ;

PROCEDURE ReadCard (VAR x: CARDINAL) ;

PROCEDURE WriteCard (x, n: CARDINAL) ;

PROCEDURE ReadHex (VAR x: CARDINAL) ;

PROCEDURE WriteHex (x, n: CARDINAL) ;

PROCEDURE ReadInt (VAR x: INTEGER) ;

PROCEDURE WriteInt (x: INTEGER ; n: CARDINAL) ;

PROCEDURE CardToStr (x, n: CARDINAL ; VAR a: ARRAY OF CHAR) ;

PROCEDURE StrToCard (a: ARRAY OF CHAR ; VAR x: CARDINAL) ;

PROCEDURE HexToStr (x, n: CARDINAL ; VAR a: ARRAY OF CHAR) ;

PROCEDURE StrToHex (a: ARRAY OF CHAR ; VAR x: CARDINAL) ;

PROCEDURE IntToStr (x: INTEGER ; n: CARDINAL ; VAR a: ARRAY OF CHAR) ;

PROCEDURE StrToInt (a: ARRAY OF CHAR ; VAR x: INTEGER) ;

PROCEDURE ReadOct (VAR x: CARDINAL) ;

PROCEDURE WriteOct (x, n: CARDINAL) ;

PROCEDURE OctToStr (x, n: CARDINAL ; VAR a: ARRAY OF CHAR) ;

PROCEDURE StrToOct (a: ARRAY OF CHAR ; VAR x: CARDINAL) ;

PROCEDURE ReadBin (VAR x: CARDINAL) ;

PROCEDURE WriteBin (x, n: CARDINAL) ;

```

```
PROCEDURE BinToStr (x, n: CARDINAL ; VAR a: ARRAY OF CHAR) ;  
  
PROCEDURE StrToBin (a: ARRAY OF CHAR ; VAR x: CARDINAL) ;  
  
PROCEDURE StrToBinInt (a: ARRAY OF CHAR ; VAR x: INTEGER) ;  
  
PROCEDURE StrToHexInt (a: ARRAY OF CHAR ; VAR x: INTEGER) ;  
  
PROCEDURE StrToOctInt (a: ARRAY OF CHAR ; VAR x: INTEGER) ;  
  
END NumberIO.
```

4.1.29 gm2-libs/OptLib

```

DEFINITION MODULE OptLib ;

FROM SYSTEM IMPORT ADDRESS ;
FROM DynamicStrings IMPORT String ;

TYPE
    Option ;

(*
    InitOption - constructor for Option.
*)

PROCEDURE InitOption (argc: INTEGER; argv: ADDRESS) : Option ;

(*
    KillOption - deconstructor for Option.
*)

PROCEDURE KillOption (o: Option) : Option ;

(*
    Dup - duplicate the option array inside, o.
        Notice that this does not duplicate all the contents
        (strings) of argv.
        Shallow copy of the top level indices.
*)

PROCEDURE Dup (o: Option) : Option ;

(*
    Slice - return a new option which has elements [low:high] from the
            options, o.
*)

PROCEDURE Slice (o: Option; low, high: INTEGER) : Option ;

(*
    IndexStrCmp - returns the index in the argv array which matches
                  string, s. -1 is returned if the string is not found.
*)

```

```
PROCEDURE IndexStrCmp (o: Option; s: String) : INTEGER ;

(*
  IndexStrNCmp - returns the index in the argv array where the first
                  characters are matched by string, s.
                  -1 is returned if the string is not found.
*)

PROCEDURE IndexStrNCmp (o: Option; s: String) : INTEGER ;

(*
  ConCat - returns the concatenation of a and b.
*)

PROCEDURE ConCat (a, b: Option) : Option ;

(*
  GetArgv - return the argv component of option.
*)

PROCEDURE GetArgv (o: Option) : ADDRESS ;

(*
  GetArgc - return the argc component of option.
*)

PROCEDURE GetArgc (o: Option) : INTEGER ;

END OptLib.
```

4.1.30 gm2-libs/PushBackInput

```
DEFINITION MODULE PushBackInput ;

FROM FIO IMPORT File ;
FROM DynamicStrings IMPORT String ;

EXPORT QUALIFIED Open, PutCh, GetCh, Error, WarnError, WarnString,
                  Close, SetDebug, GetExitStatus, PutStr,
                  PutString, GetColumnPosition, GetCurrentLine ;

(*
  Open - opens a file for reading.
*)

PROCEDURE Open (a: ARRAY OF CHAR) : File ;

(*
  GetCh - gets a character from either the push back stack or
          from file, f.
*)

PROCEDURE GetCh (f: File) : CHAR ;

(*
  PutCh - pushes a character onto the push back stack, it also
          returns the character which has been pushed.
*)

PROCEDURE PutCh (ch: CHAR) : CHAR ;

(*
  PutString - pushes a string onto the push back stack.
*)

PROCEDURE PutString (a: ARRAY OF CHAR) ;

(*
  PutStr - pushes a dynamic string onto the push back stack.
           The string, s, is not deallocated.
*)
```

```
PROCEDURE PutStr (s: String) ;
```

```
(*  
    Error - emits an error message with the appropriate file, line combination.■  
*)
```

```
PROCEDURE Error (a: ARRAY OF CHAR) ;
```

```
(*  
    WarnError - emits an error message with the appropriate file, line combination.■  
                It does not terminate but when the program finishes an exit status of■  
                1 will be issued.  
*)
```

```
PROCEDURE WarnError (a: ARRAY OF CHAR) ;
```

```
(*  
    WarnString - emits an error message with the appropriate file, line combination.■  
                It does not terminate but when the program finishes an exit status of■  
                1 will be issued.  
*)
```

```
PROCEDURE WarnString (s: String) ;
```

```
(*  
    Close - closes the opened file.  
*)
```

```
PROCEDURE Close (f: File) ;
```

```
(*  
    GetExitStatus - returns the exit status which will be 1 if any warnings were issued  
*)
```

```
PROCEDURE GetExitStatus () : CARDINAL ;
```

```
(*  
    SetDebug - sets the debug flag on or off.  
*)
```

```
PROCEDURE SetDebug (d: BOOLEAN) ;
```

```
(*
  GetColumnPosition - returns the column position of the current character.■
*)

PROCEDURE GetColumnPosition () : CARDINAL ;

(*
  GetCurrentLine - returns the current line number.
*)

PROCEDURE GetCurrentLine () : CARDINAL ;

END PushBackInput.
```

4.1.31 gm2-libs/RTExceptions

```

DEFINITION MODULE RTExceptions ;

(* Runtime exception handler routines.  This should
   be considered as a system module for GNU Modula-2
   and allow the compiler to interface with exception
   handling.  *)

FROM SYSTEM IMPORT ADDRESS ;
EXPORT QUALIFIED EHBlock,
    Raise, SetExceptionBlock, GetExceptionBlock,
    GetTextBuffer, GetTextBufferSize, GetNumber,
    InitExceptionBlock, KillExceptionBlock,
    PushHandler, PopHandler,
    BaseExceptionsThrow, DefaultErrorCatch,
    IsInExceptionState, SetExceptionState,
    SwitchExceptionState, GetBaseExceptionBlock,
    SetExceptionSource, GetExceptionSource ;

TYPE
    EHBlock ;
    ProcedureHandler = PROCEDURE ;

(*
   Raise - invoke the exception handler associated with, number,
           in the active EHBlock.  It keeps a record of the number
           and message in the EHBlock for later use.
   *)

PROCEDURE Raise (number: CARDINAL;
                file: ADDRESS; line: CARDINAL;
                column: CARDINAL; function: ADDRESS;
                message: ADDRESS) <* noreturn *> ;

(*
   SetExceptionBlock - sets, source, as the active EHB.
   *)

PROCEDURE SetExceptionBlock (source: EHBlock) ;

(*
   GetExceptionBlock - returns the active EHB.
   *)

```

```
PROCEDURE GetExceptionBlock () : EHBlock ;
```

```
(*  
  GetTextBuffer - returns the address of the EHB buffer.  
*)
```

```
PROCEDURE GetTextBuffer (e: EHBlock) : ADDRESS ;
```

```
(*  
  GetTextBufferSize - return the size of the EHB text buffer.  
*)
```

```
PROCEDURE GetTextBufferSize (e: EHBlock) : CARDINAL ;
```

```
(*  
  GetNumber - return the exception number associated with,  
              source.  
*)
```

```
PROCEDURE GetNumber (source: EHBlock) : CARDINAL ;
```

```
(*  
  InitExceptionBlock - creates and returns a new exception block.  
*)
```

```
PROCEDURE InitExceptionBlock () : EHBlock ;
```

```
(*  
  KillExceptionBlock - destroys the EHB, e, and all its handlers.  
*)
```

```
PROCEDURE KillExceptionBlock (e: EHBlock) : EHBlock ;
```

```
(*  
  PushHandler - install a handler in EHB, e.  
*)
```

```
PROCEDURE PushHandler (e: EHBlock; number: CARDINAL; p: ProcedureHandler) ;■
```

```
(*
  PopHandler - removes the handler associated with, number, from
               EHB, e.
*)

PROCEDURE PopHandler (e: EHBlock; number: CARDINAL) ;

(*
  DefaultErrorCatch - displays the current error message in
                     the current exception block and then
                     calls HALT.
*)

PROCEDURE DefaultErrorCatch ;

(*
  BaseExceptionsThrow - configures the Modula-2 exceptions to call
                       THROW which in turn can be caught by an
                       exception block. If this is not called then
                       a Modula-2 exception will simply call an
                       error message routine and then HALT.
*)

PROCEDURE BaseExceptionsThrow ;

(*
  IsInExceptionState - returns TRUE if the program is currently
                     in the exception state.
*)

PROCEDURE IsInExceptionState () : BOOLEAN ;

(*
  SetExceptionState - returns the current exception state and
                    then sets the current exception state to,
                    to.
*)

PROCEDURE SetExceptionState (to: BOOLEAN) : BOOLEAN ;

(*
  SwitchExceptionState - assigns, from, with the current exception
```

```
                                state and then assigns the current exception
                                to, to.
*)

PROCEDURE SwitchExceptionState (VAR from: BOOLEAN; to: BOOLEAN) ;

(*
    GetBaseExceptionBlock - returns the initial language exception block
                           created.
*)

PROCEDURE GetBaseExceptionBlock () : EHBlock ;

(*
    SetExceptionSource - sets the current exception source to, source.
*)

PROCEDURE SetExceptionSource (source: ADDRESS) ;

(*
    GetExceptionSource - returns the current exception source.
*)

PROCEDURE GetExceptionSource () : ADDRESS ;

END RTEExceptions.
```

4.1.32 gm2-libs/RTint

```

DEFINITION MODULE RTint ;

(* Provides users of the COROUTINES library with the
   ability to create interrupt sources based on
   file descriptors and timeouts. *)

FROM SYSTEM IMPORT ADDRESS ;

TYPE
  DispatchVector = PROCEDURE (CARDINAL, CARDINAL, ADDRESS) ;

(*
   InitInputVector - returns an interrupt vector which is associated
                     with the file descriptor, fd.
   *)

PROCEDURE InitInputVector (fd: INTEGER; pri: CARDINAL) : CARDINAL ;

(*
   InitOutputVector - returns an interrupt vector which is associated
                     with the file descriptor, fd.
   *)

PROCEDURE InitOutputVector (fd: INTEGER; pri: CARDINAL) : CARDINAL ;

(*
   InitTimeVector - returns an interrupt vector associated with
                   the relative time.
   *)

PROCEDURE InitTimeVector (micro, secs: CARDINAL; pri: CARDINAL) : CARDINAL ;

(*
   ReArmTimeVector - reprimes the vector, vec, to deliver an interrupt
                     at the new relative time.
   *)

PROCEDURE ReArmTimeVector (vec: CARDINAL; micro, secs: CARDINAL) ;

(*

```

```
    GetTimeVector - assigns, micro, and, secs, with the remaining
                    time before this interrupt will expire.
                    This value is only updated when a Listen
                    occurs.
*)

PROCEDURE GetTimeVector (vec: CARDINAL; VAR micro, secs: CARDINAL) ;

(*
    AttachVector - adds the pointer, p, to be associated with the interrupt
                    vector. It returns the previous value attached to this
                    vector.
*)

PROCEDURE AttachVector (vec: CARDINAL; ptr: ADDRESS) : ADDRESS ;

(*
    IncludeVector - includes, vec, into the dispatcher list of
                    possible interrupt causes.
*)

PROCEDURE IncludeVector (vec: CARDINAL) ;

(*
    ExcludeVector - excludes, vec, from the dispatcher list of
                    possible interrupt causes.
*)

PROCEDURE ExcludeVector (vec: CARDINAL) ;

(*
    Listen - will either block indefinitely (until an interrupt)
              or alternatively will test to see whether any interrupts
              are pending.
              If a pending interrupt was found then, call, is called
              and then this procedure returns.
              It only listens for interrupts > pri.
*)

PROCEDURE Listen (untilInterrupt: BOOLEAN;
                  call: DispatchVector;
                  pri: CARDINAL) ;
```

```
(*  
  Init - allows the user to force the initialize order.  
*)  
  
PROCEDURE Init ;  
  
END RTint.
```

4.1.33 gm2-libs/SArgs

```
DEFINITION MODULE SArgs ;

FROM DynamicStrings IMPORT String ;
EXPORT QUALIFIED GetArg, Narg ;

(*
  GetArg - returns the nth argument from the command line.
           The success of the operation is returned.
           If TRUE is returned then the string, s, contains a
           new string, otherwise s is set to NIL.
*)

PROCEDURE GetArg (VAR s: String ; n: CARDINAL) : BOOLEAN ;

(*
  Narg - returns the number of arguments available from
         command line.
*)

PROCEDURE Narg() : CARDINAL ;

END SArgs.
```

4.1.34 gm2-libs/SCmdArgs

```
DEFINITION MODULE SCmdArgs ;

FROM DynamicStrings IMPORT String ;

EXPORT QUALIFIED GetArg, Narg ;

(*
  GetArg - returns the nth argument from the command line, CmdLine
           the success of the operation is returned.
*)

PROCEDURE GetArg (CmdLine: String;
                  n: CARDINAL; VAR Argi: String) : BOOLEAN ;

(*
  Narg - returns the number of arguments available from
         command line, CmdLine.
*)

PROCEDURE Narg (CmdLine: String) : CARDINAL ;

END SCmdArgs.
```

4.1.35 gm2-libs/SEnvironment

```
DEFINITION MODULE SEnvironment ;

FROM DynamicStrings IMPORT String ;
EXPORT QUALIFIED GetEnvironment ;

(*
  GetEnvironment - gets the environment variable Env and places
                  a copy of its value into String, dest.
                  It returns TRUE if the string Env was found in
                  the processes environment.
*)

PROCEDURE GetEnvironment (Env: String;
                        VAR dest: String) : BOOLEAN ;

(*
  PutEnvironment - change or add an environment variable definition EnvDef.
                  TRUE is returned if the environment variable was
                  set or changed successfully.
*)

PROCEDURE PutEnvironment (EnvDef: String) : BOOLEAN ;

END SEnvironment.
```

4.1.36 gm2-libs/SFIO

```

DEFINITION MODULE SFIO ;

FROM DynamicStrings IMPORT String ;
FROM FIO IMPORT File ;

EXPORT QUALIFIED OpenToRead, OpenToWrite, OpenForRandom, Exists, WriteS, ReadS ;

(*
  Exists - returns TRUE if a file named, fname exists for reading.
*)

PROCEDURE Exists (fname: String) : BOOLEAN ;

(*
  OpenToRead - attempts to open a file, fname, for reading and
               it returns this file.
               The success of this operation can be checked by
               calling IsNoError.
*)

PROCEDURE OpenToRead (fname: String) : File ;

(*
  OpenToWrite - attempts to open a file, fname, for write and
                it returns this file.
                The success of this operation can be checked by
                calling IsNoError.
*)

PROCEDURE OpenToWrite (fname: String) : File ;

(*
  OpenForRandom - attempts to open a file, fname, for random access
                  read or write and it returns this file.
                  The success of this operation can be checked by
                  calling IsNoError.
                  towrite, determines whether the file should be
                  opened for writing or reading.
                  if towrite is TRUE or whether the previous file should
                  be left alone, allowing this descriptor to seek
                  and modify an existing file.
*)

```

*)

PROCEDURE OpenForRandom (fname: String; towrite, newfile: BOOLEAN) : File ;

(*

WriteS - writes a string, s, to, file. It returns the String, s.

*)

PROCEDURE WriteS (file: File; s: String) : String ;

(*

ReadS - reads a string, s, from, file. It returns the String, s.

It stops reading the string at the end of line or end of file.

It consumes the newline at the end of line but does not place
this into the returned string.

*)

PROCEDURE ReadS (file: File) : String ;

END SFIO.

4.1.37 gm2-libs/SMathLib0

```
DEFINITION MODULE SMathLib0 ;

CONST
  pi    = 3.1415926535897932384626433832795028841972;
  exp1  = 2.7182818284590452353602874713526624977572;

PROCEDURE __BUILTIN__ sqrt (x: SHORTREAL) : SHORTREAL ;
PROCEDURE exp (x: SHORTREAL) : SHORTREAL ;
PROCEDURE ln (x: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ sin (x: SHORTREAL) : SHORTREAL ;
PROCEDURE __BUILTIN__ cos (x: SHORTREAL) : SHORTREAL ;
PROCEDURE tan (x: SHORTREAL) : SHORTREAL ;
PROCEDURE arctan (x: SHORTREAL) : SHORTREAL ;
PROCEDURE entier (x: SHORTREAL) : INTEGER ;

END SMathLib0.
```

4.1.38 gm2-libs/SYSTEM

```

DEFINITION MODULE SYSTEM ;

EXPORT QUALIFIED BITS_PER_BYTE, BYTES_PER_WORD,
    ADDRESS, WORD, BYTE, C_SIZE_T, C_SIZE_T, COFF_T, CARDINAL64, (*
    Target specific data types. *)
    ADR, T_SIZE, ROTATE, SHIFT, THROW, T_BIT_SIZE ;
    (* SIZE is also exported if -fpim2 is used. *)

CONST
    BITS_PER_BYTE = __ATTRIBUTE__ __BUILTIN__ ((BITS_PER_UNIT)) ;
    BYTES_PER_WORD = __ATTRIBUTE__ __BUILTIN__ ((UNITS_PER_WORD)) ;

(* Note that the full list of system and sized datatypes include:
    LOC, WORD, BYTE, ADDRESS,

    (and the non language standard target types)

    INTEGER8, INTEGER16, INTEGER32, INTEGER64,
    CARDINAL8, CARDINAL16, CARDINAL32, CARDINAL64,
    WORD16, WORD32, WORD64, BITSET8, BITSET16,
    BITSET32, REAL32, REAL64, REAL128, COMPLEX32,
    COMPLEX64, COMPLEX128, C_SIZE_T, C_SIZE_T.

    Also note that the non-standard data types will
    move into another module in the future. *)

(* The following types are supported on this target:
TYPE
    (* Target specific data types. *)
*)

(*
    all the functions below are declared internally to gm2
    =====

PROCEDURE ADR (VAR v: <anytype>): ADDRESS;
    (* Returns the address of variable v. *)

PROCEDURE SIZE (v: <type>) : ZType;
    (* Returns the number of BYTES used to store a v of
    any specified <type>. Only available if -fpim2 is used.
    *)

```

```

PROCEDURE TSIZE (<type>) : CARDINAL;
  (* Returns the number of BYTES used to store a value of the
     specified <type>.
  *)

PROCEDURE ROTATE (val: <a set type>;
                  num: INTEGER): <type of first parameter>;
  (* Returns a bit sequence obtained from val by rotating up/right
     or down/right by the absolute value of num. The direction is
     down/right if the sign of num is negative, otherwise the direction
     is up/left.
  *)

PROCEDURE SHIFT (val: <a set type>;
                 num: INTEGER): <type of first parameter>;
  (* Returns a bit sequence obtained from val by shifting up/left
     or down/right by the absolute value of num, introducing
     zeros as necessary. The direction is down/right if the sign of
     num is negative, otherwise the direction is up/left.
  *)

PROCEDURE THROW (i: INTEGER) <* noreturn *> ;
  (*
     THROW is a GNU extension and was not part of the PIM or ISO
     standards. It throws an exception which will be caught by the
     EXCEPT block (assuming it exists). This is a compiler builtin
     function which interfaces to the GCC exception handling runtime
     system.
     GCC uses the term throw, hence the naming distinction between
     the GCC builtin and the Modula-2 runtime library procedure Raise.
     The later library procedure Raise will call SYSTEM.THROW after
     performing various housekeeping activities.
  *)

PROCEDURE TBITSIZE (<type>) : CARDINAL ;
  (* Returns the minimum number of bits necessary to represent
     <type>. This procedure function is only useful for determining
     the number of bits used for any type field within a packed RECORD.
     It is not particularly useful elsewhere since <type> might be
     optimized for speed, for example a BOOLEAN could occupy a WORD.
  *)

(* The following procedures are invoked by GNU Modula-2 to
   shift non word sized set types. They are not strictly part
   of the core PIM Modula-2, however they are used
   to implement the SHIFT procedure defined above,

```


4.1.39 gm2-libs/Scan

```
DEFINITION MODULE Scan ;

(* Provides a primitive symbol fetching from input.
   Symbols are delimited by spaces and tabs.
   Limitation only allows one source file at
   a time to deliver symbols.  *)

EXPORT QUALIFIED GetNextSymbol, WriteError,
                  OpenSource, CloseSource,
                  TerminateOnError, DefineComments ;

(* OpenSource - opens a source file for reading. *)

PROCEDURE OpenSource (a: ARRAY OF CHAR) : BOOLEAN ;

(* CloseSource - closes the current source file from reading. *)

PROCEDURE CloseSource ;

(* GetNextSymbol gets the next source symbol and returns it in a. *)

PROCEDURE GetNextSymbol (VAR a: ARRAY OF CHAR) ;

(* WriteError writes a message, a, under the source line, which
   attempts to pinpoint the Symbol at fault. *)

PROCEDURE WriteError (a: ARRAY OF CHAR) ;

(*
   TerminateOnError - exits with status 1 if we call WriteError.
   *)

PROCEDURE TerminateOnError ;

(*
   DefineComments - defines the start of comments within the source
   file.
```

The characters in Start define the comment start and characters in End define the end.

The BOOLEAN eoln determine whether the comment is terminated by end of line. If eoln is TRUE then End is ignored.

If this procedure is never called then no comments are allowed.

*)

PROCEDURE DefineComments (Start, End: ARRAY OF CHAR; eoln: BOOLEAN) ;

END Scan.

4.1.40 gm2-libs/Selective

```

DEFINITION MODULE Selective ;

FROM SYSTEM IMPORT ADDRESS ;

EXPORT QUALIFIED SetOfFd, Timeval,
    InitSet, KillSet, InitTime, KillTime,
    GetTime, SetTime,
    FdZero, FdSet, FdClr, FdIsSet, Select,
    MaxFdsPlusOne, WriteCharRaw, ReadCharRaw,
    GetTimeOfDay ;

TYPE
    SetOfFd = ADDRESS ;      (* Hidden type in Selective.c *)
    Timeval = ADDRESS ;      (* Hidden type in Selective.c *)

PROCEDURE Select (nooffds: CARDINAL;
    readfds, writefds, exceptfds: SetOfFd;
    timeout: Timeval) : INTEGER ;

PROCEDURE InitTime (sec, usec: CARDINAL) : Timeval ;
PROCEDURE KillTime (t: Timeval) : Timeval ;
PROCEDURE GetTime (t: Timeval; VAR sec, usec: CARDINAL) ;
PROCEDURE SetTime (t: Timeval; sec, usec: CARDINAL) ;
PROCEDURE InitSet () : SetOfFd ;
PROCEDURE KillSet (s: SetOfFd) : SetOfFd ;
PROCEDURE FdZero (s: SetOfFd) ;
PROCEDURE FdSet (fd: INTEGER; s: SetOfFd) ;
PROCEDURE FdClr (fd: INTEGER; s: SetOfFd) ;
PROCEDURE FdIsSet (fd: INTEGER; s: SetOfFd) : BOOLEAN ;
PROCEDURE MaxFdsPlusOne (a, b: INTEGER) : INTEGER ;

(* you must use the raw routines with select - not the FIO buffered routines *)
PROCEDURE WriteCharRaw (fd: INTEGER; ch: CHAR) ;
PROCEDURE ReadCharRaw (fd: INTEGER) : CHAR ;

(*
    GetTimeOfDay - fills in a record, Timeval, filled in with the
                    current system time in seconds and microseconds.
                    It returns zero (see man 3p gettimeofday)
*)

PROCEDURE GetTimeOfDay (tv: Timeval) : INTEGER ;

```

END Selective.

4.1.41 gm2-libs/StdIO

```
DEFINITION MODULE StdIO ;

EXPORT QUALIFIED ProcRead, ProcWrite,
                  Read, Write,
                  PushOutput, PopOutput, GetCurrentOutput,
                  PushInput, PopInput, GetCurrentInput ;

TYPE
  ProcWrite = PROCEDURE (CHAR) ;
  ProcRead  = PROCEDURE (VAR CHAR) ;

(*
  Read - is the generic procedure that all higher application layers
         should use to receive a character.
*)

PROCEDURE Read (VAR ch: CHAR) ;

(*
  Write - is the generic procedure that all higher application layers
         should use to emit a character.
*)

PROCEDURE Write (ch: CHAR) ;

(*
  PushOutput - pushes the current Write procedure onto a stack,
              any future references to Write will actually invoke
              procedure, p.
*)

PROCEDURE PushOutput (p: ProcWrite) ;

(*
  PopOutput - restores Write to use the previous output procedure.
*)

PROCEDURE PopOutput ;
```

```
(*
  GetCurrentOutput - returns the current output procedure.
*)

PROCEDURE GetCurrentOutput () : ProcWrite ;

(*
  PushInput - pushes the current Read procedure onto a stack,
              any future references to Read will actually invoke
              procedure, p.
*)

PROCEDURE PushInput (p: ProcRead) ;

(*
  PopInput - restores Write to use the previous output procedure.
*)

PROCEDURE PopInput ;

(*
  GetCurrentInput - returns the current input procedure.
*)

PROCEDURE GetCurrentInput () : ProcRead ;

END StdIO.
```

4.1.42 gm2-libs/Storage

```
DEFINITION MODULE Storage ;

FROM SYSTEM IMPORT ADDRESS ;

EXPORT QUALIFIED ALLOCATE, DEALLOCATE, REALLOCATE, Available ;


(*
  ALLOCATE - attempt to allocate memory from the heap.
             NIL is returned in, a, if ALLOCATE fails.
*)

PROCEDURE ALLOCATE (VAR a: ADDRESS ; Size: CARDINAL) ;


(*
  DEALLOCATE - return, Size, bytes to the heap.
              The variable, a, is set to NIL.
*)

PROCEDURE DEALLOCATE (VAR a: ADDRESS ; Size: CARDINAL) ;


(*
  REALLOCATE - attempts to reallocate storage. The address,
              a, should either be NIL in which case ALLOCATE
              is called, or alternatively it should have already
              been initialized by ALLOCATE. The allocated storage
              is resized accordingly.
*)

PROCEDURE REALLOCATE (VAR a: ADDRESS; Size: CARDINAL) ;


(*
  Available - returns TRUE if, Size, bytes can be allocated.
*)

PROCEDURE Available (Size: CARDINAL) : BOOLEAN ;

END Storage.
```

4.1.43 gm2-libs/StrCase

```
DEFINITION MODULE StrCase ;

EXPORT QUALIFIED StrToUpperCase, StrToLowerCase, Cap, Lower ;

(*
  StrToUpperCase - converts string, a, to uppercase returning the
                  result in, b.
*)

PROCEDURE StrToUpperCase (a: ARRAY OF CHAR ; VAR b: ARRAY OF CHAR) ;

(*
  StrToLowerCase - converts string, a, to lowercase returning the
                  result in, b.
*)

PROCEDURE StrToLowerCase (a: ARRAY OF CHAR ; VAR b: ARRAY OF CHAR) ;

(*
  Cap - converts a lower case character into a capital character.
        If the character is not a lower case character 'a'..'z'
        then the character is simply returned unaltered.
*)

PROCEDURE Cap (ch: CHAR) : CHAR ;

(*
  Lower - converts an upper case character into a lower case character.
          If the character is not an upper case character 'A'..'Z'
          then the character is simply returned unaltered.
*)

PROCEDURE Lower (ch: CHAR) : CHAR ;

END StrCase.
```

4.1.44 gm2-libs/StrIO

```
DEFINITION MODULE StrIO ;

EXPORT QUALIFIED ReadString, WriteString,
                  WriteLn ;

(*
  WriteLn - writes a carriage return and a newline
           character.
*)

PROCEDURE WriteLn ;

(*
  ReadString - reads a sequence of characters into a string.
              Line editing accepts Del, Ctrl H, Ctrl W and
              Ctrl U.
*)

PROCEDURE ReadString (VAR a: ARRAY OF CHAR) ;

(*
  WriteString - writes a string to the default output.
*)

PROCEDURE WriteString (a: ARRAY OF CHAR) ;

END StrIO.
```

4.1.45 gm2-libs/StrLib

```
DEFINITION MODULE StrLib ;
```

```
EXPORT QUALIFIED StrConCat, StrLen, StrCopy, StrEqual, StrLess,  
                  IsSubString, StrRemoveWhitePrefix ;
```

```
(*  
  StrConCat - combines a and b into c.  
*)
```

```
PROCEDURE StrConCat (a, b: ARRAY OF CHAR; VAR c: ARRAY OF CHAR) ;
```

```
(*  
  StrLess - returns TRUE if string, a, alphabetically occurs before  
            string, b.  
*)
```

```
PROCEDURE StrLess (a, b: ARRAY OF CHAR) : BOOLEAN ;
```

```
(*  
  StrEqual - performs a = b on two strings.  
*)
```

```
PROCEDURE StrEqual (a, b: ARRAY OF CHAR) : BOOLEAN ;
```

```
(*  
  StrLen - returns the length of string, a.  
*)
```

```
PROCEDURE StrLen (a: ARRAY OF CHAR) : CARDINAL ;
```

```
(*  
  StrCopy - copy string src into string dest providing dest is large enough.■  
            If dest is smaller than a then src then the string is truncated when■  
            dest is full. Add a nul character if there is room in dest.■  
*)
```

```
PROCEDURE StrCopy (src: ARRAY OF CHAR ; VAR dest: ARRAY OF CHAR) ;
```

```
(*
```

```
    IsSubString - returns true if b is a subcomponent of a.
*)

PROCEDURE IsSubString (a, b: ARRAY OF CHAR) : BOOLEAN ;

(*
    StrRemoveWhitePrefix - copies string, into string, b, excluding any white
                           space in front of a.
*)

PROCEDURE StrRemoveWhitePrefix (a: ARRAY OF CHAR; VAR b: ARRAY OF CHAR) ;

END StrLib.
```

4.1.46 gm2-libs/String

```
DEFINITION MODULE String ;

FROM DynamicStrings IMPORT String ;
FROM FIO IMPORT File ;

PROCEDURE Write (f: File; str: String) ;
PROCEDURE WriteLn (f: File) ;

END String.
```



```

(*)
    StringToInteger - converts a string, s, of, base, into an INTEGER.
                     Leading white space is ignored. It stops converting
                     when either the string is exhausted or if an illegal
                     numeral is found.
                     The parameter found is set TRUE if a number was found.
*)

PROCEDURE StringToInteger (s: String; base: CARDINAL; VAR found: BOOLEAN) : INTEGER ;

(*)
    StringToCardinal - converts a string, s, of, base, into a CARDINAL.
                      Leading white space is ignored. It stops converting
                      when either the string is exhausted or if an illegal
                      numeral is found.
                      The parameter found is set TRUE if a number was found.
*)

PROCEDURE StringToCardinal (s: String; base: CARDINAL; VAR found: BOOLEAN) : CARDINAL

(*)
    LongIntegerToString - converts LONGINT, i, into a String. The field width
                        can be specified if non zero. Leading characters
                        are defined by padding and this function will
                        prepend a + if sign is set to TRUE.
                        The base allows the caller to generate binary,
                        octal, decimal, hexadecimal numbers.
                        The value of lower is only used when hexadecimal
                        numbers are generated and if TRUE then digits
                        abcdef are used, and if FALSE then ABCDEF are used.
*)

PROCEDURE LongIntegerToString (i: LONGINT; width: CARDINAL; padding: CHAR;
                               sign: BOOLEAN; base: CARDINAL; lower: BOOLEAN) : String

(*)
    StringToLongInteger - converts a string, s, of, base, into an LONGINT.
                        Leading white space is ignored. It stops converting
                        when either the string is exhausted or if an illegal
                        numeral is found.
                        The parameter found is set TRUE if a number was found.
*)

```

```
PROCEDURE StringToLongInteger (s: String; base: CARDINAL; VAR found: BOOLEAN) : LONGIN
```

```
(*
  LongCardinalToString - converts LONGCARD, c, into a String. The field
                        width can be specified if non zero. Leading
                        characters are defined by padding.
                        The base allows the caller to generate binary,
                        octal, decimal, hexadecimal numbers.
                        The value of lower is only used when hexadecimal
                        numbers are generated and if TRUE then digits
                        abcdef are used, and if FALSE then ABCDEF are used.
*)
```

```
PROCEDURE LongCardinalToString (c: LONGCARD; width: CARDINAL; padding: CHAR;
                                base: CARDINAL; lower: BOOLEAN) : String ;
```

```
(*
  StringToLongCardinal - converts a string, s, of, base, into a LONGCARD.
                        Leading white space is ignored. It stops converting
                        when either the string is exhausted or if an illegal
                        numeral is found.
                        The parameter found is set TRUE if a number was found.
*)
```

```
PROCEDURE StringToLongCardinal (s: String; base: CARDINAL; VAR found: BOOLEAN) : LONGC
```

```
(*
  ShortCardinalToString - converts SHORTCARD, c, into a String. The field
                        width can be specified if non zero. Leading
                        characters are defined by padding.
                        The base allows the caller to generate binary,
                        octal, decimal, hexadecimal numbers.
                        The value of lower is only used when hexadecimal
                        numbers are generated and if TRUE then digits
                        abcdef are used, and if FALSE then ABCDEF are used.
*)
```

```
PROCEDURE ShortCardinalToString (c: SHORTCARD; width: CARDINAL; padding: CHAR;
                                base: CARDINAL; lower: BOOLEAN) : String ;
```

```
(*
  StringToShortCardinal - converts a string, s, of, base, into a SHORTCARD.
*)
```

Leading white space is ignored. It stops converting
when either the string is exhausted or if an illegal
numeral is found.
The parameter found is set TRUE if a number was found.

*)

```
PROCEDURE StringToShortCardinal (s: String; base: CARDINAL;
                                VAR found: BOOLEAN) : SHORTCARD ;
```

(*
 stoi - decimal string to INTEGER
*)

```
PROCEDURE stoi (s: String) : INTEGER ;
```

(*
 itos - integer to decimal string.
*)

```
PROCEDURE itos (i: INTEGER; width: CARDINAL; padding: CHAR; sign: BOOLEAN) : String ;
```

(*
 ctos - cardinal to decimal string.
*)

```
PROCEDURE ctos (c: CARDINAL; width: CARDINAL; padding: CHAR) : String ;
```

(*
 stoc - decimal string to CARDINAL
*)

```
PROCEDURE stoc (s: String) : CARDINAL ;
```

(*
 hstoi - hexadecimal string to INTEGER
*)

```
PROCEDURE hstoi (s: String) : INTEGER ;
```

(*
 ostoi - octal string to INTEGER

*)

PROCEDURE ostoi (s: String) : INTEGER ;

(*

 bstoi - binary string to INTEGER

*)

PROCEDURE bstoi (s: String) : INTEGER ;

(*

 hstoc - hexadecimal string to CARDINAL

*)

PROCEDURE hstoc (s: String) : CARDINAL ;

(*

 ostoc - octal string to CARDINAL

*)

PROCEDURE ostoc (s: String) : CARDINAL ;

(*

 bstoc - binary string to CARDINAL

*)

PROCEDURE bstoc (s: String) : CARDINAL ;

(*

 StringToLongreal - returns a LONGREAL and sets found to TRUE
 if a legal number is seen.

*)

PROCEDURE StringToLongreal (s: String; VAR found: BOOLEAN) : LONGREAL ;

(*

 LongrealToString - converts a LONGREAL number, Real, which has,
 TotalWidth, and FractionWidth into a string.

So for example:


```

        3      12.3
        2      12
        1      10
*)

PROCEDURE ToSigFig (s: String; n: CARDINAL) : String ;

(*
    ToDecimalPlaces - returns a floating point or base 10 integer
                     string which is accurate to, n, decimal
                     places. It will return a new String
                     and, s, will be destroyed.
                     Decimal places yields, n, digits after
                     the .

                     So:  12.345

                     rounded to the following decimal places yields

                     5      12.34500
                     4      12.3450
                     3      12.345
                     2      12.34
                     1      12.3
*)

PROCEDURE ToDecimalPlaces (s: String; n: CARDINAL) : String ;

END StringConvert.
```

4.1.48 gm2-libs/StringFileSysOp

```
DEFINITION MODULE StringFileSysOp ;

FROM DynamicStrings IMPORT String ;
FROM CFileSysOp IMPORT AccessMode ;


PROCEDURE Exists (filename: String) : BOOLEAN ;
PROCEDURE IsDir (dirname: String) : BOOLEAN ;
PROCEDURE IsFile (filename: String) : BOOLEAN ;
PROCEDURE Unlink (filename: String) : BOOLEAN ;
PROCEDURE Access (pathname: String; mode: AccessMode) : AccessMode ;


END StringFileSysOp.
```

4.1.49 gm2-libs/SysExceptions

```
DEFINITION MODULE SysExceptions ;

(* Provides a mechanism for the underlying libraries to
   configure the exception routines. This mechanism
   is used by both the ISO and PIM libraries.
   It is written to be ISO compliant and this also
   allows for mixed dialect projects. *)

FROM SYSTEM IMPORT ADDRESS ;

TYPE
  PROCEXCEPTION = PROCEDURE (ADDRESS) ;

PROCEDURE InitExceptionHandler (indexf, range, casef, invalidloc,
                                function, wholevalue, wholediv,
                                realvalue, realdiv, complexvalue,
                                complexdiv, protection, systemf,
                                coroutine, exception: PROCEXCEPTION) ;

END SysExceptions.
```

4.1.50 gm2-libs/SysStorage

```
DEFINITION MODULE SysStorage ;
```

```
(* Provides dynamic allocation for the system components.
   This allows the application to use the traditional Storage module
   which can be handled differently. *)
```

```
FROM SYSTEM IMPORT ADDRESS ;
```

```
EXPORT QUALIFIED ALLOCATE, DEALLOCATE, REALLOCATE, Available, Init ;
```

```
(*
   ALLOCATE - attempt to allocate memory from the heap.
               NIL is returned in, a, if ALLOCATE fails.
*)
```

```
PROCEDURE ALLOCATE (VAR a: ADDRESS ; size: CARDINAL) ;
```

```
(*
   DEALLOCATE - return, size, bytes to the heap.
                 The variable, a, is set to NIL.
*)
```

```
PROCEDURE DEALLOCATE (VAR a: ADDRESS ; size: CARDINAL) ;
```

```
(*
   REALLOCATE - attempts to reallocate storage. The address,
                 a, should either be NIL in which case ALLOCATE
                 is called, or alternatively it should have already
                 been initialized by ALLOCATE. The allocated storage
                 is resized accordingly.
*)
```

```
PROCEDURE REALLOCATE (VAR a: ADDRESS; size: CARDINAL) ;
```

```
(*
   Available - returns TRUE if, size, bytes can be allocated.
*)
```

```
PROCEDURE Available (size: CARDINAL) : BOOLEAN;
```

```
(*
```

```
    Init - initializes the heap.  
          This does nothing on a GNU/Linux system.  
          But it remains here since it might be used in an  
          embedded system.  
*)  
  
PROCEDURE Init ;  
  
END SysStorage.
```

4.1.51 gm2-libs/TimeString

```
DEFINITION MODULE TimeString ;
```

```
EXPORT QUALIFIED GetTimeString ;
```

```
(*  
  GetTimeString - places the time in ascii format into array, a.
```

```
*)
```

```
PROCEDURE GetTimeString (VAR a: ARRAY OF CHAR) ;
```

```
END TimeString.
```

4.1.52 gm2-libs/UnixArgs

```
DEFINITION MODULE UnixArgs ;

FROM SYSTEM IMPORT ADDRESS ;

EXPORT QUALIFIED GetArgC, GetArgV, GetEnvV ;

PROCEDURE GetArgC () : INTEGER ;
PROCEDURE GetArgV () : ADDRESS ;
PROCEDURE GetEnvV () : ADDRESS ;

END UnixArgs.
```

4.1.53 gm2-libs/cbuiltin

```

DEFINITION MODULE FOR "C" cbuiltin ;

FROM SYSTEM IMPORT ADDRESS ;
EXPORT UNQUALIFIED alloca, memcpy,
    isfinite, isfinitef, isfinitel,
    isinf_sign, isinf_signf, isinf_signl,
        sinf, sinl, sin,
        cosf, cosl, cos,
        atan2f, atan2l, atan2,
        sqrtf, sqrtl, sqrt,
        fabsf, fabsl, fabs,
        logf, logl, log,
        expf, expl, exp,
        log10f, log10l, log10,
        exp10f, exp10l, exp10,
        ilogbf, ilogbl, ilogb,
        significand, significandf, significandl,
        modf, modff, modfl,
        nextafter, nextafterf, nextafterl,
        nexttoward, nexttowardf, nexttowardl,
        scalb, scalbf, scalbl,
        scalbn, scalbnf, scalbnl,
        scalbln, scalblnf, scalblnl,

        cabsf, cabsl, cabs,
        cargf, carg, cargl,
        conjf, conj, conjl,
        cpowf, cpow, cpowl,
        csqrtf, csqrt, csqrtl,
        cexpf, cexp, cexpl,
        clogf, clog, clogl,
        csinf, csin, csinl,
        ccosf, ccos, ccosl,
        ctanf, ctan, ctanl,
        casinf, casin, casinl,
        cacosf, cacos, cacosl,
        catanf, catan, catanl,

        index, rindex,
        memcmp, memset, memmove,
        strcat, strncat, strcpy, strncpy, strcmp, strncmp,
        strlen, strstr, strpbrk, strspn, strcspn, strchr, strrchr,

        clz, clzll,
        ctz, ctzll ;

```

```

PROCEDURE alloca (i: CARDINAL) : ADDRESS ;
PROCEDURE memcpy (dest, src: ADDRESS; n: CARDINAL) : ADDRESS ;
PROCEDURE isfinite (x: REAL) : BOOLEAN ;
PROCEDURE isfinitel (x: LONGREAL) : BOOLEAN ;
PROCEDURE isfinitef (x: SHORTREAL) : BOOLEAN ;
PROCEDURE isinf_sign (x: REAL) : BOOLEAN ;
PROCEDURE isinf_signl (x: LONGREAL) : BOOLEAN ;
PROCEDURE isinf_signf (x: SHORTREAL) : BOOLEAN ;
PROCEDURE sinf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE sin (x: REAL) : REAL ;
PROCEDURE sinl (x: LONGREAL) : LONGREAL ;
PROCEDURE cosf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE cos (x: REAL) : REAL ;
PROCEDURE cosl (x: LONGREAL) : LONGREAL ;
PROCEDURE atan2f (x, y: SHORTREAL) : SHORTREAL ;
PROCEDURE atan2 (x, y: REAL) : REAL ;
PROCEDURE atan2l (x, y: LONGREAL) : LONGREAL ;
PROCEDURE sqrtf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE sqrt (x: REAL) : REAL ;
PROCEDURE sqrtl (x: LONGREAL) : LONGREAL ;
PROCEDURE fabsf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE fabs (x: REAL) : REAL ;
PROCEDURE fabsl (x: LONGREAL) : LONGREAL ;
PROCEDURE logf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE log (x: REAL) : REAL ;
PROCEDURE logl (x: LONGREAL) : LONGREAL ;
PROCEDURE expf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE exp (x: REAL) : REAL ;
PROCEDURE expl (x: LONGREAL) : LONGREAL ;
PROCEDURE log10f (x: SHORTREAL) : SHORTREAL ;
PROCEDURE log10 (x: REAL) : REAL ;
PROCEDURE log10l (x: LONGREAL) : LONGREAL ;
PROCEDURE exp10f (x: SHORTREAL) : SHORTREAL ;
PROCEDURE exp10 (x: REAL) : REAL ;
PROCEDURE exp10l (x: LONGREAL) : LONGREAL ;
PROCEDURE ilogbf (x: SHORTREAL) : INTEGER ;
PROCEDURE ilogb (x: REAL) : INTEGER ;
PROCEDURE ilogbl (x: LONGREAL) : INTEGER ;

PROCEDURE significand (r: REAL) : REAL ;
PROCEDURE significandf (s: SHORTREAL) : SHORTREAL ;
PROCEDURE significandl (l: LONGREAL) : LONGREAL ;

PROCEDURE modf (x: REAL; VAR y: REAL) : REAL ;
PROCEDURE modff (x: SHORTREAL; VAR y: SHORTREAL) : SHORTREAL ;
PROCEDURE modfl (x: LONGREAL; VAR y: LONGREAL) : LONGREAL ;

```

```
PROCEDURE nextafter (x, y: REAL) : REAL ;
PROCEDURE nextafterf (x, y: SHORTREAL) : SHORTREAL ;
PROCEDURE nextafterl (x, y: LONGREAL) : LONGREAL ;

PROCEDURE nexttoward (x: REAL; y: LONGREAL) : REAL ;
PROCEDURE nexttowardf (x: SHORTREAL; y: LONGREAL) : SHORTREAL ;
PROCEDURE nexttowardl (x, y: LONGREAL) : LONGREAL ;

PROCEDURE scalb (x, n: REAL) : REAL ;
PROCEDURE scalbf (x, n: SHORTREAL) : SHORTREAL ;
PROCEDURE scalbl (x, n: LONGREAL) : LONGREAL ;

PROCEDURE scalbn (x: REAL; n: INTEGER) : REAL ;
PROCEDURE scalbnf (x: SHORTREAL; n: INTEGER) : SHORTREAL ;
PROCEDURE scalbnl (x: LONGREAL; n: INTEGER) : LONGREAL ;

PROCEDURE scalbln (x: REAL; n: LONGINT) : REAL ;
PROCEDURE scalblnf (x: SHORTREAL; n: LONGINT) : SHORTREAL ;
PROCEDURE scalblnl (x: LONGREAL; n: LONGINT) : LONGREAL ;

PROCEDURE cabsf (z: SHORTCOMPLEX) : SHORTREAL ;
PROCEDURE cabs (z: COMPLEX) : REAL ;
PROCEDURE cabsl (z: LONGCOMPLEX) : LONGREAL ;

PROCEDURE cargf (z: SHORTCOMPLEX) : SHORTREAL ;
PROCEDURE carg (z: COMPLEX) : REAL ;
PROCEDURE cargl (z: LONGCOMPLEX) : LONGREAL ;

PROCEDURE conjf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE conj (z: COMPLEX) : COMPLEX ;
PROCEDURE conjl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE cpowf (base: SHORTCOMPLEX; exp: SHORTREAL) : SHORTCOMPLEX ;
PROCEDURE cpow (base: COMPLEX; exp: REAL) : COMPLEX ;
PROCEDURE cpowl (base: LONGCOMPLEX; exp: LONGREAL) : LONGCOMPLEX ;

PROCEDURE csqrtf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE csqrt (z: COMPLEX) : COMPLEX ;
PROCEDURE csqrtl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE cexpf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE cexp (z: COMPLEX) : COMPLEX ;
PROCEDURE cexpl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE clogf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE clog (z: COMPLEX) : COMPLEX ;
```

```

PROCEDURE clogl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE csinf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE csin (z: COMPLEX) : COMPLEX ;
PROCEDURE csinl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE ccosf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE ccos (z: COMPLEX) : COMPLEX ;
PROCEDURE ccosl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE ctanf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE ctan (z: COMPLEX) : COMPLEX ;
PROCEDURE ctanl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE casinf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE casin (z: COMPLEX) : COMPLEX ;
PROCEDURE casinl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE cacosf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE cacos (z: COMPLEX) : COMPLEX ;
PROCEDURE cacosl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE catanf (z: SHORTCOMPLEX) : SHORTCOMPLEX ;
PROCEDURE catan (z: COMPLEX) : COMPLEX ;
PROCEDURE catanl (z: LONGCOMPLEX) : LONGCOMPLEX ;

PROCEDURE index (s: ADDRESS; c: INTEGER) : ADDRESS ;
PROCEDURE rindex (s: ADDRESS; c: INTEGER) : ADDRESS ;
PROCEDURE memcmp (s1, s2: ADDRESS; n: CARDINAL) : INTEGER ;
PROCEDURE memmove (s1, s2: ADDRESS; n: CARDINAL) : ADDRESS ;
PROCEDURE memset (s: ADDRESS; c: INTEGER; n: CARDINAL) : ADDRESS ;
PROCEDURE strcat (dest, src: ADDRESS) : ADDRESS ;
PROCEDURE strncat (dest, src: ADDRESS; n: CARDINAL) : ADDRESS ;
PROCEDURE strcpy (dest, src: ADDRESS) : ADDRESS ;
PROCEDURE strncpy (dest, src: ADDRESS; n: CARDINAL) : ADDRESS ;
PROCEDURE strcmp (s1, s2: ADDRESS) : INTEGER ;
PROCEDURE strncmp (s1, s2: ADDRESS; n: CARDINAL) : INTEGER ;
PROCEDURE strlen (s: ADDRESS) : INTEGER ;
PROCEDURE strstr (haystack, needle: ADDRESS) : ADDRESS ;
PROCEDURE strpbrk (s, accept: ADDRESS) : ADDRESS ;
PROCEDURE strspn (s, accept: ADDRESS) : CARDINAL ;
PROCEDURE strcspn (s, accept: ADDRESS) : CARDINAL ;
PROCEDURE strchr (s: ADDRESS; c: INTEGER) : ADDRESS ;
PROCEDURE strrchr (s: ADDRESS; c: INTEGER) : ADDRESS ;

PROCEDURE clz (value: CARDINAL) : INTEGER ;
PROCEDURE clzll (value: CARDINAL) : INTEGER ;

```

```
PROCEDURE ctz (value: CARDINAL) : INTEGER ;  
PROCEDURE ctzll (value: CARDINAL) : INTEGER ;
```

```
END cbuiltin.
```

4.1.54 gm2-libs/cgetopt

```
DEFINITION MODULE cgetopt ;
```

```
FROM SYSTEM IMPORT ADDRESS ;
```

```
TYPE
```

```
  Options = ADDRESS ;
```

```
VAR
```

```
  optarg          : ADDRESS ;
```

```
  optind, opterr, optopt: INTEGER ;
```

```
(*
```

```
  getopt - the getopt() function parses the command-line arguments.
```

```
  Its arguments argc and argv are the argument count and array as
  passed to the main() function on program invocation. An element of
  argv that starts with '-' (and is not exactly "-" or "--") is an
  option element. The characters of this element (aside from the
  initial '-') are option characters. If getopt() is called
  repeatedly, it returns successively each of the option characters
  from each of the option elements.
```

```
*)
```

```
PROCEDURE getopt (argc: INTEGER; argv: ADDRESS; optstring: ADDRESS) : CHAR ;
```

```
(*
```

```
  getopt_long - works like getopt() except that it also accepts long options,
  started with two dashes. (If the program accepts only long
  options, then optstring should be specified as an empty string (""),
  not NULL.) Long option names may be abbreviated if the abbreviation
  is unique or is an exact match for some defined option. A
  long option may take a parameter, of the form --arg=param or
  --arg param.
```

```
*)
```

```
PROCEDURE getopt_long (argc: INTEGER; argv: ADDRESS; optstring: ADDRESS;
  longopts: ADDRESS; VAR longindex: INTEGER) : INTEGER ;
```

```
(*
```

```
  getopt_long_only - a wrapper for the C getopt_long_only.
```

```
*)
```

```
PROCEDURE getopt_long_only (argc: INTEGER; argv: ADDRESS; optstring: ADDRESS;
```

```
                                longopts: ADDRESS; VAR longindex: INTEGER) : INTEGER ;■

(*
  InitOptions - constructor for empty Options.
*)

PROCEDURE InitOptions () : Options ;

(*
  KillOptions - deconstructor for empty Options.
*)

PROCEDURE KillOptions (o: Options) : Options ;

(*
  SetOption - set option[index] with {name, has_arg, flag, val}.
*)

PROCEDURE SetOption (o: Options; index: CARDINAL;
                    name: ADDRESS; has_arg: INTEGER;
                    VAR flag: INTEGER; val: INTEGER) ;

(*
  GetLongOptionArray - return a pointer to the C array containing all
                      long options.
*)

PROCEDURE GetLongOptionArray (o: Options) : ADDRESS ;

END cgetopt.
```

4.1.55 gm2-libs/cxxabi

```
DEFINITION MODULE FOR "C" cxxabi ;

(* This should only be used by the compiler and it matches the
   g++ implementation. *)

FROM SYSTEM IMPORT ADDRESS ;
EXPORT UNQUALIFIED __cxa_begin_catch, __cxa_end_catch, __cxa_rethrow ;

PROCEDURE __cxa_begin_catch (a: ADDRESS) : ADDRESS ;
PROCEDURE __cxa_end_catch ;
PROCEDURE __cxa_rethrow ;

END cxxabi.
```

4.1.56 gm2-libs/dtoa

```

DEFINITION MODULE dtoa ;

FROM SYSTEM IMPORT ADDRESS ;

TYPE
  Mode = (maxsignificant, decimaldigits) ;

(*
  strtod - returns a REAL given a string, s.  It will set
           error to TRUE if the number is too large.
*)

PROCEDURE strtod (s: ADDRESS; VAR error: BOOLEAN) : REAL ;

(*
  dtoa - converts a REAL, d, into a string.  The address of the
         string is returned.
         mode      indicates the type of conversion required.
         ndigits   determines the number of digits according to mode.
         decpt     the position of the decimal point.
         sign      does the string have a sign?
*)

PROCEDURE dtoa (d          : REAL;
               mode       : INTEGER;
               ndigits    : INTEGER;
               VAR decpt: INTEGER;
               VAR sign : BOOLEAN) : ADDRESS ;

END dtoa.

```

4.1.57 gm2-libs/errno

```
DEFINITION MODULE errno ;

CONST
    EINTR  = 4 ;    (* system call interrupted *)
    ERANGE = 34 ;   (* result is too large    *)
    EAGAIN = 11 ;   (* retry the system call  *)

PROCEDURE geterrno () : INTEGER ;

END errno.
```

4.1.58 gm2-libs/gdbif

```
DEFINITION MODULE gdbif ;

(* Provides interactive connectivity with gdb useful for debugging
   Modula-2 shared libraries. *)

EXPORT UNQUALIFIED sleepSpin, finishSpin, connectSpin ;

(*
   finishSpin - sets boolean mustWait to FALSE.
*)

PROCEDURE finishSpin ;

(*
   sleepSpin - waits for the boolean variable mustWait to become FALSE.
               It sleeps for a second between each test of the variable.
*)

PROCEDURE sleepSpin ;

(*
   connectSpin - breakpoint placeholder. Its only purpose is to allow users
                 to set a breakpoint. This procedure is called once
                 sleepSpin is released from its spin (via a call from
                 finishSpin).
*)

PROCEDURE connectSpin ;

END gdbif.
```

4.1.59 gm2-libs/ldtoa

```

DEFINITION MODULE ldtoa ;

FROM SYSTEM IMPORT ADDRESS ;

TYPE
  Mode = (maxsignificant, decimaldigits) ;

  (*
    strtold - returns a LONGREAL given a C string, s. It will set
               error to TRUE if the number is too large or badly formed.
  *)

PROCEDURE strtold (s: ADDRESS; VAR error: BOOLEAN) : LONGREAL ;

  (*
    ldtoa - converts a LONGREAL, d, into a string. The address of the
             string is returned.
             mode      indicates the type of conversion required.
             ndigits   determines the number of digits according to mode.
             decpt     the position of the decimal point.
             sign      does the string have a sign?
  *)

PROCEDURE ldtoa (d          : LONGREAL;
                 mode       : INTEGER;
                 ndigits    : INTEGER;
                 VAR decpt  : INTEGER;
                 VAR sign   : BOOLEAN) : ADDRESS ;

END ldtoa.

```

4.1.60 gm2-libs/libc

```

DEFINITION MODULE FOR "C" libc ;

FROM SYSTEM IMPORT ADDRESS, CSIZE_T, CSSIZE_T, COFF_T ;

EXPORT UNQUALIFIED time_t, timeb, tm, ptrToTM,
                    atof, atoi, atol, atoll,
                    strtod, strtof, strtold, strtol, strtoll, strtoul, strtoull,
                    write, read,
                    system, abort,
                    malloc, free,
                    exit, isatty,
                    getenv, putenv, getpid,
                    dup, close, open, lseek,
                    readv, writev,
                    perror, creat,
                    getcwd, chown, strlen, strcpy, strncpy,
                    unlink, setenv,
                    memcpy, memset, memmove, printf, realloc,
                    rand, srand,
                    time, localtime, ftime,
                    shutdown, snprintf,
                    rename, setjmp, longjmp, atexit,
                    ttyname, sleep, execv ;

TYPE
    time_t = LONGINT ;

    ptrToTM = POINTER TO tm ;
    tm = RECORD
        tm_sec: INTEGER ;      (* Seconds.      [0-60] (1 leap second) *)
        tm_min: INTEGER ;      (* Minutes.     [0-59]  *)
        tm_hour: INTEGER ;     (* Hours.      [0-23]  *)
        tm_mday: INTEGER ;     (* Day.        [1-31]  *)
        tm_mon: INTEGER ;      (* Month.      [0-11]  *)
        tm_year: INTEGER ;     (* Year - 1900. *)
        tm_wday: INTEGER ;     (* Day of week. [0-6]   *)
        tm_yday: INTEGER ;     (* Days in year. [0-365] *)
        tm_isdst: INTEGER ;    (* DST.        [-1/0/1] *)
        tm_gmtoff: LONGINT ;   (* Seconds east of UTC. *)
        tm_zone: ADDRESS ;     (* char * zone name   *)
    END ;

    timeb = RECORD
        time      : time_t ;

```

```

        millitm : SHORTCARD ;
        timezone: SHORTCARD ;
        dstflag : SHORTCARD ;
    END ;

    exitP = PROCEDURE () : INTEGER ;

(*
    double atof(const char *nptr)
*)
PROCEDURE atof (nptr: ADDRESS) : REAL ;

(*
    int atoi(const char *nptr)
*)
PROCEDURE atoi (nptr: ADDRESS) : INTEGER ;

(*
    long atol(const char *nptr);
*)
PROCEDURE atol (nptr: ADDRESS) : CSSIZE_T ;

(*
    long long atoll(const char *nptr);
*)
PROCEDURE atoll (nptr: ADDRESS) : LONGINT ;

(*
    double strtod(const char *restrict nptr, char **_Nullable restrict endptr)■
*)
PROCEDURE strtod (nptr, endptr: ADDRESS) : REAL ;

(*
    float strtodf(const char *restrict nptr, char **_Nullable restrict endptr)■
*)

```

```

PROCEDURE strtouf (nptr, endptr: ADDRESS) : SHORTREAL ;

(*
    long double strtold(const char *restrict nptr,
                        char **_Nullable restrict endptr)
*)

PROCEDURE strtold (nptr, endptr: ADDRESS) : LONGREAL ;

(*
    long strtol(const char *restrict nptr, char **_Nullable restrict endptr,
                int base)
*)

PROCEDURE strtol (nptr, endptr: ADDRESS; base: INTEGER) : CSSIZE_T ;

(*
    long long strtoll(const char *restrict nptr,
                      char **_Nullable restrict endptr, int base)
*)

PROCEDURE strtoll (nptr, endptr: ADDRESS; base: INTEGER) : LONGINT ;

(*
    unsigned long strtoul(const char *restrict nptr,
                          char **_Nullable restrict endptr, int base)
*)

PROCEDURE strtoul (nptr, endptr: ADDRESS; base: INTEGER) : CSIZE_T ;

(*
    unsigned long long strtoull(const char *restrict nptr,
                                char **_Nullable restrict endptr, int base)
*)

PROCEDURE strtoull (nptr, endptr: ADDRESS; base: INTEGER) : LONGCARD ;

(*
    ssize_t write (int d, void *buf, size_t nbytes)
*)

```

```
PROCEDURE write (d: INTEGER; buf: ADDRESS; nbytes: CSIZE_T) : [ CSSIZE_T ] ;■
```

```
(*
    ssize_t read (int d, void *buf, size_t nbytes)
*)
```

```
PROCEDURE read (d: INTEGER; buf: ADDRESS; nbytes: CSIZE_T) : [ CSSIZE_T ] ;■
```

```
(*
    int system(string)
    char *string;
*)
```

```
PROCEDURE system (a: ADDRESS) : [ INTEGER ] ;
```

```
(*
    abort - generate a fault

    abort() first closes all open files if possible, then sends
    an IOT signal to the process. This signal usually results
    in termination with a core dump, which may be used for
    debugging.

    It is possible for abort() to return control if is caught or
    ignored, in which case the value returned is that of the
    kill(2V) system call.
*)
```

```
PROCEDURE abort <* noreturn *> ;
```

```
(*
    malloc - memory allocator.

    void *malloc(size_t size);

    malloc() returns a pointer to a block of at least size
    bytes, which is appropriately aligned. If size is zero,
    malloc() returns a non-NULL pointer, but this pointer should
    not be dereferenced.
*)
```

```
PROCEDURE malloc (size: CSIZE_T) : ADDRESS ;
```

```

(*)
    free - memory deallocator.

    free (void *ptr);

    free() releases a previously allocated block. Its argument
    is a pointer to a block previously allocated by malloc,
    calloc, realloc, malloc, or memalign.
*)

PROCEDURE free (ptr: ADDRESS) ;

(*)
    void *realloc (void *ptr, size_t size);

    realloc changes the size of the memory block pointed to
    by ptr to size bytes. The contents will be unchanged to
    the minimum of the old and new sizes; newly allocated memory
    will be uninitialized. If ptr is NIL, the call is
    equivalent to malloc(size); if size is equal to zero, the
    call is equivalent to free(ptr). Unless ptr is NIL, it
    must have been returned by an earlier call to malloc(),
    realloc.
*)

PROCEDURE realloc (ptr: ADDRESS; size: CSIZE_T) : ADDRESS ;

(*)
    isatty - does this descriptor refer to a terminal.
*)

PROCEDURE isatty (fd: INTEGER) : INTEGER ;

(*)
    exit - returns control to the invoking process. Result, r, is
    returned.
*)

PROCEDURE exit (r: INTEGER) <* noreturn *> ;

(*)
    getenv - returns the C string for the equivalent C environment

```

```
        variable.
*)

PROCEDURE getenv (s: ADDRESS) : ADDRESS ;

(*
    putenv - change or add an environment variable.
*)

PROCEDURE putenv (s: ADDRESS) : INTEGER ;

(*
    getpid - returns the UNIX process identification number.
*)

PROCEDURE getpid () : INTEGER ;

(*
    dup - duplicates the file descriptor, d.
*)

PROCEDURE dup (d: INTEGER) : INTEGER ;

(*
    close - closes the file descriptor, d.
*)

PROCEDURE close (d: INTEGER) : [ INTEGER ] ;

(*
    open - open the file, filename with flag and mode.
*)

PROCEDURE open (filename: ADDRESS; oflag: INTEGER; mode: INTEGER) : INTEGER ;■

(*
    creat - creates a new file
*)

PROCEDURE creat (filename: ADDRESS; mode: CARDINAL) : INTEGER;
```

```

(*)
    lseek - calls unix lseek:

        off_t lseek(int fildes, off_t offset, int whence);
*)

PROCEDURE lseek (fd: INTEGER; offset: COFF_T; whence: INTEGER) : [ COFF_T ] ;■

(*)
    perror - writes errno and string. (ARRAY OF CHAR is translated onto ADDRESS).■
*)

PROCEDURE perror (string: ARRAY OF CHAR);

(*)
    readv - reads an io vector of bytes.
*)

PROCEDURE readv (fd: INTEGER; v: ADDRESS; n: INTEGER) : [ INTEGER ] ;

(*)
    writev - writes an io vector of bytes.
*)

PROCEDURE writev (fd: INTEGER; v: ADDRESS; n: INTEGER) : [ INTEGER ] ;

(*)
    getcwd - copies the absolute pathname of the
              current working directory to the array pointed to by buf,
              which is of length size.

              If the current absolute path name would require a buffer
              longer than size elements, NULL is returned, and errno is
              set to ERANGE; an application should check for this error,
              and allocate a larger buffer if necessary.
*)

PROCEDURE getcwd (buf: ADDRESS; size: CSIZE_T) : ADDRESS ;

(*)
    chown - The owner of the file specified by path or by fd is

```

changed. Only the super-user may change the owner of a file. The owner of a file may change the group of the file to any group of which that owner is a member. The super-user may change the group arbitrarily.

If the owner or group is specified as -1, then that ID is not changed.

On success, zero is returned. On error, -1 is returned, and errno is set appropriately.

*)

```
PROCEDURE chown (filename: ADDRESS; uid, gid: INTEGER) : [ INTEGER ] ;
```

(*

strlen - returns the length of string, a.

*)

```
PROCEDURE strlen (a: ADDRESS) : CSIZE_T ;
```

(*

strcpy - copies string, src, into, dest.
It returns dest.

*)

```
PROCEDURE strcpy (dest, src: ADDRESS) : [ ADDRESS ] ;
```

(*

strncpy - copies string, src, into, dest, copying at most, n, bytes.
It returns dest.

*)

```
PROCEDURE strncpy (dest, src: ADDRESS; n: CARDINAL) : [ ADDRESS ] ;
```

(*

unlink - removes file and returns 0 if successful.

*)

```
PROCEDURE unlink (file: ADDRESS) : [ INTEGER ] ;
```

(*

memcpy - copy memory area

SYNOPSIS

```
#include <string.h>
```

```
void *memcpy(void *dest, const void *src, size_t n);
It returns dest.
```

```
*)
```

```
PROCEDURE memcpy (dest, src: ADDRESS; size: CSIZE_T) : [ ADDRESS ] ;
```

```
(*
```

```
memset - fill memory with a constant byte
```

SYNOPSIS

```
#include <string.h>
```

```
void *memset(void *s, int c, size_t n);
It returns s.
```

```
*)
```

```
PROCEDURE memset (s: ADDRESS; c: INTEGER; size: CSIZE_T) : [ ADDRESS ] ;
```

```
(*
```

```
memmove - copy memory areas which may overlap
```

SYNOPSIS

```
#include <string.h>
```

```
void *memmove(void *dest, const void *src, size_t n);
It returns dest.
```

```
*)
```

```
PROCEDURE memmove (dest, src: ADDRESS; size: CSIZE_T) : [ ADDRESS ] ;
```

```
(*
```

```
int printf(const char *format, ...);
```

```
*)
```

```
PROCEDURE printf (format: ARRAY OF CHAR; ...) : [ INTEGER ] ;
```

```

(*)
    int snprintf(char *str, size_t size, const char *format, ...);
*)

PROCEDURE snprintf (dest: ADDRESS; size: CSIZE_T;
                    format: ARRAY OF CHAR; ...) : [ INTEGER ] ;

(*)
    setenv - sets environment variable, name, to value.
            It will overwrite an existing value if, overwrite,
            is true. It returns 0 on success and -1 for an error.
*)

PROCEDURE setenv (name: ADDRESS; value: ADDRESS; overwrite: INTEGER) : [ INTEGER ] ;■

(*)
    srand - initialize the random number seed.
*)

PROCEDURE srand (seed: INTEGER) ;

(*)
    rand - return a random integer.
*)

PROCEDURE rand () : INTEGER ;

(*)
    time - returns a pointer to the time_t value. If, a,
           is not NIL then the libc value is copied into
           memory at address, a.
*)

PROCEDURE time (a: ADDRESS) : time_t ;

(*)
    localtime - returns a pointer to the libc copy of the tm
               structure.
*)

PROCEDURE localtime (VAR t: time_t) : ADDRESS ;

```

```
(*
    ftime - return date and time.
*)

PROCEDURE ftime (VAR t: timeb) : [ INTEGER ] ;

(*
    shutdown - shutdown a socket, s.
               if how = 0, then no more reads are allowed.
               if how = 1, then no more writes are allowed.
               if how = 2, then no more reads or writes are allowed.
*)

PROCEDURE shutdown (s: INTEGER; how: INTEGER) : [ INTEGER ] ;

(*
    rename - change the name or location of a file
*)

PROCEDURE rename (oldpath, newpath: ADDRESS) : [ INTEGER ] ;

(*
    setjmp - returns 0 if returning directly, and non-zero
             when returning from longjmp using the saved
             context.
*)

PROCEDURE setjmp (env: ADDRESS) : INTEGER ;

(*
    longjmp - restores the environment saved by the last call
              of setjmp with the corresponding env argument.
              After longjmp is completed, program execution
              continues as if the corresponding call of setjmp
              had just returned the value val. The value of
              val must not be zero.
*)

PROCEDURE longjmp (env: ADDRESS; val: INTEGER) ;

(*
    atexit - execute, proc, when the function exit is called.
```

```
*)

PROCEDURE atexit (proc: exitP) : [ INTEGER ] ;

(*
  ttyname - returns a pointer to a string determining the ttyname.
*)

PROCEDURE ttyname (filedes: INTEGER) : ADDRESS ;

(*
  sleep - calling thread sleeps for seconds.
*)

PROCEDURE sleep (seconds: CARDINAL) : [ CARDINAL ] ;

(*
  execv - execute a file.
*)

PROCEDURE execv (pathname: ADDRESS; argv: ADDRESS) : [ INTEGER ] ;

END libc.
```

4.1.61 gm2-libs/libm

```
DEFINITION MODULE FOR "C" libm ;
```

```
(* Users are strongly advised to use MathLib0 or RealMath as calls
   to functions within these modules will generate inline code.
   This module is used by MathLib0 and RealMath when inline code cannot
   be generated. *)
```

```
EXPORT UNQUALIFIED sin, sinl, sinf,
                    cos, cosl, cosf,
                    tan, tanl, tanf,
                    sqrt, sqrtl, sqrtf,
                    asin, asinl, asinf,
                    acos, acosl, acosf,
                    atan, atanl, atanf,
                    atan2, atan2l, atan2f,
                    exp, expl, expf,
                    log, logl, logf,
                    exp10, exp10l, exp10f,
                    pow, powl, powf,
                    floor, floorl, floorf,
                    ceil, ceill, ceilf ;
```

```
PROCEDURE sin (x: REAL) : REAL ;
PROCEDURE sinl (x: LONGREAL) : LONGREAL ;
PROCEDURE sinf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE cos (x: REAL) : REAL ;
PROCEDURE cosl (x: LONGREAL) : LONGREAL ;
PROCEDURE cosf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE tan (x: REAL) : REAL ;
PROCEDURE tanl (x: LONGREAL) : LONGREAL ;
PROCEDURE tanf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE sqrt (x: REAL) : REAL ;
PROCEDURE sqrtl (x: LONGREAL) : LONGREAL ;
PROCEDURE sqrtf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE asin (x: REAL) : REAL ;
PROCEDURE asinl (x: LONGREAL) : LONGREAL ;
PROCEDURE asinf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE acos (x: REAL) : REAL ;
PROCEDURE acosl (x: LONGREAL) : LONGREAL ;
PROCEDURE acosf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE atan (x: REAL) : REAL ;
PROCEDURE atanl (x: LONGREAL) : LONGREAL ;
PROCEDURE atanf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE atan2 (x, y: REAL) : REAL ;
PROCEDURE atan2l (x, y: LONGREAL) : LONGREAL ;
```

```
PROCEDURE atan2f (x, y: SHORTREAL) : SHORTREAL ;
PROCEDURE exp (x: REAL) : REAL ;
PROCEDURE expl (x: LONGREAL) : LONGREAL ;
PROCEDURE expf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE log (x: REAL) : REAL ;
PROCEDURE logl (x: LONGREAL) : LONGREAL ;
PROCEDURE logf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE exp10 (x: REAL) : REAL ;
PROCEDURE exp10l (x: LONGREAL) : LONGREAL ;
PROCEDURE exp10f (x: SHORTREAL) : SHORTREAL ;
PROCEDURE pow (x, y: REAL) : REAL ;
PROCEDURE powl (x, y: LONGREAL) : LONGREAL ;
PROCEDURE powf (x, y: SHORTREAL) : SHORTREAL ;
PROCEDURE floor (x: REAL) : REAL ;
PROCEDURE floorl (x: LONGREAL) : LONGREAL ;
PROCEDURE floorf (x: SHORTREAL) : SHORTREAL ;
PROCEDURE ceil (x: REAL) : REAL ;
PROCEDURE ceill (x: LONGREAL) : LONGREAL ;
PROCEDURE ceilf (x: SHORTREAL) : SHORTREAL ;

END libm.
```

4.1.62 gm2-libs/sckt

```

DEFINITION MODULE sckt ;

FROM SYSTEM IMPORT ADDRESS ;
EXPORT QUALIFIED tcpServerState,
                 tcpServerEstablish, tcpServerEstablishPort,
                 tcpServerAccept, getLocalIP,
                 tcpServerPortNo, tcpServerIP, tcpServerSocketFd,
                 tcpServerClientIP, tcpServerClientPortNo,
                 tcpClientState,
                 tcpClientSocket, tcpClientSocketIP, tcpClientConnect,
                 tcpClientPortNo, tcpClientIP, tcpClientSocketFd ;

TYPE
  tcpServerState = ADDRESS ;
  tcpClientState = ADDRESS ;

(*
  tcpServerEstablish - returns a tcpState containing the relevant
                      information about a socket declared to receive
                      tcp connections.
*)

PROCEDURE tcpServerEstablish () : tcpServerState ;

(*
  tcpServerEstablishPort - returns a tcpState containing the relevant
                          information about a socket declared to receive
                          tcp connections. This method attempts to use
                          the port specified by the parameter.
*)

PROCEDURE tcpServerEstablishPort (port: CARDINAL) : tcpServerState ;

(*
  tcpServerAccept - returns a file descriptor once a client has connected and
                   been accepted.
*)

PROCEDURE tcpServerAccept (s: tcpServerState) : INTEGER ;

(*

```



```
PROCEDURE tcpClientSocket (serverName: ADDRESS; portNo: CARDINAL) : tcpClientState ;■

(*
  tcpClientSocketIP - returns a file descriptor (socket) which has
                    connected to, ip:portNo.
*)

PROCEDURE tcpClientSocketIP (ip: CARDINAL; portNo: CARDINAL) : tcpClientState ;■

(*
  tcpClientConnect - returns the file descriptor associated with, s,
                    once a connect has been performed.
*)

PROCEDURE tcpClientConnect (s: tcpClientState) : INTEGER ;

(*
  tcpClientPortNo - returns the portNo from structure, s.
*)

PROCEDURE tcpClientPortNo (s: tcpClientState) : INTEGER ;

(*
  tcpClientSocketFd - returns the sockFd from structure, s.
*)

PROCEDURE tcpClientSocketFd (s: tcpClientState) : INTEGER ;

(*
  tcpClientIP - returns the IP address from structure, s.
*)

PROCEDURE tcpClientIP (s: tcpClientState) : CARDINAL ;

END sckt.
```

4.1.63 gm2-libs/termios

```

DEFINITION MODULE termios ;

FROM SYSTEM IMPORT ADDRESS ;

TYPE
  TERMIOS = ADDRESS ;

  ControlChar = (vintr, vquit, verase, vkill, veof, vtime, vmin,
                 vswtc, vstart, vstop, vsusp, veol, vreprint, vdiscard,
                 vwerase, vlnext, veol2) ;

  Flag = (
    (* input flag bits *)
    ignbrk, ibrkint, ignpar, iparmrk, inpck, istrip, inlcr,
    igncr, icrnl, iuclc, ixon, ixany, ixoff, imaxbel,
    (* output flag bits *)
    opost, olcuc, onlcr, ocrnl, onocr, onlret, ofill, ofdel,
    onl0, onl1, ocr0, ocr1, ocr2, ocr3,
    otab0, otab1, otab2, otab3, obs0, obs1, off0, off1, ovt0, ovt1,
    (* baud rate *)
    b0, b50, b75, b110, b135, b150, b200, b300, b600, b1200,
    b1800, b2400, b4800, b9600, b19200, b38400,
    b57600, b115200, b240400, b460800, b500000, b576000,
    b921600, b1000000, b1152000, b1500000, b2000000, b2500000,
    b3000000, b3500000, b4000000, maxbaud, crtscts,
    (* character size *)
    cs5, cs6, cs7, cs8, cstopb, cread, parenb, parodd, hupcl, clocal,
    (* local flags *)
    lisig, licanon, lxcase, lecho, lechoe, lechok, lechonl, lnoflsh,
    ltopstop, lechoctl, lechopr, lechoke, lflusho, lpendin, liexten) ;

  (*
    InitTermios - new data structure.
  *)

PROCEDURE InitTermios () : TERMIOS ;

  (*
    KillTermios - delete data structure.
  *)

PROCEDURE KillTermios (t: TERMIOS) : TERMIOS ;

```

```
(*
    cfgetospeed - return output baud rate.
*)

PROCEDURE cfgetospeed (t: TERMIOS) : INTEGER ;

(*
    cfgetispeed - return input baud rate.
*)

PROCEDURE cfgetispeed (t: TERMIOS) : INTEGER ;

(*
    cfsetospeed - set output baud rate.
*)

PROCEDURE cfsetospeed (t: TERMIOS; b: CARDINAL) : INTEGER ;

(*
    cfsetispeed - set input baud rate.
*)

PROCEDURE cfsetispeed (t: TERMIOS; b: CARDINAL) : INTEGER ;

(*
    cfsetspeed - set input and output baud rate.
*)

PROCEDURE cfsetspeed (t: TERMIOS; b: CARDINAL) : INTEGER ;

(*
    tcgetattr - get state of, fd, into, t.
*)

PROCEDURE tcgetattr (fd: INTEGER; t: TERMIOS) : INTEGER ;

(*
    The following three functions return the different option values.
*)
```

```
PROCEDURE tcsnow () : INTEGER ;    (* alter fd now *)
PROCEDURE tcsdrain () : INTEGER ; (* alter when all output has been sent *)
PROCEDURE tcsflush () : INTEGER ; (* like drain, except discard any pending input *)

(*
    tcsetattr - set state of, fd, to, t, using option.
*)

PROCEDURE tcsetattr (fd: INTEGER; option: INTEGER; t: TERMIOS) : INTEGER ;

(*
    cfmakeraw - sets, t, to raw mode.
*)

PROCEDURE cfmakeraw (t: TERMIOS) ;

(*
    tcsendbreak - send zero bits for duration.
*)

PROCEDURE tcsendbreak (fd: INTEGER; duration: INTEGER) : INTEGER ;

(*
    tcdrain - waits for pending output to be written on, fd.
*)

PROCEDURE tcdrain (fd: INTEGER) : INTEGER ;

(*
    tcflushi - flush input.
*)

PROCEDURE tcflushi (fd: INTEGER) : INTEGER ;

(*
    tcflusho - flush output.
*)

PROCEDURE tcflusho (fd: INTEGER) : INTEGER ;
```

```
(*
    tcflushio - flush input and output.
*)

PROCEDURE tcflushio (fd: INTEGER) : INTEGER ;

(*
    tcflowoni - restart input on, fd.
*)

PROCEDURE tcflowoni (fd: INTEGER) : INTEGER ;

(*
    tcflowoffi - stop input on, fd.
*)

PROCEDURE tcflowoffi (fd: INTEGER) : INTEGER ;

(*
    tcflowono - restart output on, fd.
*)

PROCEDURE tcflowono (fd: INTEGER) : INTEGER ;

(*
    tcflowoffo - stop output on, fd.
*)

PROCEDURE tcflowoffo (fd: INTEGER) : INTEGER ;

(*
    GetFlag - sets a flag value from, t, in, b, and returns TRUE
              if, t, supports, f.
*)

PROCEDURE GetFlag (t: TERMIOS; f: Flag; VAR b: BOOLEAN) : BOOLEAN ;

(*
    SetFlag - sets a flag value in, t, to, b, and returns TRUE if
              this flag value is supported.
*)
```

```
PROCEDURE SetFlag (t: TERMIOS; f: Flag; b: BOOLEAN) : BOOLEAN ;

(*
  GetChar - sets a CHAR, ch, value from, t, and returns TRUE if
             this value is supported.
*)

PROCEDURE GetChar (t: TERMIOS; c: ControlChar; VAR ch: CHAR) : BOOLEAN ;

(*
  SetChar - sets a CHAR value in, t, and returns TRUE if, c,
             is supported.
*)

PROCEDURE SetChar (t: TERMIOS; c: ControlChar; ch: CHAR) : BOOLEAN ;

END termios.
```

4.1.64 gm2-libs/wrapc

```
DEFINITION MODULE wrapc ;

FROM SYSTEM IMPORT ADDRESS ;

(*
    strftime - returns the C string for the equivalent C asctime
               function.
*)

PROCEDURE strftime () : ADDRESS ;

(*
    filesize - assigns the size of a file, f, into low, high and
               returns zero if successful.
*)

PROCEDURE filesize (f: INTEGER; VAR low, high: CARDINAL) : INTEGER ;

(*
    fileinode - return the inode associated with file, f.
*)

PROCEDURE fileinode (f: INTEGER; VAR low, high: CARDINAL) : INTEGER ;

(*
    filemtime - returns the mtime of a file, f.
*)

PROCEDURE filemtime (f: INTEGER) : INTEGER ;

(*
    getrand - returns a random number between 0..n-1
*)

PROCEDURE getrand (n: INTEGER) : INTEGER ;

(*
    getusername - returns a C string describing the current user.
*)
```

```
PROCEDURE getusername () : ADDRESS ;
```

```
(*
  getnameuidgid - fills in the, uid, and, gid, which represents
                  user, name.
*)
```

```
PROCEDURE getnameuidgid (name: ADDRESS; VAR uid, gid: INTEGER) ;
```

```
(*
  in C these procedure functions are really macros, so we provide
  real C functions and let gm2 call these if the builtins
  are unavailable.
*)
```

```
PROCEDURE signbit (r: REAL) : INTEGER ;
PROCEDURE signbitf (s: SHORTREAL) : INTEGER ;
PROCEDURE signbitl (l: LONGREAL) : INTEGER ;
```

```
(*
  isfinite - provide non builtin alternative to the gcc builtin isfinite.■
             Returns 1 if x is finite and 0 if it is not.
*)
```

```
PROCEDURE isfinite (x: REAL) : INTEGER ;
```

```
(*
  isfinitef - provide non builtin alternative to the gcc builtin isfinite.■
             Returns 1 if x is finite and 0 if it is not.
*)
```

```
PROCEDURE isfinitef (x: SHORTREAL) : INTEGER ;
```

```
(*
  isfinitel - provide non builtin alternative to the gcc builtin isfinite.■
             Returns 1 if x is finite and 0 if it is not.
*)
```

```
PROCEDURE isfinitel (x: LONGREAL) : INTEGER ;
```

```
(*
  isnan - provide non builtin alternative to the gcc builtin isnan.
         Returns 1 if x is a NaN otherwise return 0.
*)

PROCEDURE isnan (x: REAL) : INTEGER ;

(*
  isnanf - provide non builtin alternative to the gcc builtin isnanf.
          Returns 1 if x is a NaN otherwise return 0.
*)

PROCEDURE isnanf (x: SHORTREAL) : INTEGER ;

(*
  isnanl - provide non builtin alternative to the gcc builtin isnanl.
          Returns 1 if x is a NaN otherwise return 0.
*)

PROCEDURE isnanl (x: LONGREAL) : INTEGER ;

(*
  SeekSet - return the system libc SEEK_SET value.
*)

PROCEDURE SeekSet () : INTEGER ;

(*
  SeekEnd - return the system libc SEEK_END value.
*)

PROCEDURE SeekEnd () : INTEGER ;

(*
  ReadOnly - return the system value of O_RDONLY.
*)

PROCEDURE ReadOnly () : BITSET ;

(*
  WriteOnly - return the system value of O_WRONLY.
```

*)

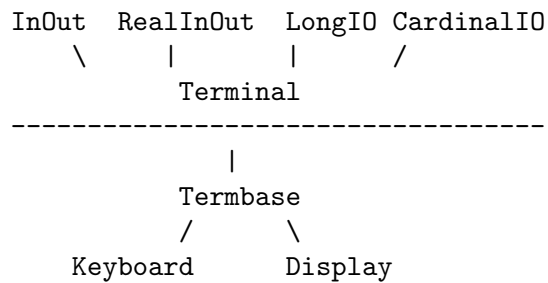
```
PROCEDURE WriteOnly () : BITSET ;
```

```
END wrapc.
```

4.2 PIM and Logitech 3.0 Compatible

These modules are provided to enable legacy Modula-2 applications to build with GNU Modula-2. It is advised that these module should not be used for new projects, maybe the ISO libraries or the native compiler PIM libraries (FIO) should be used instead.

Here is an outline of the module layering:



Above the line are user level PIM [234] and Logitech 3.0 compatible modules. Below the line Logitech 3.0 advised that these modules should be considered part of the runtime system. The libraries do not provide all the features found in the Logitech libraries as a number of these features were MS-DOS related. Essentially the basic input/output, file system, string manipulation and conversion routines are provided. Access to DOSCALL, graphics, time and date are not as these were constrained by the limitations of MS-DOS.

The following libraries are contained within the base GNU Modula-2 libraries and are also Logitech-3.0 compatible: See Section 4.1.2 [gm2-libs/ASCII], page 85, See Section 4.1.42 [gm2-libs/Storage], page 170, and See Section 4.1.26 [gm2-libs/MathLib0], page 138. These libraries are always available for any dialect of the language (although their implementation and behaviour might differ, for example Storage ISO and PIM).

The following libraries are Logitech-3.0 compatible but fall outside the base GNU Modula-2 libraries.

4.2.1 gm2-libs-log/BitBlockOps

```
DEFINITION MODULE BitBlockOps ;
```

```
FROM SYSTEM IMPORT ADDRESS ;
```

```
(*
  BlockAnd - performs a bitwise AND on blocks
              [dest..dest+size-1] := [dest..dest+size-1] AND
                                      [src..src+size-1]
*)
```

```
PROCEDURE BlockAnd (dest, src: ADDRESS; size: CARDINAL) ;
```

```

(*)
    BlockOr - performs a bitwise OR on blocks
              [dest..dest+size-1] := [dest..dest+size-1] OR
                                      [src..src+size-1]
*)

PROCEDURE BlockOr (dest, src: ADDRESS; size: CARDINAL) ;

(*)
    BlockXor - performs a bitwise XOR on blocks
              [dest..dest+size-1] := [dest..dest+size-1] XOR
                                      [src..src+size-1]
*)

PROCEDURE BlockXor (dest, src: ADDRESS; size: CARDINAL) ;

(*)
    BlockNot - performs a bitsize NOT on the block as defined
              by: [dest..dest+size-1]
*)

PROCEDURE BlockNot (dest: ADDRESS; size: CARDINAL) ;

(*)
    BlockShr - performs a block shift right of, count, bits.
              Where the block is defined as:
              [dest..dest+size-1].
              The block is considered to be an ARRAY OF BYTES
              which is shifted, bit at a time over each byte in
              turn. The left most byte is considered the byte
              located at the lowest address.
              If you require an endianness SHIFT use
              the SYSTEM.SHIFT procedure and declare the
              block as a POINTER TO set type.
*)

PROCEDURE BlockShr (dest: ADDRESS; size, count: CARDINAL) ;

(*)
    BlockShl - performs a block shift left of, count, bits.
              Where the block is defined as:
              [dest..dest+size-1].
              The block is considered to be an ARRAY OF BYTES

```

which is shifted, bit at a time over each byte in turn. The left most byte is considered the byte located at the lowest address.

If you require an endianness SHIFT use the SYSTEM.SHIFT procedure and declare the block as a POINTER TO set type.

*)

```
PROCEDURE BlockShl (dest: ADDRESS; size, count: CARDINAL) ;
```

(*

BlockRor - performs a block rotate right of, count, bits.

Where the block is defined as:

[dest..dest+size-1].

The block is considered to be an ARRAY OF BYTES which is rotated, bit at a time over each byte in turn. The left most byte is considered the byte located at the lowest address.

If you require an endianness ROTATE use the SYSTEM.ROTATE procedure and declare the block as a POINTER TO set type.

*)

```
PROCEDURE BlockRor (dest: ADDRESS; size, count: CARDINAL) ;
```

(*

BlockRol - performs a block rotate left of, count, bits.

Where the block is defined as:

[dest..dest+size-1].

The block is considered to be an ARRAY OF BYTES which is rotated, bit at a time over each byte in turn. The left most byte is considered the byte located at the lowest address.

If you require an endianness ROTATE use the SYSTEM.ROTATE procedure and declare the block as a POINTER TO set type.

*)

```
PROCEDURE BlockRol (dest: ADDRESS; size, count: CARDINAL) ;
```

```
END BitBlockOps.
```

4.2.2 gm2-libs-log/BitByteOps

```
DEFINITION MODULE BitByteOps ;
```

```
FROM SYSTEM IMPORT BYTE ;
```

```
(*
  GetBits - returns the bits firstBit..lastBit from source.
            Bit 0 of byte maps onto the firstBit of source.
*)
```

```
PROCEDURE GetBits (source: BYTE; firstBit, lastBit: CARDINAL) : BYTE ;
```

```
(*
  SetBits - sets bits in, byte, starting at, firstBit, and ending at,
            lastBit, with, pattern. The bit zero of, pattern, will
            be placed into, byte, at position, firstBit.
*)
```

```
PROCEDURE SetBits (VAR byte: BYTE; firstBit, lastBit: CARDINAL;
                  pattern: BYTE) ;
```

```
(*
  ByteAnd - returns a bitwise (left AND right)
*)
```

```
PROCEDURE ByteAnd (left, right: BYTE) : BYTE ;
```

```
(*
  ByteOr - returns a bitwise (left OR right)
*)
```

```
PROCEDURE ByteOr (left, right: BYTE) : BYTE ;
```

```
(*
  ByteXor - returns a bitwise (left XOR right)
*)
```

```
PROCEDURE ByteXor (left, right: BYTE) : BYTE ;
```

```
(*
```

```
    ByteNot - returns a byte with all bits inverted.
*)

PROCEDURE ByteNot (byte: BYTE) : BYTE ;

(*
    ByteShr - returns a, byte, which has been shifted, count
              bits to the right.
*)

PROCEDURE ByteShr (byte: BYTE; count: CARDINAL) : BYTE ;

(*
    ByteShl - returns a, byte, which has been shifted, count
              bits to the left.
*)

PROCEDURE ByteShl (byte: BYTE; count: CARDINAL) : BYTE ;

(*
    ByteSar - shift byte arithmetic right. Preserves the top
              end bit and as the value is shifted right.
*)

PROCEDURE ByteSar (byte: BYTE; count: CARDINAL) : BYTE ;

(*
    ByteRor - returns a, byte, which has been rotated, count
              bits to the right.
*)

PROCEDURE ByteRor (byte: BYTE; count: CARDINAL) : BYTE ;

(*
    ByteRol - returns a, byte, which has been rotated, count
              bits to the left.
*)

PROCEDURE ByteRol (byte: BYTE; count: CARDINAL) : BYTE ;

(*
```

```
    HighNibble - returns the top nibble only from, byte.
                The top nibble of, byte, is extracted and
                returned in the bottom nibble of the return
                value.
*)

PROCEDURE HighNibble (byte: BYTE) : BYTE ;

(*
    LowNibble - returns the low nibble only from, byte.
                The top nibble is replaced by zeros.
*)

PROCEDURE LowNibble (byte: BYTE) : BYTE ;

(*
    Swap - swaps the low and high nibbles in the, byte.
*)

PROCEDURE Swap (byte: BYTE) : BYTE ;

END BitByteOps.
```

4.2.3 gm2-libs-log/BitWordOps

```
DEFINITION MODULE BitWordOps ;

FROM SYSTEM IMPORT WORD ;

(*
  GetBits - returns the bits firstBit..lastBit from source.
            Bit 0 of word maps onto the firstBit of source.
*)

PROCEDURE GetBits (source: WORD; firstBit, lastBit: CARDINAL) : WORD ;

(*
  SetBits - sets bits in, word, starting at, firstBit, and ending at,
            lastBit, with, pattern.  The bit zero of, pattern, will
            be placed into, word, at position, firstBit.
*)

PROCEDURE SetBits (VAR word: WORD; firstBit, lastBit: CARDINAL;
                  pattern: WORD) ;

(*
  WordAnd - returns a bitwise (left AND right)
*)

PROCEDURE WordAnd (left, right: WORD) : WORD ;

(*
  WordOr - returns a bitwise (left OR right)
*)

PROCEDURE WordOr (left, right: WORD) : WORD ;

(*
  WordXor - returns a bitwise (left XOR right)
*)

PROCEDURE WordXor (left, right: WORD) : WORD ;

(*
```

```
    WordNot - returns a word with all bits inverted.
*)

PROCEDURE WordNot (word: WORD) : WORD ;

(*
    WordShr - returns a, word, which has been shifted, count
              bits to the right.
*)

PROCEDURE WordShr (word: WORD; count: CARDINAL) : WORD ;

(*
    WordShl - returns a, word, which has been shifted, count
              bits to the left.
*)

PROCEDURE WordShl (word: WORD; count: CARDINAL) : WORD ;

(*
    WordSar - shift word arithmetic right. Preserves the top
              end bit and as the value is shifted right.
*)

PROCEDURE WordSar (word: WORD; count: CARDINAL) : WORD ;

(*
    WordRor - returns a, word, which has been rotated, count
              bits to the right.
*)

PROCEDURE WordRor (word: WORD; count: CARDINAL) : WORD ;

(*
    WordRol - returns a, word, which has been rotated, count
              bits to the left.
*)

PROCEDURE WordRol (word: WORD; count: CARDINAL) : WORD ;

(*
```

```
    HighByte - returns the top byte only from, word.
               The byte is returned in the bottom byte
               in the return value.
*)

PROCEDURE HighByte (word: WORD) : WORD ;

(*
    LowByte - returns the low byte only from, word.
               The byte is returned in the bottom byte
               in the return value.
*)

PROCEDURE LowByte (word: WORD) : WORD ;

(*
    Swap - byte flips the contents of word.
*)

PROCEDURE Swap (word: WORD) : WORD ;

END BitWordOps.
```

4.2.4 gm2-libs-log/BlockOps

```

DEFINITION MODULE BlockOps ;

FROM SYSTEM IMPORT ADDRESS ;

(*
  MoveBlockForward - moves, n, bytes from, src, to, dest.
                    Starts copying from src and keep copying
                    until, n, bytes have been copied.
*)

PROCEDURE BlockMoveForward (dest, src: ADDRESS; n: CARDINAL) ;

(*
  MoveBlockBackward - moves, n, bytes from, src, to, dest.
                    Starts copying from src+n and keeps copying
                    until, n, bytes have been copied.
                    The last datum to be copied will be the byte
                    at address, src.
*)

PROCEDURE BlockMoveBackward (dest, src: ADDRESS; n: CARDINAL) ;

(*
  BlockClear - fills, block..block+n-1, with zeros.
*)

PROCEDURE BlockClear (block: ADDRESS; n: CARDINAL) ;

(*
  BlockSet - fills, n, bytes starting at, block, with a pattern
            defined at address pattern..pattern+patternSize-1.
*)

PROCEDURE BlockSet (block: ADDRESS; n: CARDINAL;
                   pattern: ADDRESS; patternSize: CARDINAL) ;

(*
  BlockEqual - returns TRUE if the blocks defined, a..a+n-1, and,
              b..b+n-1 contain the same bytes.
*)

```

```
PROCEDURE BlockEqual (a, b: ADDRESS; n: CARDINAL) : BOOLEAN ;
```

```
(*
```

```
    BlockPosition - searches for a pattern as defined by  
                    pattern..patternSize-1 in the block,  
                    block..block+blockSize-1. It returns  
                    the offset from block indicating the  
                    first occurrence of, pattern.  
                    MAX(CARDINAL) is returned if no match  
                    is detected.
```

```
*)
```

```
PROCEDURE BlockPosition (block: ADDRESS; blockSize: CARDINAL;  
                        pattern: ADDRESS; patternSize: CARDINAL) : CARDINAL ;■
```

```
END BlockOps.
```

4.2.5 gm2-libs-log/Break

```
DEFINITION MODULE Break ;
```

```
EXPORT QUALIFIED EnableBreak, DisableBreak, InstallBreak, UnInstallBreak ;■
```

```
(*  
  EnableBreak - enable the current break handler.  
*)
```

```
PROCEDURE EnableBreak ;
```

```
(*  
  DisableBreak - disable the current break handler (and all  
                 installed handlers).  
*)
```

```
PROCEDURE DisableBreak ;
```

```
(*  
  InstallBreak - installs a procedure, p, to be invoked when  
                 a ctrl-c is caught. Any number of these  
                 procedures may be stacked. Only the top  
                 procedure is run when ctrl-c is caught.  
*)
```

```
PROCEDURE InstallBreak (p: PROC) ;
```

```
(*  
  UnInstallBreak - pops the break handler stack.  
*)
```

```
PROCEDURE UnInstallBreak ;
```

```
END Break.
```

4.2.6 gm2-libs-log/CardinalIO

```

DEFINITION MODULE CardinalIO ;

EXPORT QUALIFIED Done,
    ReadCardinal, WriteCardinal, ReadHex, WriteHex,
    ReadLongCardinal, WriteLongCardinal, ReadLongHex,
    WriteLongHex,
    ReadShortCardinal, WriteShortCardinal, ReadShortHex,
    WriteShortHex ;

VAR
    Done: BOOLEAN ;

(*
    ReadCardinal - read an unsigned decimal number from the terminal.
                  The read continues until a space, newline, esc or
                  end of file is reached.
*)

PROCEDURE ReadCardinal (VAR c: CARDINAL) ;

(*
    WriteCardinal - writes the value, c, to the terminal and ensures
                  that at least, n, characters are written. The number
                  will be padded out by preceeding spaces if necessary.
*)

PROCEDURE WriteCardinal (c: CARDINAL; n: CARDINAL) ;

(*
    ReadHex - reads in an unsigned hexadecimal number from the terminal.
             The read continues until a space, newline, esc or
             end of file is reached.
*)

PROCEDURE ReadHex (VAR c: CARDINAL) ;

(*
    WriteHex - writes out a CARDINAL, c, in hexadecimal format padding
             with, n, characters (leading with '0')
*)

```

```
PROCEDURE WriteHex (c: CARDINAL; n: CARDINAL) ;
```

```
(*  
  ReadLongCardinal - read an unsigned decimal number from the terminal.  
                    The read continues until a space, newline, esc or  
                    end of file is reached.  
)
```

```
PROCEDURE ReadLongCardinal (VAR c: LONGCARD) ;
```

```
(*  
  WriteLongCardinal - writes the value, c, to the terminal and ensures  
                    that at least, n, characters are written. The number  
                    will be padded out by preceeding spaces if necessary.  
)
```

```
PROCEDURE WriteLongCardinal (c: LONGCARD; n: CARDINAL) ;
```

```
(*  
  ReadLongHex - reads in an unsigned hexadecimal number from the terminal.  
               The read continues until a space, newline, esc or  
               end of file is reached.  
)
```

```
PROCEDURE ReadLongHex (VAR c: LONGCARD) ;
```

```
(*  
  WriteLongHex - writes out a LONGCARD, c, in hexadecimal format padding  
               with, n, characters (leading with '0')  
)
```

```
PROCEDURE WriteLongHex (c: LONGCARD; n: CARDINAL) ;
```

```
(*  
  WriteShortCardinal - writes the value, c, to the terminal and ensures  
                    that at least, n, characters are written. The number  
                    will be padded out by preceeding spaces if necessary.  
)
```

```
PROCEDURE WriteShortCardinal (c: SHORTCARD; n: CARDINAL) ;
```

```
(*
  ReadShortCardinal - read an unsigned decimal number from the terminal.
                      The read continues until a space, newline, esc or
                      end of file is reached.
*)

PROCEDURE ReadShortCardinal (VAR c: SHORTCARD) ;

(*
  ReadShortHex - reads in an unsigned hexadecimal number from the terminal.
                The read continues until a space, newline, esc or
                end of file is reached.
*)

PROCEDURE ReadShortHex (VAR c: SHORTCARD) ;

(*
  WriteShortHex - writes out a SHORTCARD, c, in hexadecimal format padding
                 with, n, characters (leading with '0')
*)

PROCEDURE WriteShortHex (c: SHORTCARD; n: CARDINAL) ;

END CardinalIO.
```

4.2.7 gm2-libs-log/Conversions

```

DEFINITION MODULE Conversions ;

EXPORT QUALIFIED ConvertOctal, ConvertHex, ConvertCardinal,
                  ConvertInteger, ConvertLongInt, ConvertShortInt ;

(*
   ConvertOctal - converts a CARDINAL, num, into an octal/hex/decimal
                  string and right justifies the string. It adds
                  spaces rather than '0' to pad out the string
                  to len characters.

                  If the length of str is < num then the number is
                  truncated on the right.
*)

PROCEDURE ConvertOctal (num, len: CARDINAL; VAR str: ARRAY OF CHAR) ;
PROCEDURE ConvertHex   (num, len: CARDINAL; VAR str: ARRAY OF CHAR) ;
PROCEDURE ConvertCardinal (num, len: CARDINAL; VAR str: ARRAY OF CHAR) ;

(*
   The INTEGER counterparts will add a '-' if, num, is <0
*)

PROCEDURE ConvertInteger (num: INTEGER; len: CARDINAL; VAR str: ARRAY OF CHAR) ;
PROCEDURE ConvertLongInt (num: LONGINT; len: CARDINAL; VAR str: ARRAY OF CHAR) ;
PROCEDURE ConvertShortInt (num: SHORTINT; len: CARDINAL; VAR str: ARRAY OF CHAR) ;

END Conversions.

```

4.2.8 gm2-libs-log/DebugPMD

```
DEFINITION MODULE DebugPMD ;
```

```
END DebugPMD.
```

4.2.9 gm2-libs-log/DebugTrace

```
DEFINITION MODULE DebugTrace ;
```

```
END DebugTrace.
```

4.2.10 gm2-libs-log/Delay

```
DEFINITION MODULE Delay ;
```

```
EXPORT QUALIFIED Delay ;
```

```
(*  
  milliSec - delays the program by approximately, milliSec, milliseconds.■  
*)
```

```
PROCEDURE Delay (milliSec: INTEGER) ;
```

```
END Delay.
```

4.2.11 gm2-libs-log/Display

```
DEFINITION MODULE Display ;
```

```
EXPORT QUALIFIED Write ;
```

```
(*  
  Write - display a character to the stdout.  
          ASCII.EOL moves to the beginning of the next line.  
          ASCII.del erases the character to the left of the cursor.  
*)
```

```
PROCEDURE Write (ch: CHAR) ;
```

```
END Display.
```

4.2.12 gm2-libs-log/ErrorCode

```
DEFINITION MODULE ErrorCode ;

EXPORT QUALIFIED SetErrorCode, GetErrorCode, ExitToOS ;

(*
  SetErrorCode - sets the exit value which will be used if
                 the application terminates normally.
*)

PROCEDURE SetErrorCode (value: INTEGER) ;

(*
  GetErrorCode - returns the current value to be used upon
                 application termination.
*)

PROCEDURE GetErrorCode (VAR value: INTEGER) ;

(*
  ExitToOS - terminate the application and exit returning
             the last value set by SetErrorCode to the OS.
*)

PROCEDURE ExitToOS ;

END ErrorCode.
```

4.2.13 gm2-libs-log/FileSystem

```

DEFINITION MODULE FileSystem ;

(* Use this module sparingly, FIO or the ISO file modules have a
   much cleaner interface. *)

FROM SYSTEM IMPORT WORD, BYTE, ADDRESS ;
IMPORT FIO ;
FROM DynamicStrings IMPORT String ;

EXPORT QUALIFIED File, Response, Flag, FlagSet,

    Create, Close, Lookup, Rename, Delete,
    SetRead, SetWrite, SetModify, SetOpen,
    Doio, SetPos, GetPos, Length, Reset,

    ReadWord, ReadChar, ReadByte, ReadNBytes,
    WriteWord, WriteChar, WriteByte, WriteNBytes ;

TYPE
    File = RECORD
        res      : Response ;
        flags    : FlagSet ;
        eof      : BOOLEAN ;
        lastWord : WORD ;
        lastByte : BYTE ;
        fio      : FIO.File ;
        highpos,
        lowpos   : CARDINAL ;
        name     : String ;
    END ;

    Flag = (
        read,      (* read access mode *)
        write,     (* write access mode *)
        modify,
        truncate,  (* truncate file when closed *)
        again,     (* reread the last character *)
        temporary, (* file is temporary *)
        opened     (* file has been opened *)
    );

    FlagSet = SET OF Flag;

    Response = (done, notdone, notsupported, callerror,
        unknownfile, paramerror, toomanyfiles,

```

```
        userdeverror) ;

    Command = (create, close, lookup, rename, delete,
               setread, setwrite, setmodify, setopen,
               doio, setpos, getpos, length) ;

    (*
       Create - creates a temporary file. To make the file perminant
               the file must be renamed.
    *)

    PROCEDURE Create (VAR f: File) ;

    (*
       Close - closes an open file.
    *)

    PROCEDURE Close (f: File) ;

    (*
       Lookup - looks for a file, filename. If the file is found
               then, f, is opened. If it is not found and, newFile,
               is TRUE then a new file is created and attached to, f.
               If, newFile, is FALSE and no file was found then f.res
               is set to notdone.
    *)

    PROCEDURE Lookup (VAR f: File; filename: ARRAY OF CHAR; newFile: BOOLEAN) ;■

    (*
       Rename - rename a file and change a temporary file to a permanent
               file. f.res is set appropriately.
    *)

    PROCEDURE Rename (VAR f: File; newname: ARRAY OF CHAR) ;

    (*
       Delete - deletes a file, name, and sets the f.res field.
               f.res is set appropriately.
    *)

    PROCEDURE Delete (name: ARRAY OF CHAR; VAR f: File) ;
```

```
(*
  ReadWord - reads a WORD, w, from file, f.
             f.res is set appropriately.
*)

PROCEDURE ReadWord (VAR f: File; VAR w: WORD) ;

(*
  WriteWord - writes one word to a file, f.
             f.res is set appropriately.
*)

PROCEDURE WriteWord (VAR f: File; w: WORD) ;

(*
  ReadChar - reads one character from a file, f.
*)

PROCEDURE ReadChar (VAR f: File; VAR ch: CHAR) ;

(*
  WriteChar - writes a character, ch, to a file, f.
             f.res is set appropriately.
*)

PROCEDURE WriteChar (VAR f: File; ch: CHAR) ;

(*
  ReadByte - reads a BYTE, b, from file, f.
            f.res is set appropriately.
*)

PROCEDURE ReadByte (VAR f: File; VAR b: BYTE) ;

(*
  WriteByte - writes one BYTE, b, to a file, f.
            f.res is set appropriately.
*)

PROCEDURE WriteByte (VAR f: File; b: BYTE) ;
```

```
(*
  ReadNBytes - reads a sequence of bytes from a file, f.
*)

PROCEDURE ReadNBytes (VAR f: File; a: ADDRESS; amount: CARDINAL;
                     VAR actuallyRead: CARDINAL) ;

(*
  WriteNBytes - writes a sequence of bytes to file, f.
*)

PROCEDURE WriteNBytes (VAR f: File; a: ADDRESS; amount: CARDINAL;
                      VAR actuallyWritten: CARDINAL) ;

(*
  Again - returns the last character read to the internal buffer
          so that it can be read again.
*)

PROCEDURE Again (VAR f: File) ;

(*
  SetRead - puts the file, f, into the read state.
            The file position is unchanged.
*)

PROCEDURE SetRead (VAR f: File) ;

(*
  SetWrite - puts the file, f, into the write state.
            The file position is unchanged.
*)

PROCEDURE SetWrite (VAR f: File) ;

(*
  SetModify - puts the file, f, into the modify state.
             The file position is unchanged but the file can be
             read and written.
*)
```

```
PROCEDURE SetModify (VAR f: File) ;

(*
  SetOpen - places a file, f, into the open state. The file may
            have been in the read/write/modify state before and
            in which case the previous buffer contents are flushed
            and the file state is reset to open. The position is
            unaltered.
*)

PROCEDURE SetOpen (VAR f: File) ;

(*
  Reset - places a file, f, into the open state and reset the
          position to the start of the file.
*)

PROCEDURE Reset (VAR f: File) ;

(*
  SetPos - lseek to a position within a file.
*)

PROCEDURE SetPos (VAR f: File; high, low: CARDINAL) ;

(*
  GetPos - return the position within a file.
*)

PROCEDURE GetPos (VAR f: File; VAR high, low: CARDINAL) ;

(*
  Length - returns the length of file, in, high, and, low.
*)

PROCEDURE Length (VAR f: File; VAR high, low: CARDINAL) ;

(*
  Doio - effectively flushes a file in write mode, rereads the
         current buffer from disk if in read mode and writes
```

```
        and rereads the buffer if in modify mode.
*)

PROCEDURE Doio (VAR f: File) ;

(*
  FileNameChar - checks to see whether the character, ch, is
                  legal in a filename. nul is returned if the
                  character was illegal.
*)

PROCEDURE FileNameChar (ch: CHAR) : CHAR ;

END FileSystem.
```

4.2.14 gm2-libs-log/FloatingUtilities

```
DEFINITION MODULE FloatingUtilities ;
```

```
EXPORT QUALIFIED Frac, Round, Float, Trunc,  
                  Fracl, Roundl, Floatl, Truncl ;
```

```
(*  
  Frac - returns the fractional component of, r.  
*)
```

```
PROCEDURE Frac (r: REAL) : REAL ;
```

```
(*  
  Int - returns the integer part of r. It rounds the value towards zero.■  
*)
```

```
PROCEDURE Int (r: REAL) : INTEGER ;
```

```
(*  
  Round - returns the number rounded to the nearest integer.  
*)
```

```
PROCEDURE Round (r: REAL) : INTEGER ;
```

```
(*  
  Float - returns a REAL value corresponding to, i.  
*)
```

```
PROCEDURE Float (i: INTEGER) : REAL ;
```

```
(*  
  Trunc - round to the nearest integer not larger in absolute  
          value.  
*)
```

```
PROCEDURE Trunc (r: REAL) : INTEGER ;
```

```
(*  
  Fracl - returns the fractional component of, r.  
*)
```

```
PROCEDURE Fracl (r: LONGREAL) : LONGREAL ;
```

```
(*  
  Intl - returns the integer part of r. It rounds the value towards zero.■  
*)
```

```
PROCEDURE Intl (r: LONGREAL) : LONGINT ;
```

```
(*  
  Roundl - returns the number rounded to the nearest integer.  
*)
```

```
PROCEDURE Roundl (r: LONGREAL) : LONGINT ;
```

```
(*  
  Floatl - returns a REAL value corresponding to, i.  
*)
```

```
PROCEDURE Floatl (i: INTEGER) : LONGREAL ;
```

```
(*  
  Trunc1 - round to the nearest integer not larger in absolute  
           value.  
*)
```

```
PROCEDURE Trunc1 (r: LONGREAL) : LONGINT ;
```

```
END FloatingUtilities.
```

4.2.15 gm2-libs-log/InOut

```

DEFINITION MODULE InOut ;

IMPORT ASCII ;
FROM DynamicStrings IMPORT String ;
EXPORT QUALIFIED EOL, Done, termCH, OpenInput, OpenOutput,
                CloseInput, CloseOutput,
                Read, ReadString, ReadInt, ReadCard,
                Write, WriteLn, WriteString, WriteInt, WriteCard,
                WriteOct, WriteHex,
                ReadS, WriteS ;

CONST
    EOL = ASCII.EOL ;

VAR
    Done   : BOOLEAN ;
    termCH: CHAR ;

(*
    OpenInput - reads a string from stdin as the filename for reading.
                If the filename ends with '.' then it appends the defext
                extension. The global variable Done is set if all
                was successful.
*)

PROCEDURE OpenInput (defext: ARRAY OF CHAR) ;

(*
    CloseInput - closes an opened input file and returns input back to
                StdIn.
*)

PROCEDURE CloseInput ;

(*
    OpenOutput - reads a string from stdin as the filename for writing.
                If the filename ends with '.' then it appends the defext
                extension. The global variable Done is set if all
                was successful.
*)

PROCEDURE OpenOutput (defext: ARRAY OF CHAR) ;

```

```
(*
  CloseOutput - closes an opened output file and returns output back to
                StdOut.
*)
```

```
PROCEDURE CloseOutput ;
```

```
(*
  Read - reads a single character from the current input file.
        Done is set to FALSE if end of file is reached or an
        error occurs.
*)
```

```
PROCEDURE Read (VAR ch: CHAR) ;
```

```
(*
  ReadString - reads a sequence of characters. Leading white space
               is ignored and the string is terminated with a character
               <= ' '
*)
```

```
PROCEDURE ReadString (VAR s: ARRAY OF CHAR) ;
```

```
(*
  WriteString - writes a string to the output file.
*)
```

```
PROCEDURE WriteString (s: ARRAY OF CHAR) ;
```

```
(*
  Write - writes out a single character, ch, to the current output file.
*)
```

```
PROCEDURE Write (ch: CHAR) ;
```

```
(*
  WriteLn - writes a newline to the output file.
*)
```

```
PROCEDURE WriteLn ;
```

```
(*
  ReadInt - reads a string and converts it into an INTEGER, x.
           Done is set if an INTEGER is read.
*)

PROCEDURE ReadInt (VAR x: INTEGER) ;

(*
  ReadInt - reads a string and converts it into an INTEGER, x.
           Done is set if an INTEGER is read.
*)

PROCEDURE ReadCard (VAR x: CARDINAL) ;

(*
  WriteCard - writes the CARDINAL, x, to the output file. It ensures
              that the number occupies, n, characters. Leading spaces
              are added if required.
*)

PROCEDURE WriteCard (x, n: CARDINAL) ;

(*
  WriteInt - writes the INTEGER, x, to the output file. It ensures
              that the number occupies, n, characters. Leading spaces
              are added if required.
*)

PROCEDURE WriteInt (x: INTEGER; n: CARDINAL) ;

(*
  WriteOct - writes the CARDINAL, x, to the output file in octal.
             It ensures that the number occupies, n, characters.
             Leading spaces are added if required.
*)

PROCEDURE WriteOct (x, n: CARDINAL) ;

(*
  WriteHex - writes the CARDINAL, x, to the output file in hexadecimal.
```

```
        It ensures that the number occupies, n, characters.
        Leading spaces are added if required.
*)

PROCEDURE WriteHex (x, n: CARDINAL) ;

(*
    ReadS - returns a string which has is a sequence of characters.
           Leading white space is ignored and string is terminated
           with a character <= ' '.
*)

PROCEDURE ReadS () : String ;

(*
    WriteS - writes a String to the output device.
            It returns the string, s.
*)

PROCEDURE WriteS (s: String) : String ;

END InOut.
```

4.2.16 gm2-libs-log/Keyboard

```
DEFINITION MODULE Keyboard ;

EXPORT QUALIFIED Read, KeyPressed ;

(*
  Read - reads a character from StdIn. If necessary it will wait
         for a key to become present on StdIn.
*)

PROCEDURE Read (VAR ch: CHAR) ;

(*
  KeyPressed - returns TRUE if a character can be read from StdIn
              without blocking the caller.
*)

PROCEDURE KeyPressed () : BOOLEAN ;

END Keyboard.
```

4.2.17 gm2-libs-log/LongIO

```
DEFINITION MODULE LongIO ;

EXPORT QUALIFIED Done, ReadLongInt, WriteLongInt ;

VAR
    Done: BOOLEAN ;

PROCEDURE ReadLongInt (VAR i: LONGINT) ;
PROCEDURE WriteLongInt (i: LONGINT; n: CARDINAL) ;

END LongIO.
```

4.2.18 gm2-libs-log/NumberConversion

```
DEFINITION MODULE NumberConversion ;
```

```
(* --fixme-- finish this. *)
```

```
END NumberConversion.
```

4.2.19 gm2-libs-log/Random

```
DEFINITION MODULE Random ;
```

```
FROM SYSTEM IMPORT BYTE ;
```

```
EXPORT QUALIFIED Randomize, RandomInit, RandomBytes, RandomCard, RandomInt, RandomReal
```

```
(*  
  Randomize - initialize the random number generator with a seed  
              based on the microseconds.  
*)
```

```
PROCEDURE Randomize ;
```

```
(*  
  RandomInit - initialize the random number generator with value, seed.  
*)
```

```
PROCEDURE RandomInit (seed: CARDINAL) ;
```

```
(*  
  RandomBytes - fills in an array with random values.  
*)
```

```
PROCEDURE RandomBytes (VAR a: ARRAY OF BYTE) ;
```

```
(*  
  RandomInt - return an INTEGER in the range 0..bound-1  
*)
```

```
PROCEDURE RandomInt (bound: INTEGER) : INTEGER ;
```

```
(*  
  RandomCard - return a CARDINAL in the range 0..bound-1  
*)
```

```
PROCEDURE RandomCard (bound: CARDINAL) : CARDINAL ;
```

```
(*  
  RandomReal - return a REAL number in the range 0.0..1.0  
*)
```

```
PROCEDURE RandomReal ( ) : REAL ;

(*
  RandomLongReal - return a LONGREAL number in the range 0.0..1.0
*)

PROCEDURE RandomLongReal ( ) : LONGREAL ;

END Random.
```

4.2.20 gm2-libs-log/RealConversions

```
DEFINITION MODULE RealConversions ;
```

```
EXPORT QUALIFIED SetNoOfExponentDigits,
                  RealToString, StringToReal,
                  LongRealToString, StringToLongReal ;
```

```
(*
  SetNoOfExponentDigits - sets the number of exponent digits to be
                          used during future calls of LongRealToString
                          and RealToString providing that the width
                          is sufficient.
                          If this value is set to 0 (the default) then
                          the number digits used is the minimum necessary.
*)
```

```
PROCEDURE SetNoOfExponentDigits (places: CARDINAL) ;
```

```
(*
  RealToString - converts a real, r, into a right justified string, str.
                 The number of digits to the right of the decimal point
                 is given in, digits. The value, width, represents the
                 maximum number of characters to be used in the string,
                 str.

                 If digits is negative then exponent notation is used
                 whereas if digits is positive then fixed point notation
                 is used.

                 If, r, is less than 0.0 then a '-' preceeds the value,
                 str. However, if, r, is >= 0.0 a '+' is not added.

                 If the conversion of, r, to a string requires more
                 than, width, characters then the string, str, is set
                 to a nul string and, ok is assigned FALSE.

                 For fixed point notation the minimum width required is
                 ABS(width)+8

                 For exponent notation the minimum width required is
                 ABS(digits)+2+log10(magnitude).

                 if r is a NaN then the string 'nan' is returned formatted and
                 ok will be FALSE.
```

*)

```
PROCEDURE RealToString (r: REAL; digits, width: INTEGER;
    VAR str: ARRAY OF CHAR; VAR ok: BOOLEAN) ;
```

(*

LongRealToString - converts a real, r, into a right justified string, str. The number of digits to the right of the decimal point is given in, digits. The value, width, represents the maximum number of characters to be used in the string, str.

If digits is negative then exponent notation is used whereas if digits is positive then fixed point notation is used.

If, r, is less than 0.0 then a '-' preceeds the value, str. However, if, r, is ≥ 0.0 a '+' is not added.

If the conversion of, r, to a string requires more than, width, characters then the string, str, is set to a nul string and, ok is assigned FALSE.

For fixed point notation the minimum width required is $ABS(width)+8$

For exponent notation the minimum width required is $ABS(digits)+2+\log_{10}(\text{magnitude})$.

Examples:

```
RealToString(100.0, 10, 10, a, ok)      -> '100.000000'
```

```
RealToString(100.0, -5, 12, a, ok)      -> ' 1.00000E+2'
```

```
RealToString(123.456789, 10, 10, a, ok) -> '123.456789'
```

```
RealToString(123.456789, -5, 13, a, ok) -> ' 1.23456E+2'
```

```
RealToString(123.456789, -2, 15, a, ok) -> '          1.23E+2'
```

if r is a NaN then the string 'nan' is returned formatted and ok will be FALSE.

*)

```
PROCEDURE LongRealToString (r: LONGREAL; digits, width: INTEGER;
    VAR str: ARRAY OF CHAR; VAR ok: BOOLEAN) ;
```

```
(*
  StringToReal - converts, str, into a REAL, r. The parameter, ok, is
                  set to TRUE if the conversion was successful.
*)

PROCEDURE StringToReal (str: ARRAY OF CHAR; VAR r: REAL; VAR ok: BOOLEAN) ;■

(*
  StringToLongReal - converts, str, into a LONGREAL, r. The parameter, ok, is■
                  set to TRUE if the conversion was successful.
*)

PROCEDURE StringToLongReal (str: ARRAY OF CHAR; VAR r: LONGREAL; VAR ok: BOOLEAN) ;■

END RealConversions.
```

4.2.21 gm2-libs-log/RealInOut

```

DEFINITION MODULE RealInOut ;

EXPORT QUALIFIED SetNoOfDecimalPlaces,
                  ReadReal, WriteReal, WriteRealOct,
                  ReadLongReal, WriteLongReal, WriteLongRealOct,
                  ReadShortReal, WriteShortReal, WriteShortRealOct,
                  Done ;

CONST
  DefaultDecimalPlaces = 6 ;

VAR
  Done: BOOLEAN ;

(*
  SetNoOfDecimalPlaces - number of decimal places WriteReal and
                        WriteLongReal should emit. This procedure
                        can be used to override the default
                        DefaultDecimalPlaces constant.
*)

PROCEDURE SetNoOfDecimalPlaces (places: CARDINAL) ;

(*
  ReadReal - reads a real number, legal syntaxes include:
              100, 100.0, 100e0, 100E0, 100E-1, E2, +1E+2, 1e+2
*)

PROCEDURE ReadReal (VAR x: REAL) ;

(*
  WriteReal - writes a real to the terminal. The real number
              is right justified and, n, is the minimum field
              width.
*)

PROCEDURE WriteReal (x: REAL; n: CARDINAL) ;

(*
  WriteRealOct - writes the real to terminal in octal words.
*)

```

```
PROCEDURE WriteRealOct (x: REAL) ;

(*
  ReadLongReal - reads a LONGREAL number, legal syntaxes include:
                  100, 100.0, 100e0, 100E0, 100E-1, E2, +1E+2, 1e+2
*)

PROCEDURE ReadLongReal (VAR x: LONGREAL) ;

(*
  WriteLongReal - writes a LONGREAL to the terminal. The real number
                  is right justified and, n, is the minimum field
                  width.
*)

PROCEDURE WriteLongReal (x: LONGREAL; n: CARDINAL) ;

(*
  WriteLongRealOct - writes the LONGREAL to terminal in octal words.
*)

PROCEDURE WriteLongRealOct (x: LONGREAL) ;

(*
  ReadShortReal - reads a SHORTREAL number, legal syntaxes include:
                  100, 100.0, 100e0, 100E0, 100E-1, E2, +1E+2, 1e+2
*)

PROCEDURE ReadShortReal (VAR x: SHORTREAL) ;

(*
  WriteShortReal - writes a SHORTREAL to the terminal. The real number
                  is right justified and, n, is the minimum field
                  width.
*)

PROCEDURE WriteShortReal (x: SHORTREAL; n: CARDINAL) ;

(*
  WriteShortRealOct - writes the SHORTREAL to terminal in octal words.
```

*)

```
PROCEDURE WriteShortRealOct (x: SHORTREAL) ;
```

```
END RealInOut.
```

4.2.22 gm2-libs-log/Strings

```

DEFINITION MODULE Strings ;

EXPORT QUALIFIED Assign, Insert, Delete, Pos, Copy, ConCat, Length,
                  CompareStr ;

(*
  Assign - dest := source.
*)

PROCEDURE Assign (VAR dest: ARRAY OF CHAR; source: ARRAY OF CHAR) ;

(*
  Insert - insert the string, substr, into str at position, index.
           substr, is added to the end of, str, if, index >= length(str)
*)

PROCEDURE Insert (substr: ARRAY OF CHAR; VAR str: ARRAY OF CHAR;
                  index: CARDINAL) ;

(*
  Delete - delete len characters from, str, starting at, index.
*)

PROCEDURE Delete (VAR str: ARRAY OF CHAR; index: CARDINAL; length: CARDINAL) ;

(*
  Pos - return the first position of, substr, in, str.
*)

PROCEDURE Pos (substr, str: ARRAY OF CHAR) : CARDINAL ;

(*
  Copy - copy at most, length, characters in, substr, to, str,
         starting at position, index.
*)

PROCEDURE Copy (str: ARRAY OF CHAR;
                index, length: CARDINAL; VAR result: ARRAY OF CHAR) ;

(*
  ConCat - concatenates two strings, s1, and, s2

```

```
        and places the result into, dest.
*)

PROCEDURE ConCat (s1, s2: ARRAY OF CHAR; VAR dest: ARRAY OF CHAR) ;

(*
  Length - return the length of string, s.
*)

PROCEDURE Length (s: ARRAY OF CHAR) : CARDINAL ;

(*
  CompareStr - compare two strings, left, and, right.
*)

PROCEDURE CompareStr (left, right: ARRAY OF CHAR) : INTEGER ;

END Strings.
```

4.2.23 gm2-libs-log/Termbase

```
DEFINITION MODULE Termbase ;
```

```
(*
  Initially the read routines from Keyboard and the
  write routine from Display is assigned to the Read,
  KeyPressed and Write procedures.
*)
```

```
EXPORT QUALIFIED ReadProcedure, StatusProcedure, WriteProcedure,
                  AssignRead, AssignWrite, UnAssignRead, UnAssignWrite,
                  Read, KeyPressed, Write ;
```

```
TYPE
```

```
  ReadProcedure = PROCEDURE (VAR CHAR) ;
  WriteProcedure = PROCEDURE (CHAR) ;
  StatusProcedure = PROCEDURE () : BOOLEAN ;
```

```
(*
  AssignRead - assigns a read procedure and status procedure for terminal
  input. Done is set to TRUE if successful. Subsequent
  Read and KeyPressed calls are mapped onto the user supplied
  procedures. The previous read and status procedures are
  uncovered and reused after UnAssignRead is called.
*)
```

```
PROCEDURE AssignRead (rp: ReadProcedure; sp: StatusProcedure;
                     VAR Done: BOOLEAN) ;
```

```
(*
  UnAssignRead - undo the last call to AssignRead and set Done to TRUE
  on success.
*)
```

```
PROCEDURE UnAssignRead (VAR Done: BOOLEAN) ;
```

```
(*
  Read - reads a single character using the currently active read
  procedure.
*)
```

```
PROCEDURE Read (VAR ch: CHAR) ;
```

```
(*
  KeyPressed - returns TRUE if a character is available to be read.
*)
```

```
PROCEDURE KeyPressed () : BOOLEAN ;
```

```
(*
  AssignWrite - assigns a write procedure for terminal output.
                Done is set to TRUE if successful. Subsequent
                Write calls are mapped onto the user supplied
                procedure. The previous write procedure is
                uncovered and reused after UnAssignWrite is called.
*)
```

```
PROCEDURE AssignWrite (wp: WriteProcedure; VAR Done: BOOLEAN) ;
```

```
(*
  UnAssignWrite - undo the last call to AssignWrite and set Done to TRUE
                  on success.
*)
```

```
PROCEDURE UnAssignWrite (VAR Done: BOOLEAN) ;
```

```
(*
  Write - writes a single character using the currently active write
          procedure.
*)
```

```
PROCEDURE Write (VAR ch: CHAR) ;
```

```
END Termbase.
```

4.2.24 gm2-libs-log/Terminal

```
DEFINITION MODULE Terminal ;
```

```
(*  
  It provides simple terminal input output  
  routines which all utilize the TermBase module.  
*)
```

```
EXPORT QUALIFIED Read, KeyPressed, ReadAgain, ReadString, Write,  
                  WriteString, WriteLn ;
```

```
(*  
  Read - reads a single character.  
*)
```

```
PROCEDURE Read (VAR ch: CHAR) ;
```

```
(*  
  KeyPressed - returns TRUE if a character can be read without blocking  
               the caller.  
*)
```

```
PROCEDURE KeyPressed () : BOOLEAN ;
```

```
(*  
  ReadString - reads a sequence of characters.  
               Tabs are expanded into 8 spaces and <cr> or <lf> terminates  
               the string.  
*)
```

```
PROCEDURE ReadString (VAR s: ARRAY OF CHAR) ;
```

```
(*  
  ReadAgain - makes the last character readable again.  
*)
```

```
PROCEDURE ReadAgain ;
```

```
(*  
  Write - writes a single character to the Termbase module.  
*)
```

```
PROCEDURE Write (ch: CHAR) ;

(*
  WriteString - writes out a string which is terminated by a <nul>
                character or the end of string HIGH(s).
*)

PROCEDURE WriteString (s: ARRAY OF CHAR) ;

(*
  WriteLn - writes a lf character.
*)

PROCEDURE WriteLn ;

END Terminal.
```

4.2.25 gm2-libs-log/TimeDate

```

DEFINITION MODULE TimeDate ;

(*
  Legacy compatibility - you are advised to use cleaner
  designed modules based on 'man 3 strptime'
  and friends for new projects as the day value here is ugly.
  [it was mapped onto MSDOS pre 2000].
*)

EXPORT QUALIFIED Time, GetTime, SetTime, CompareTime, TimeToZero,
                  TimeToString ;

TYPE
(*
  day holds:  bits 0..4 = day of month (1..31)
               5..8 = month of year (1..12)
               9..  = year - 1900
  minute holds:  hours * 60 + minutes
  millisec holds: seconds * 1000 + millisec
                  which is reset to 0 every minute
*)

  Time = RECORD
    day, minute, millisec: CARDINAL ;
  END ;

(*
  GetTime - returns the current date and time.
*)

PROCEDURE GetTime (VAR curTime: Time) ;

(*
  SetTime - does nothing, but provides compatibility with
            the Logitech-3.0 library.
*)

PROCEDURE SetTime (curTime: Time) ;

(*
  CompareTime - compare two dates and time which returns:

```

```
        -1  if t1 < t2
         0  if t1 = t2
         1  if t1 > t2
*)

PROCEDURE CompareTime (t1, t2: Time) : INTEGER ;

(*
  TimeToZero - initializes, t, to zero.
*)

PROCEDURE TimeToZero (VAR t: Time) ;

(*
  TimeToString - convert time, t, to a string.
                 The string, s, should be at least 19 characters
                 long and the returned string will be

                 yyyy-mm-dd hh:mm:ss
*)

PROCEDURE TimeToString (t: Time; VAR s: ARRAY OF CHAR) ;

END TimeDate.
```

4.3 PIM coroutine support

This directory contains a PIM SYSTEM containing the PROCESS primitives built on top of gthreads.

4.3.1 gm2-libs-coroutines/Executive

```

DEFINITION MODULE Executive ;

EXPORT QUALIFIED SEMAPHORE, DESCRIPTOR,
    InitProcess, KillProcess, Resume, Suspend, InitSemaphore,
    Wait, Signal, WaitForIO, Ps, GetCurrentProcess,
    RotateRunQueue, ProcessName, DebugProcess ;

TYPE
    SEMAPHORE ;          (* defines Dijkstras semaphores *)
    DESCRIPTOR ;         (* handle onto a process *)

(*
    InitProcess - initializes a process which is held in the suspended
                  state. When the process is resumed it will start executing
                  procedure, p. The process has a maximum stack size of,
                  StackSize, bytes and its textual name is, Name.
                  The StackSize should be at least 5000 bytes.
*)

PROCEDURE InitProcess (p: PROC; StackSize: CARDINAL;
                      Name: ARRAY OF CHAR) : DESCRIPTOR ;

(*
    KillProcess - kills the current process. Notice that if InitProcess
                  is called again, it might reuse the DESCRIPTOR of the
                  killed process. It is the responsibility of the caller
                  to ensure all other processes understand this process
                  is different.
*)

PROCEDURE KillProcess ;

(*
    Resume - resumes a suspended process. If all is successful then the process, p,
             is returned. If it fails then NIL is returned.
*)

PROCEDURE Resume (d: DESCRIPTOR) : DESCRIPTOR ;

```

```
(*
  Suspend - suspend the calling process.
            The process can only continue running if another process
            Resumes it.
*)

PROCEDURE Suspend ;

(*
  InitSemaphore - creates a semaphore whose initial value is, v, and
                 whose name is, Name.
*)

PROCEDURE InitSemaphore (v: CARDINAL; Name: ARRAY OF CHAR) : SEMAPHORE ;

(*
  Wait - performs dijkstras P operation on a semaphore.
        A process which calls this procedure will
        wait until the value of the semaphore is > 0
        and then it will decrement this value.
*)

PROCEDURE Wait (s: SEMAPHORE) ;

(*
  Signal - performs dijkstras V operation on a semaphore.
          A process which calls the procedure will increment
          the semaphores value.
*)

PROCEDURE Signal (s: SEMAPHORE) ;

(*
  WaitForIO - waits for an interrupt to occur on vector, VectorNo.
*)

PROCEDURE WaitForIO (VectorNo: CARDINAL) ;

(*
  Ps - displays a process list together with process status.
```

```
*)

PROCEDURE Ps ;

(*
    GetCurrentProcess - returns the descriptor of the current running
                      process.
*)

PROCEDURE GetCurrentProcess () : DESCRIPTOR ;

(*
    RotateRunQueue - rotates the process run queue.
                   It does not call the scheduler.
*)

PROCEDURE RotateRunQueue ;

(*
    ProcessName - displays the name of process, d, through
                 DebugString.
*)

PROCEDURE ProcessName (d: DESCRIPTOR) ;

(*
    DebugProcess - gdb debug handle to enable users to debug deadlocked
                  semaphore processes.
*)

PROCEDURE DebugProcess (d: DESCRIPTOR) ;

END Executive.
```

4.3.2 gm2-libs-coroutines/KeyBoardLEDs

```
DEFINITION MODULE KeyBoardLEDs ;

EXPORT QUALIFIED SwitchLeds,
                  SwitchScroll, SwitchNum, SwitchCaps ;

(*
  SwitchLeds - switch the keyboard LEDs to the state defined
               by the BOOLEAN variables. TRUE = ON.
*)

PROCEDURE SwitchLeds (NumLock, CapsLock, ScrollLock: BOOLEAN) ;

(*
  SwitchScroll - switches the scroll LED on or off.
*)

PROCEDURE SwitchScroll (Scroll: BOOLEAN) ;

(*
  SwitchNum - switches the Num LED on or off.
*)

PROCEDURE SwitchNum (Num: BOOLEAN) ;

(*
  SwitchCaps - switches the Caps LED on or off.
*)

PROCEDURE SwitchCaps (Caps: BOOLEAN) ;

END KeyBoardLEDs.
```

4.3.3 gm2-libs-coroutines/SYSTEM

```

DEFINITION MODULE SYSTEM ;

(* This module is designed to be used on a native operating system
   rather than an embedded system as it implements the coroutine
   primitives TRANSFER, IOTRANSFER and
   NEWPROCESS through the GNU Pthread library.  *)

FROM COROUTINES IMPORT PROTECTION ;

EXPORT QUALIFIED (* the following are built into the compiler: *)
    ADDRESS, WORD, BYTE, CSIZE_T, CSSIZE_T, COFF_T, (*
    Target specific data types. *)
    ADR, TSIZE, ROTATE, SHIFT, THROW, TBITSIZE,
    (* SIZE is exported depending upon -fpim2 and
       -fpedantic.  *)
    (* The rest are implemented in SYSTEM.mod.  *)
    PROCESS, TRANSFER, NEWPROCESS, IOTRANSFER,
    LISTEN,
    ListenLoop, TurnInterrupts,
    (* Internal GM2 compiler functions.  *)
    ShiftVal, ShiftLeft, ShiftRight,
    RotateVal, RotateLeft, RotateRight ;

TYPE
    PROCESS = RECORD
        context: INTEGER ;
    END ;

(* Note that the full list of system and sized datatypes include:
   LOC, WORD, BYTE, ADDRESS,

   (and the non language standard target types)

   INTEGER8, INTEGER16, INTEGER32, INTEGER64,
   CARDINAL8, CARDINAL16, CARDINAL32, CARDINAL64,
   WORD16, WORD32, WORD64, BITSET8, BITSET16,
   BITSET32, REAL32, REAL64, REAL128, COMPLEX32,
   COMPLEX64, COMPLEX128, CSIZE_T, CSSIZE_T.

   Also note that the non-standard data types will
   move into another module in the future.  *)

(* The following types are supported on this target:
   (* Target specific data types.  *)

```

*)

(*

TRANSFER - save the current volatile environment into, p1.
Restore the volatile environment from, p2.

*)

PROCEDURE TRANSFER (VAR p1: PROCESS; p2: PROCESS) ;

(*

NEWPROCESS - p is a parameterless procedure, a, is the origin of
the workspace used for the process stack and containing
the volatile environment of the process. StackSize, is
the maximum size of the stack in bytes which can be used
by this process. new, is the new process.

*)

PROCEDURE NEWPROCESS (p: PROC; a: ADDRESS; StackSize: CARDINAL; VAR new: PROCESS) ;■

(*

IOTRANSFER - saves the current volatile environment into, First,
and restores volatile environment, Second.
When an interrupt, InterruptNo, is encountered then
the reverse takes place. (The then current volatile
environment is shelved onto Second and First is resumed).■

NOTE: that upon interrupt the Second might not be the
same process as that before the original call to
IOTRANSFER.

*)

PROCEDURE IOTRANSFER (VAR First, Second: PROCESS; InterruptNo: CARDINAL) ;■

(*

LISTEN - briefly listen for any interrupts.

*)

PROCEDURE LISTEN ;

(*

ListenLoop - should be called instead of users writing:

```

LOOP
    LISTEN
END

```

It performs the same function but yields control back to the underlying operating system via a call to pth_select. It also checks for deadlock. This function returns when an interrupt occurs ie a file descriptor becomes ready or a time event expires. See the module RTint.

```
*)
```

```
PROCEDURE ListenLoop ;
```

```

(*)
    TurnInterrupts - switches processor interrupts to the protection
                    level, to. It returns the old value.
*)

```

```
PROCEDURE TurnInterrupts (to: PROTECTION) : PROTECTION ;
```

```

(*)
    all the functions below are declared internally to gm2
    =====

```

```

PROCEDURE ADR (VAR v: <anytype>): ADDRESS;
    (* Returns the address of variable v. *)

```

```

PROCEDURE SIZE (v: <type>) : ZType;
    (* Returns the number of BYTES used to store a v of
       any specified <type>. Only available if -fpim2 is used.
    *)

```

```

PROCEDURE TSIZE (<type>) : CARDINAL;
    (* Returns the number of BYTES used to store a value of the
       specified <type>.
    *)

```

```

PROCEDURE ROTATE (val: <a set type>;
                  num: INTEGER): <type of first parameter>;
    (* Returns a bit sequence obtained from val by rotating up or down
       (left or right) by the absolute value of num. The direction is
       down if the sign of num is negative, otherwise the direction is up.
    *)

```

```

PROCEDURE SHIFT (val: <a set type>;
                 num: INTEGER): <type of first parameter>;
(* Returns a bit sequence obtained from val by shifting up or down
   (left or right) by the absolute value of num, introducing
   zeros as necessary. The direction is down if the sign of
   num is negative, otherwise the direction is up.
*)

PROCEDURE THROW (i: INTEGER) <* noreturn *> ;
(*
   THROW is a GNU extension and was not part of the PIM or ISO
   standards. It throws an exception which will be caught by the EXCEPT
   block (assuming it exists). This is a compiler builtin function which
   interfaces to the GCC exception handling runtime system.
   GCC uses the term throw, hence the naming distinction between
   the GCC builtin and the Modula-2 runtime library procedure Raise.
   The later library procedure Raise will call SYSTEM.THROW after
   performing various housekeeping activities.
*)

PROCEDURE TBITSIZE (<type>) : CARDINAL ;
(* Returns the minimum number of bits necessary to represent
   <type>. This procedure function is only useful for determining
   the number of bits used for any type field within a packed RECORD.
   It is not particularly useful elsewhere since <type> might be
   optimized for speed, for example a BOOLEAN could occupy a WORD.
*)

(* The following procedures are invoked by GNU Modula-2 to
   shift non word sized set types. They are not strictly part
   of the core PIM Modula-2, however they are used
   to implement the SHIFT procedure defined above,
   which are in turn used by the Logitech compatible libraries.

   Users will access these procedures by using the procedure
   SHIFT above and GNU Modula-2 will map SHIFT onto one of
   the following procedures.

   ShiftVal - is a runtime procedure whose job is to implement
   the SHIFT procedure of ISO SYSTEM. GNU Modula-2 will
   inline a SHIFT of a single WORD sized set and will
   only call this routine for larger sets.
*)

```

```
PROCEDURE ShiftVal (VAR s, d: ARRAY OF BITSET;
                   SetSizeInBits: CARDINAL;
                   ShiftCount: INTEGER) ;

(*
  ShiftLeft - performs the shift left for a multi word set.
              This procedure might be called by the back end of
              GNU Modula-2 depending whether amount is known at
              compile time.
*)

PROCEDURE ShiftLeft (VAR s, d: ARRAY OF BITSET;
                   SetSizeInBits: CARDINAL;
                   ShiftCount: CARDINAL) ;

(*
  ShiftRight - performs the shift left for a multi word set.
               This procedure might be called by the back end of
               GNU Modula-2 depending whether amount is known at
               compile time.
*)

PROCEDURE ShiftRight (VAR s, d: ARRAY OF BITSET;
                    SetSizeInBits: CARDINAL;
                    ShiftCount: CARDINAL) ;

(*
  RotateVal - is a runtime procedure whose job is to implement
              the ROTATE procedure of ISO SYSTEM. GNU Modula-2 will
              inline a ROTATE of a single WORD (or less)
              sized set and will only call this routine for
              larger sets.
*)

PROCEDURE RotateVal (VAR s, d: ARRAY OF BITSET;
                   SetSizeInBits: CARDINAL;
                   RotateCount: INTEGER) ;

(*
  RotateLeft - performs the rotate left for a multi word set.
               This procedure might be called by the back end of
               GNU Modula-2 depending whether amount is known
               at compile time.
```

*)

```
PROCEDURE RotateLeft (VAR s, d: ARRAY OF BITSET;  
                      SetSizeInBits: CARDINAL;  
                      RotateCount: CARDINAL) ;
```

(*

RotateRight - performs the rotate right for a multi word set.
This procedure might be called by the back end of
GNU Modula-2 depending whether amount is known at
compile time.

*)

```
PROCEDURE RotateRight (VAR s, d: ARRAY OF BITSET;  
                      SetSizeInBits: CARDINAL;  
                      RotateCount: CARDINAL) ;
```

```
END SYSTEM.
```

4.3.4 gm2-libs-coroutines/TimerHandler

```

DEFINITION MODULE TimerHandler ;

(* It also provides the Executive with a basic round robin scheduler. *)

EXPORT QUALIFIED TicksPerSecond, GetTicks,
                  EVENT,
                  Sleep, ArmEvent, WaitOn, Cancel, ReArmEvent ;

CONST
  TicksPerSecond = 25 ; (* Number of ticks per second. *)

TYPE
  EVENT ;

(*
  GetTicks - returns the number of ticks since boottime.
*)

PROCEDURE GetTicks () : CARDINAL ;

(*
  Sleep - suspends the current process for a time, t.
          The time is measured in ticks.
*)

PROCEDURE Sleep (t: CARDINAL) ;

(*
  ArmEvent - initializes an event, e, to occur at time, t.
             The time, t, is measured in ticks.
             The event is NOT placed onto the event queue.
*)

PROCEDURE ArmEvent (t: CARDINAL) : EVENT ;

(*
  WaitOn - places event, e, onto the event queue and then the calling
           process suspends. It is resumed up by either the event
           expiring or the event, e, being cancelled.
           TRUE is returned if the event was cancelled

```

```
        FALSE is returned if the event expires.
        The event, e, is always assigned to NIL when the function
        finishes.
*)

PROCEDURE WaitOn (VAR e: EVENT) : BOOLEAN ;

(*
    Cancel - cancels the event, e, on the event queue and makes
             the appropriate process runnable again.
    TRUE is returned if the event was cancelled and
    FALSE is returned if the event was not found or
             no process was waiting on this event.
*)

PROCEDURE Cancel (e: EVENT) : BOOLEAN ;

(*
    ReArmEvent - removes an event, e, from the event queue. A new time
                 is given to this event and it is then re-inserted onto the
                 event queue in the correct place.
    TRUE is returned if this occurred
    FALSE is returned if the event was not found.
*)

PROCEDURE ReArmEvent (e: EVENT; t: CARDINAL) : BOOLEAN ;

END TimerHandler.
```

4.4 M2 ISO Libraries

This directory contains the ISO definition modules and some corresponding implementation modules. The definition files: `ChanConsts.def`, `CharClass.def`, `ComplexMath.def`, `ConvStringLong.def`, `ConvStringReal.def`, `ConvTypes.def`, `COROUTINES.def`, `EXCEPTIONS.def`, `GeneralUserExceptions.def`, `IOChan.def`, `IOConsts.def`, `IOLink.def`, `IOLink.def`, `IOResult.def`, `LongComplexMath.def`, `LongConv.def`, `LongIO.def`, `LongMath.def`, `LongStr.def`, `LowLong.def`, `LowReal.def`, `M2EXCEPTION.def`, `Processes.def`, `ProgramArgs.def`, `RawIO.def`, `RealConv.def`, `RealIO.def`, `RealMath.def`, `RealStr.def`, `RndFile.def`, `Semaphores.def`, `SeqFile.def`, `SIOResult.def`, `SLongIO.def`, `SRawIO.def`, `SRealIO.def`, `StdChans.def`, `STextIO.def`, `Storage.def`, `StreamFile.def`, `Strings.def`, `SWholeIO.def`, `SysClock.def`, `SYSTEM.def`, `TERMINATION.def`, `TextIO.def`, `WholeConv.def`, `WholeIO.def` and `WholeStr.def` were defined by the International Standard Information technology - programming languages BS ISO/IEC 10514-1:1996E Part 1: Modula-2, Base Language.

The Copyright to the definition files `ChanConsts.def`, `CharClass.def`, `ComplexMath.def`, `ConvStringLong.def`, `ConvStringReal.def`, `ConvTypes.def`, `COROUTINES.def`, `EXCEPTIONS.def`, `GeneralUserExceptions.def`, `IOChan.def`, `IOConsts.def`, `IOLink.def`, `IOLink.def`, `IOResult.def`, `LongComplexMath.def`, `LongConv.def`, `LongIO.def`, `LongMath.def`, `LongStr.def`, `LowLong.def`, `LowReal.def`, `M2EXCEPTION.def`, `Processes.def`, `ProgramArgs.def`, `RawIO.def`, `RealConv.def`, `RealIO.def`, `RealMath.def`, `RealStr.def`, `RndFile.def`, `Semaphores.def`, `SeqFile.def`, `SIOResult.def`, `SLongIO.def`, `SRawIO.def`, `SRealIO.def`, `StdChans.def`, `STextIO.def`, `Storage.def`, `StreamFile.def`, `Strings.def`, `SWholeIO.def`, `SysClock.def`, `SYSTEM.def`, `TERMINATION.def`, `TextIO.def`, `WholeConv.def`, `WholeIO.def` and `WholeStr.def` belong to ISO/IEC (International Organization for Standardization and International Electrotechnical Commission). The licence allows them to be distributed with the compiler (as described on page 707 of the Information technology - Programming languages Part 1: Modula-2, Base Language. BS ISO/IEC 10514-1:1996).

All implementation modules and `ClientSocket.def`, `LongWholeIO.def`, `M2RTS.def`, `MemStream.def`, `pth.def`, `RandomNumber.def`, `RTdata.def`, `RTentity.def`, `RTfio.def`, `RTio.def`, `ShortComplexMath.def`, `ShortIO.def`, `ShortWholeIO.def`, `SimpleCipher.def`, `SLongWholeIO.def`, `SShortIO.def`, `SShortWholeIO.def`, `StringChan.def` and `wraptime.def` are Copyright of the FSF and are held under the GPLv3 with runtime exceptions.

Under Section 7 of GPL version 3, you are granted additional permissions described in the GCC Runtime Library Exception, version 3.1, as published by the Free Software Foundation.

You should have received a copy of the GNU General Public License and a copy of the GCC Runtime Library Exception along with this program; see the files `COPYING3` and `COPYING.RUNTIME` respectively. If not, see <http://www.gnu.org/licenses/>.

Notice that GNU Modula-2 contains additional libraries for input/output of `SHORTREAL`, `SHORTCARD`, `SHORTINT`, `LONGCARD`, `LONGINT` data types. It also provides a `RandomNumber`, `SimpleCipher` and `ClientSocket` modules as well as low level modules which allow the IO libraries to coexist with their PIM counterparts.

4.4.1 gm2-libs-iso/COROUTINES

```

DEFINITION MODULE COROUTINES;

(* Facilities for coroutines and the handling of interrupts *)

IMPORT SYSTEM ;

CONST
    UnassignedPriority = 0 ;

TYPE
    COROUTINE ; (* Values of this type are created dynamically by NEWCOROUTINE
                  and identify the coroutine in subsequent operations *)
    INTERRUPTSOURCE = CARDINAL ;
    PROTECTION = [UnassignedPriority..7] ;

PROCEDURE NEWCOROUTINE (procBody: PROC;
                        workspace: SYSTEM.ADDRESS;
                        size: CARDINAL;
                        VAR cr: COROUTINE;
                        [initProtection: PROTECTION = UnassignedPriority]);
(* Creates a new coroutine whose body is given by procBody, and
   returns the identity of the coroutine in cr. workspace is a
   pointer to the work space allocated to the coroutine; size
   specifies the size of this workspace in terms of SYSTEM.LOC.

   The optarg, initProtection, may contain a single parameter which
   specifies the initial protection level of the coroutine.
*)

PROCEDURE TRANSFER (VAR from: COROUTINE; to: COROUTINE);
(* Returns the identity of the calling coroutine in from, and
   transfers control to the coroutine specified by to.
*)

PROCEDURE IOTRANSFER (VAR from: COROUTINE; to: COROUTINE);
(* Returns the identity of the calling coroutine in from and
   transfers control to the coroutine specified by to. On
   occurrence of an interrupt, associated with the caller, control
   is transferred back to the caller, and the identity of the
   interrupted coroutine is returned in from. The calling coroutine
   must be associated with a source of interrupts.
*)

```

```

PROCEDURE ATTACH (source: INTERRUPTSOURCE);
  (* Associates the specified source of interrupts with the calling
     coroutine. *)

PROCEDURE DETACH (source: INTERRUPTSOURCE);
  (* Dissociates the specified source of interrupts from the calling
     coroutine. *)

PROCEDURE IsATTACHED (source: INTERRUPTSOURCE): BOOLEAN;
  (* Returns TRUE if and only if the specified source of interrupts is
     currently associated with a coroutine; otherwise returns FALSE.
     *)

PROCEDURE HANDLER (source: INTERRUPTSOURCE): COROUTINE;
  (* Returns the coroutine, if any, that is associated with the source
     of interrupts. The result is undefined if IsATTACHED(source) =
     FALSE.
     *)

PROCEDURE CURRENT (): COROUTINE;
  (* Returns the identity of the calling coroutine. *)

PROCEDURE LISTEN (p: PROTECTION);
  (* Momentarily changes the protection of the calling coroutine to
     p. *)

PROCEDURE PROT (): PROTECTION;
  (* Returns the protection of the calling coroutine. *)

(*
   TurnInterrupts - switches processor interrupts to the protection
                   level, to. It returns the old value.
   *)

PROCEDURE TurnInterrupts (to: PROTECTION) : PROTECTION ;

(*
   ListenLoop - should be called instead of users writing:

       LOOP
         LISTEN
       END

   It performs the same function but yields
   control back to the underlying operating system.

```

It also checks for deadlock.

Note that this function does return when an interrupt occurs.■

(File descriptor becomes ready or time event expires).

*)

PROCEDURE ListenLoop ;

END COROUTINES.

4.4.2 gm2-libs-iso/ChanConsts

DEFINITION MODULE ChanConsts;

(* Common types and values for channel open requests and results *)

TYPE

```
ChanFlags =          (* Request flags possibly given when a channel is opened *)
( readFlag,          (* input operations are requested/available *)
  writeFlag,          (* output operations are requested/available *)
  oldFlag,            (* a file may/must/did exist before the channel is opened *)
  textFlag,           (* text operations are requested/available *)
  rawFlag,            (* raw operations are requested/available *)
  interactiveFlag,    (* interactive use is requested/applies *)
  echoFlag            (* echoing by interactive device on removal of characters from in
                      stream requested/applies *)
);
```

FlagSet = SET OF ChanFlags;

(* Singleton values of FlagSet, to allow for example, read + write *)

CONST

```
read = FlagSet{readFlag};  (* input operations are requested/available *)
write = FlagSet{writeFlag}; (* output operations are requested/available *)
old = FlagSet{oldFlag};    (* a file may/must/did exist before the channel is opened *)
text = FlagSet{textFlag};  (* text operations are requested/available *)
raw = FlagSet{rawFlag};    (* raw operations are requested/available *)
interactive = FlagSet{interactiveFlag}; (* interactive use is requested/applies *)
echo = FlagSet{echoFlag};  (* echoing by interactive device on removal of character
                      input stream requested/applies *)
```

TYPE

```
OpenResults =          (* Possible results of open requests *)
( opened,              (* the open succeeded as requested *)
  wrongNameFormat,     (* given name is in the wrong format for the implementation *)
  wrongFlags,          (* given flags include a value that does not apply to the device *)
  tooManyOpen,         (* this device cannot support any more open channels *)
  outOfChans,          (* no more channels can be allocated *)
  wrongPermissions,    (* file or directory permissions do not allow request *)
  noRoomOnDevice,      (* storage limits on the device prevent the open *)
  noSuchFile,          (* a needed file does not exist *)
  fileExists,          (* a file of the given name already exists when a new one is requested *)
  wrongFileType,       (* the file is of the wrong type to support the required operations *)
  noTextOperations,    (* text operations have been requested, but are not supported *)
  noRawOperations,     (* raw operations have been requested, but are not supported *)
  noMixedOperations,   (* text and raw operations have been requested, but they are not supported *)
```

```
                                are not supported in combination *)
alreadyOpen,                    (* the source/destination is already open for operations not su
                                in combination with the requested operations *)■
otherProblem                    (* open failed for some other reason *)
);

END ChanConsts.
```

4.4.3 gm2-libs-iso/CharClass

```
DEFINITION MODULE CharClass;

    (* Classification of values of the type CHAR *)

PROCEDURE IsNumeric (ch: CHAR): BOOLEAN;
    (* Returns TRUE if and only if ch is classified as a numeric character *)■

PROCEDURE IsLetter (ch: CHAR): BOOLEAN;
    (* Returns TRUE if and only if ch is classified as a letter *)

PROCEDURE IsUpper (ch: CHAR): BOOLEAN;
    (* Returns TRUE if and only if ch is classified as an upper case letter *)■

PROCEDURE IsLower (ch: CHAR): BOOLEAN;
    (* Returns TRUE if and only if ch is classified as a lower case letter *)■

PROCEDURE IsControl (ch: CHAR): BOOLEAN;
    (* Returns TRUE if and only if ch represents a control function *)

PROCEDURE IsWhiteSpace (ch: CHAR): BOOLEAN;
    (* Returns TRUE if and only if ch represents a space character or a format effector *)

END CharClass.
```

4.4.4 gm2-libs-iso/ClientSocket

```
DEFINITION MODULE ClientSocket ;

FROM IOChan IMPORT ChanId ;
FROM ChanConsts IMPORT FlagSet, OpenResults ;

(*
  OpenSocket - opens a TCP client connection to host:port.
*)

PROCEDURE OpenSocket (VAR cid: ChanId;
                     host: ARRAY OF CHAR; port: CARDINAL;
                     f: FlagSet; VAR res: OpenResults) ;

(*
  Close - if the channel identified by cid is not open to
         a socket stream, the exception wrongDevice is
         raised; otherwise closes the channel, and assigns
         the value identifying the invalid channel to cid.
*)

PROCEDURE Close (VAR cid: ChanId) ;

(*
  IsSocket - tests if the channel identified by cid is open as
            a client socket stream.
*)

PROCEDURE IsSocket (cid: ChanId) : BOOLEAN ;

END ClientSocket.
```

4.4.5 gm2-libs-iso/ComplexMath

```

DEFINITION MODULE ComplexMath;

  (* Mathematical functions for the type COMPLEX *)

CONST
  i =      CMPLX (0.0, 1.0);
  one =    CMPLX (1.0, 0.0);
  zero =   CMPLX (0.0, 0.0);

PROCEDURE __BUILTIN__ abs (z: COMPLEX): REAL;
  (* Returns the length of z *)

PROCEDURE __BUILTIN__ arg (z: COMPLEX): REAL;
  (* Returns the angle that z subtends to the positive real axis *)

PROCEDURE __BUILTIN__ conj (z: COMPLEX): COMPLEX;
  (* Returns the complex conjugate of z *)

PROCEDURE __BUILTIN__ power (base: COMPLEX; exponent: REAL): COMPLEX;
  (* Returns the value of the number base raised to the power exponent *)

PROCEDURE __BUILTIN__ sqrt (z: COMPLEX): COMPLEX;
  (* Returns the principal square root of z *)

PROCEDURE __BUILTIN__ exp (z: COMPLEX): COMPLEX;
  (* Returns the complex exponential of z *)

PROCEDURE __BUILTIN__ ln (z: COMPLEX): COMPLEX;
  (* Returns the principal value of the natural logarithm of z *)

PROCEDURE __BUILTIN__ sin (z: COMPLEX): COMPLEX;
  (* Returns the sine of z *)

PROCEDURE __BUILTIN__ cos (z: COMPLEX): COMPLEX;
  (* Returns the cosine of z *)

PROCEDURE __BUILTIN__ tan (z: COMPLEX): COMPLEX;
  (* Returns the tangent of z *)

PROCEDURE __BUILTIN__ arcsin (z: COMPLEX): COMPLEX;
  (* Returns the arcsine of z *)

PROCEDURE __BUILTIN__ arccos (z: COMPLEX): COMPLEX;
  (* Returns the arccosine of z *)

```

```
PROCEDURE __BUILTIN__ arctan (z: COMPLEX): COMPLEX;  
    (* Returns the arctangent of z *)  
  
PROCEDURE polarToComplex (abs, arg: REAL): COMPLEX;  
    (* Returns the complex number with the specified polar coordinates *)  
  
PROCEDURE scalarMult (scalar: REAL; z: COMPLEX): COMPLEX;  
    (* Returns the scalar product of scalar with z *)  
  
PROCEDURE IsCMathException (): BOOLEAN;  
    (* Returns TRUE if the current coroutine is in the exceptional  
       execution state because of the raising of an exception in a  
       routine from this module; otherwise returns FALSE.  
    *)  
  
END ComplexMath.
```

4.4.6 gm2-libs-iso/ConvStringLong

```
DEFINITION MODULE ConvStringLong ;
```

```
FROM DynamicStrings IMPORT String ;
```

```
(*
  RealToFloatString - converts a real with, sigFigs, into a string
                      and returns the result as a string.
*)
```

```
PROCEDURE RealToFloatString (real: LONGREAL; sigFigs: CARDINAL) : String ;■
```

```
(*
  RealToEngString - converts the value of real to floating-point
                   string form, with sigFigs significant figures.
                   The number is scaled with one to three digits
                   in the whole number part and with an exponent
                   that is a multiple of three.
*)
```

```
PROCEDURE RealToEngString (real: LONGREAL; sigFigs: CARDINAL) : String ;
```

```
(*
  RealToFixedString - returns the number of characters in the fixed-point■
                    string representation of real rounded to the given■
                    place relative to the decimal point.
*)
```

```
PROCEDURE RealToFixedString (real: LONGREAL; place: INTEGER) : String ;
```

```
END ConvStringLong.
```

4.4.7 gm2-libs-iso/ConvStringReal

```
DEFINITION MODULE ConvStringReal ;
```

```
FROM DynamicStrings IMPORT String ;
```

```
(*
  RealToFloatString - converts a real with, sigFigs, into a string
                      and returns the result as a string.
*)
```

```
PROCEDURE RealToFloatString (real: REAL; sigFigs: CARDINAL) : String ;
```

```
(*
  RealToEngString - converts the value of real to floating-point
                   string form, with sigFigs significant figures.
                   The number is scaled with one to three digits
                   in the whole number part and with an exponent
                   that is a multiple of three.
*)
```

```
PROCEDURE RealToEngString (real: REAL; sigFigs: CARDINAL) : String ;
```

```
(*
  RealToFixedString - returns the number of characters in the fixed-point
                     string representation of real rounded to the given
                     place relative to the decimal point.
*)
```

```
PROCEDURE RealToFixedString (real: REAL; place: INTEGER) : String ;
```

```
END ConvStringReal.
```

4.4.8 gm2-libs-iso/ConvStringShort

```

DEFINITION MODULE ConvStringShort ;

FROM DynamicStrings IMPORT String ;

(*
  RealToFloatString - converts a real with, sigFigs, into a string
                    and returns the result as a string.
*)

PROCEDURE RealToFloatString (real: SHORTREAL; sigFigs: CARDINAL) : String ;■

(*
  RealToEngString - converts the value of real to floating-point
                  string form, with sigFigs significant figures.
                  The number is scaled with one to three digits
                  in the whole number part and with an exponent
                  that is a multiple of three.
*)

PROCEDURE RealToEngString (real: SHORTREAL; sigFigs: CARDINAL) : String ;■

(*
  RealToFixedString - returns the number of characters in the fixed-point
                    string representation of real rounded to the given
                    place relative to the decimal point.
*)

PROCEDURE RealToFixedString (real: SHORTREAL; place: INTEGER) : String ;

END ConvStringShort.

```

4.4.9 gm2-libs-iso/ConvTypes

```
DEFINITION MODULE ConvTypes;
```

```
  (* Common types used in the string conversion modules *)
```

```
TYPE
```

```
  ConvResults =      (* Values of this type are used to express the format of a string
  (
    strAllRight,      (* the string format is correct for the corresponding conversion *)
    strOutOfRange,    (* the string is well-formed but the value cannot be represented *)
    strWrongFormat,    (* the string is in the wrong format for the conversion *)
    strEmpty          (* the given string is empty *)
  );
```

```
  ScanClass = (* Values of this type are used to classify input to finite state scanner
  (
    padding, (* a leading or padding character at this point in the scan - ignore it *)
    valid,   (* a valid character at this point in the scan - accept it *)
    invalid, (* an invalid character at this point in the scan - reject it *)
    terminator (* a terminating character at this point in the scan (not part of token)
  );
```

```
  ScanState = (* The type of lexical scanning control procedures *)
    PROCEDURE (CHAR, VAR ScanClass, VAR ScanState);
```

```
END ConvTypes.
```

4.4.10 gm2-libs-iso/EXCEPTIONS

```

DEFINITION MODULE EXCEPTIONS;

(* Provides facilities for raising user exceptions
   and for making enquiries concerning the current execution state.
*)

TYPE
  ExceptionSource;    (* values of this type are used within library
                       modules to identify the source of raised
                       exceptions *)
  ExceptionNumber = CARDINAL;

PROCEDURE AllocateSource(VAR newSource: ExceptionSource);
  (* Allocates a unique value of type ExceptionSource *)

PROCEDURE RAISE (source: ExceptionSource;
                 number: ExceptionNumber; message: ARRAY OF CHAR)
  <* noreturn *> ;
  (* Associates the given values of source, number and message with
     the current context and raises an exception.
  *)

PROCEDURE CurrentNumber (source: ExceptionSource): ExceptionNumber;
  (* If the current coroutine is in the exceptional execution state
     because of the raising of an exception from source, returns
     the corresponding number, and otherwise raises an exception.
  *)

PROCEDURE GetMessage (VAR text: ARRAY OF CHAR);
  (* If the current coroutine is in the exceptional execution state,
     returns the possibly truncated string associated with the
     current context. Otherwise, in normal execution state,
     returns the empty string.
  *)

PROCEDURE IsCurrentSource (source: ExceptionSource): BOOLEAN;
  (* If the current coroutine is in the exceptional execution state
     because of the raising of an exception from source, returns
     TRUE, and otherwise returns FALSE.
  *)

PROCEDURE IsExceptionalExecution (): BOOLEAN;
  (* If the current coroutine is in the exceptional execution state
     because of the raising of an exception, returns TRUE, and
     otherwise returns FALSE.
  *)

```

*)

END EXCEPTIONS.

4.4.11 gm2-libs-iso/ErrnoCategory

DEFINITION MODULE ErrnoCategory ;

(*
 provides an interface to errno (if the system
 supports it) which determines whether the current
 errno is a hard or soft error. These distinctions
 are needed by the ISO Modula-2 libraries. Not all
 errno values are tested, only those which could be
 related to a device.
*)

IMPORT ChanConsts ;

(*
 IsErrnoHard - returns TRUE if the value of errno is associated with
 a hard device error.
*)

PROCEDURE IsErrnoHard (e: INTEGER) : BOOLEAN ;

(*
 IsErrnoSoft - returns TRUE if the value of errno is associated with
 a soft device error.
*)

PROCEDURE IsErrnoSoft (e: INTEGER) : BOOLEAN ;

(*
 UnAvailable - returns TRUE if the value of errno indicates that
 the resource or device is unavailable for some
 reason.
*)

PROCEDURE UnAvailable (e: INTEGER) : BOOLEAN ;

(*
 GetOpenResults - maps errno onto the ISO Modula-2 enumerated
 type, OpenResults.
*)

PROCEDURE GetOpenResults (e: INTEGER) : ChanConsts.OpenResults ;

```
END ErrnoCategory.
```

4.4.12 gm2-libs-iso/GeneralUserExceptions

```
DEFINITION MODULE GeneralUserExceptions;

(* Provides facilities for general user-defined exceptions *)

TYPE
  GeneralExceptions = (problem, disaster);

PROCEDURE RaiseGeneralException (exception: GeneralExceptions;
                                text: ARRAY OF CHAR);
  (* Raises exception using text as the associated message *)

PROCEDURE IsGeneralException (): BOOLEAN;
  (* Returns TRUE if the current coroutine is in the exceptional
     execution state because of the raising of an exception from
     GeneralExceptions; otherwise returns FALSE.
  *)

PROCEDURE GeneralException(): GeneralExceptions;
  (* If the current coroutine is in the exceptional execution
     state because of the raising of an exception from
     GeneralExceptions, returns the corresponding enumeration value,
     and otherwise raises an exception.
  *)

END GeneralUserExceptions.
```

4.4.13 gm2-libs-iso/IOChan

```
DEFINITION MODULE IOChan;
```

```
  (* Types and procedures forming the interface to channels for
     device-independent data transfer modules
  *)
```

```
IMPORT IOConsts, ChanConsts, SYSTEM;
```

```
TYPE
```

```
  ChanId; (* Values of this type are used to identify channels *)
```

```
  (* There is one pre-defined value identifying an invalid channel
     on which no data transfer operations are available. It may
     be used to initialize variables of type ChanId.
  *)
```

```
PROCEDURE InvalidChan (): ChanId;
```

```
  (* Returns the value identifying the invalid channel. *)
```

```
  (* For each of the following operations, if the device supports
     the operation on the channel, the behaviour of the procedure
     conforms with the description below. The full behaviour is
     defined for each device module. If the device does not
     support the operation on the channel, the behaviour of the
     procedure is to raise the exception notAvailable.
  *)
```

```
  (* Text operations - these perform any required translation between the
     internal and external representation of text.
  *)
```

```
PROCEDURE Look (cid: ChanId; VAR ch: CHAR; VAR res: IOConsts.ReadResults);
```

```
  (* If there is a character as the next item in the input stream
     cid, assigns its value to ch without removing it from the stream;
     otherwise the value of ch is not defined. res (and the stored
     read result) are set to the value allRight, endOfLine, or endOfInput.
  *)
```

```
PROCEDURE Skip (cid: ChanId);
```

```
  (* If the input stream cid has ended, the exception skipAtEnd
     is raised; otherwise the next character or line mark in cid is
     removed, and the stored read result is set to the value
     allRight.
  *)
```

```

PROCEDURE SkipLook (cid: ChanId; VAR ch: CHAR; VAR res: IOConsts.ReadResults);
(* If the input stream cid has ended, the exception skipAtEnd is
   raised; otherwise the next character or line mark in cid is
   removed. If there is a character as the next item in cid
   stream, assigns its value to ch without removing it from the
   stream. Otherwise, the value of ch is not defined. res
   (and the stored read result) are set to the value allRight,
   endOfLine, or endOfInput.
*)

PROCEDURE WriteLn (cid: ChanId);
(* Writes a line mark over the channel cid. *)

PROCEDURE TextRead (cid: ChanId; to: SYSTEM.ADDRESS; maxChars: CARDINAL;
                   VAR charsRead: CARDINAL);
(* Reads at most maxChars characters from the current line in cid,
   and assigns corresponding values to successive components of
   an ARRAY OF CHAR variable for which the address of the first
   component is to. The number of characters read is assigned to charsRead.
   The stored read result is set to allRight, endOfLine, or endOfInput.
*)

PROCEDURE TextWrite (cid: ChanId; from: SYSTEM.ADDRESS;
                   charsToWrite: CARDINAL);
(* Writes a number of characters given by the value of charsToWrite,
   from successive components of an ARRAY OF CHAR variable for which
   the address of the first component is from, to the channel cid.
*)

(* Direct raw operations - these do not effect translation between
   the internal and external representation of data
*)

PROCEDURE RawRead (cid: ChanId; to: SYSTEM.ADDRESS; maxLocs: CARDINAL;
                  VAR locsRead: CARDINAL);
(* Reads at most maxLocs items from cid, and assigns corresponding
   values to successive components of an ARRAY OF LOC variable for
   which the address of the first component is to. The number of
   characters read is assigned to charsRead. The stored read result
   is set to the value allRight, or endOfInput.
*)

PROCEDURE RawWrite (cid: ChanId; from: SYSTEM.ADDRESS; locsToWrite: CARDINAL);
(* Writes a number of items given by the value of charsToWrite,
   from successive components of an ARRAY OF LOC variable for
   which the address of the first component is from, to the channel cid.
*)

```

```

(* Common operations *)

PROCEDURE GetName (cid: ChanId; VAR s: ARRAY OF CHAR);
  (* Copies to s a name associated with the channel cid, possibly truncated
  (depending on the capacity of s).
  *)

PROCEDURE Reset (cid: ChanId);
  (* Resets the channel cid to a state defined by the device module. *)

PROCEDURE Flush (cid: ChanId);
  (* Flushes any data buffered by the device module out to the channel cid. *)

(* Access to read results *)

PROCEDURE SetReadResult (cid: ChanId; res: IOConsts.ReadResults);
  (* Sets the read result value for the channel cid to the value res. *)

PROCEDURE ReadResult (cid: ChanId): IOConsts.ReadResults;
  (* Returns the stored read result value for the channel cid.
  (This is initially the value notKnown).
  *)

(* Users can discover which flags actually apply to a channel *)

PROCEDURE CurrentFlags (cid: ChanId): ChanConsts.FlagSet;
  (* Returns the set of flags that currently apply to the channel cid. *)

(* The following exceptions are defined for this module and its clients *)

TYPE
  ChanExceptions =
    (wrongDevice,      (* device specific operation on wrong device *)
     notAvailable,     (* operation attempted that is not available on that
                        channel *)
     skipAtEnd,        (* attempt to skip data from a stream that has ended *)
     softDeviceError,  (* device specific recoverable error *)
     hardDeviceError,  (* device specific non-recoverable error *)
     textParseError,   (* input data does not correspond to a character or
                        line mark - optional detection *)
     notAChannel       (* given value does not identify a channel -
                        optional detection *)
    );

PROCEDURE IsChanException (): BOOLEAN;
  (* Returns TRUE if the current coroutine is in the exceptional

```

```
        execution state because of the raising of an exception from
        ChanExceptions; otherwise returns FALSE.
    *)

PROCEDURE ChanException (): ChanExceptions;
    (* If the current coroutine is in the exceptional execution state
       because of the raising of an exception from ChanExceptions,
       returns the corresponding enumeration value, and otherwise
       raises an exception.
    *)

    (* When a device procedure detects a device error, it raises the
       exception softDeviceError or hardDeviceError. If these
       exceptions are handled, the following facilities may be
       used to discover an implementation-defined error number for
       the channel.
    *)

TYPE
    DeviceErrNum = INTEGER;

PROCEDURE DeviceError (cid: ChanId): DeviceErrNum;
    (* If a device error exception has been raised for the channel cid,
       returns the error number stored by the device module.
    *)

END IOChan.
```

4.4.14 gm2-libs-iso/IOConsts

```
DEFINITION MODULE IOConsts;
```

```
    (* Types and constants for input/output modules *)
```

```
TYPE
```

```
    ReadResults = (* This type is used to classify the result of an input operation *)
```

```
    (
```

```
        notKnown,      (* no read result is set *)
```

```
        allRight,      (* data is as expected or as required *)
```

```
        outOfRange,    (* data cannot be represented *)
```

```
        wrongFormat,   (* data not in expected format *)
```

```
        endOfLine,     (* end of line seen before expected data *)
```

```
        endOfInput     (* end of input seen before expected data *)
```

```
    );
```

```
END IOConsts.
```

4.4.15 gm2-libs-iso/IOLink

```
DEFINITION MODULE IOLink;
```

```
(* Types and procedures for the standard implementation of channels *)
```

```
IMPORT IOChan, IOConsts, ChanConsts, SYSTEM;
```

```
TYPE
```

```
  DeviceId;
```

```
    (* Values of this type are used to identify new device modules,
       and are normally obtained by them during their initialization.
    *)
```

```
PROCEDURE AllocateDeviceId (VAR did: DeviceId);
```

```
    (* Allocates a unique value of type DeviceId, and assigns this
       value to did. *)
```

```
PROCEDURE MakeChan (did: DeviceId; VAR cid: IOChan.ChanId);
```

```
    (* Attempts to make a new channel for the device module identified
       by did. If no more channels can be made, the identity of
       the invalid channel is assigned to cid. Otherwise, the identity
       of a new channel is assigned to cid.
    *)
```

```
PROCEDURE UnMakeChan (did: DeviceId; VAR cid: IOChan.ChanId);
```

```
    (* If the device module identified by did is not the module that
       made the channel identified by cid, the exception wrongDevice is
       raised; otherwise the channel is deallocated, and the value
       identifying the invalid channel is assigned to cid.
    *)
```

```
TYPE
```

```
  DeviceTablePtr = POINTER TO DeviceTable;
```

```
    (* Values of this type are used to refer to device tables *)
```

```
TYPE
```

```
  LookProc      = PROCEDURE (DeviceTablePtr, VAR CHAR, VAR IOConsts.ReadResults) ;
  SkipProc      = PROCEDURE (DeviceTablePtr) ;
  SkipLookProc  = PROCEDURE (DeviceTablePtr, VAR CHAR, VAR IOConsts.ReadResults) ;
  WriteLnProc   = PROCEDURE (DeviceTablePtr) ;
  TextReadProc  = PROCEDURE (DeviceTablePtr, SYSTEM.ADDRESS, CARDINAL, VAR CARDINAL) ;
  TextWriteProc = PROCEDURE (DeviceTablePtr, SYSTEM.ADDRESS, CARDINAL) ;
  RawReadProc   = PROCEDURE (DeviceTablePtr, SYSTEM.ADDRESS, CARDINAL, VAR CARDINAL) ;
  RawWriteProc  = PROCEDURE (DeviceTablePtr, SYSTEM.ADDRESS, CARDINAL) ;
  GetNameProc   = PROCEDURE (DeviceTablePtr, VAR ARRAY OF CHAR) ;
  ResetProc     = PROCEDURE (DeviceTablePtr) ;
```

```

FlushProc      = PROCEDURE (DeviceTablePtr) ;
FreeProc       = PROCEDURE (DeviceTablePtr) ;
    (* Carry out the operations involved in closing the corresponding
       channel, including flushing buffers, but do not unmake the
       channel.
    *)

TYPE
    DeviceData = SYSTEM.ADDRESS;

    DeviceTable =
        RECORD
            (* Initialized by MakeChan to: *)
            cd: DeviceData;          (* the value NIL *)
            did: DeviceId;           (* the value given in the call of MakeChan *)
            cid: IOChan.ChanId;      (* the identity of the channel *)
            result: IOConsts.ReadResults; (* the value notKnown *)
            errNum: IOChan.DeviceErrNum; (* undefined *)
            flags: ChanConsts.FlagSet; (* ChanConsts.FlagSet{} *)
            doLook: LookProc;         (* raise exception notAvailable *)
            doSkip: SkipProc;         (* raise exception notAvailable *)
            doSkipLook: SkipLookProc; (* raise exception notAvailable *)
            doLnWrite: WriteLnProc;   (* raise exception notAvailable *)
            doTextRead: TextReadProc; (* raise exception notAvailable *)
            doTextWrite: TextWriteProc; (* raise exception notAvailable *)
            doRawRead: RawReadProc;   (* raise exception notAvailable *)
            doRawWrite: RawWriteProc; (* raise exception notAvailable *)
            doGetName: GetNameProc;   (* return the empty string *)
            doReset: ResetProc;       (* do nothing *)
            doFlush: FlushProc;       (* do nothing *)
            doFree: FreeProc;         (* do nothing *)
        END;

    (* The pointer to the device table for a channel is obtained using the
       following procedure: *)

    (*
       If the device module identified by did is not the module that made
       the channel identified by cid, the exception wrongDevice is raised.
    *)

    PROCEDURE DeviceTablePtrValue (cid: IOChan.ChanId; did: DeviceId): DeviceTablePtr;

    (*
       Tests if the device module identified by did is the module

```

```

        that made the channel identified by cid.
    *)

PROCEDURE IsDevice (cid: IOChan.ChanId; did: DeviceId) : BOOLEAN;

TYPE
    DevExceptionRange = IOChan.ChanExceptions;

    (*
        ISO standard states defines

        DevExceptionRange = [IOChan.notAvailable .. IOChan.textParseError];

        however this must be a bug as other modules need to raise
        IOChan.wrongDevice exceptions.
    *)

PROCEDURE RAISEdevException (cid: IOChan.ChanId; did: DeviceId;
                             x: DevExceptionRange; s: ARRAY OF CHAR) <* noreturn *> ;

    (* If the device module identified by did is not the module that made the channel
       identified by cid, the exception wrongDevice is raised; otherwise the given excep
       is raised, and the string value in s is included in the exception message.
    *)

PROCEDURE IsIOException () : BOOLEAN;

    (* Returns TRUE if the current coroutine is in the exceptional execution state
       because of the raising af an exception from ChanExceptions;
       otherwise FALSE.
    *)

PROCEDURE IOException () : IOChan.ChanExceptions;

    (* If the current coroutine is in the exceptional execution state because of the
       raising af an exception from ChanExceptions, returns the corresponding
       enumeration value, and otherwise raises an exception.
    *)

END IOLink.
```

4.4.16 gm2-libs-iso/IOResult

```
DEFINITION MODULE IOResult;
```

```
    (* Read results for specified channels *)
```

```
IMPORT IOConsts, IOChan;
```

```
TYPE
```

```
    ReadResults = IOConsts.ReadResults;
```

```
    (*
```

```
    ReadResults = (* This type is used to classify the result of an input operation *
```

```
    (
```

```
        notKnown,      (* no read result is set *)
```

```
        allRight,      (* data is as expected or as required *)
```

```
        outOfRange,    (* data cannot be represented *)
```

```
        wrongFormat,   (* data not in expected format *)
```

```
        endOfLine,     (* end of line seen before expected data *)
```

```
        endOfInput     (* end of input seen before expected data *)
```

```
    );
```

```
    *)
```

```
PROCEDURE ReadResult (cid: IOChan.ChanId): ReadResults;
```

```
    (* Returns the result for the last read operation on the channel cid. *)■
```

```
END IOResult.
```

4.4.17 gm2-libs-iso/LongComplexMath

```

DEFINITION MODULE LongComplexMath;

  (* Mathematical functions for the type LONGCOMPLEX *)

CONST
  i =      CMPLX (0.0, 1.0);
  one =    CMPLX (1.0, 0.0);
  zero =   CMPLX (0.0, 0.0);

PROCEDURE abs (z: LONGCOMPLEX): LONGREAL;
  (* Returns the length of z *)

PROCEDURE arg (z: LONGCOMPLEX): LONGREAL;
  (* Returns the angle that z subtends to the positive real axis *)

PROCEDURE conj (z: LONGCOMPLEX): LONGCOMPLEX;
  (* Returns the complex conjugate of z *)

PROCEDURE power (base: LONGCOMPLEX; exponent: LONGREAL): LONGCOMPLEX;
  (* Returns the value of the number base raised to the power exponent *)

PROCEDURE sqrt (z: LONGCOMPLEX): LONGCOMPLEX;
  (* Returns the principal square root of z *)

PROCEDURE exp (z: LONGCOMPLEX): LONGCOMPLEX;
  (* Returns the complex exponential of z *)

PROCEDURE ln (z: LONGCOMPLEX): LONGCOMPLEX;
  (* Returns the principal value of the natural logarithm of z *)

PROCEDURE sin (z: LONGCOMPLEX): LONGCOMPLEX;
  (* Returns the sine of z *)

PROCEDURE cos (z: LONGCOMPLEX): LONGCOMPLEX;
  (* Returns the cosine of z *)

PROCEDURE tan (z: LONGCOMPLEX): LONGCOMPLEX;
  (* Returns the tangent of z *)

PROCEDURE arcsin (z: LONGCOMPLEX): LONGCOMPLEX;
  (* Returns the arcsine of z *)

PROCEDURE arccos (z: LONGCOMPLEX): LONGCOMPLEX;
  (* Returns the arccosine of z *)

```

```
PROCEDURE arctan (z: LONGCOMPLEX): LONGCOMPLEX;
    (* Returns the arctangent of z *)

PROCEDURE polarToComplex (abs, arg: LONGREAL): LONGCOMPLEX;
    (* Returns the complex number with the specified polar coordinates *)

PROCEDURE scalarMult (scalar: LONGREAL; z: LONGCOMPLEX): LONGCOMPLEX;
    (* Returns the scalar product of scalar with z *)

PROCEDURE IsCMathException (): BOOLEAN;
    (* Returns TRUE if the current coroutine is in the exceptional execution state
       because of the raising of an exception in a routine from this module; otherwise
       returns FALSE.
    *)

END LongComplexMath.
```

4.4.18 gm2-libs-iso/LongConv

```

DEFINITION MODULE LongConv;

    (* Low-level LONGREAL/string conversions *)

IMPORT
    ConvTypes;

TYPE
    ConvResults = ConvTypes.ConvResults; (* strAllRight, strOutOfRange,
                                           strWrongFormat, strEmpty *)

PROCEDURE ScanReal (inputCh: CHAR; VAR chClass: ConvTypes.ScanClass;
                   VAR nextState: ConvTypes.ScanState);
    (* Represents the start state of a finite state scanner for real
       numbers - assigns class of inputCh to chClass and a procedure
       representing the next state to nextState.
    *)

PROCEDURE FormatReal (str: ARRAY OF CHAR): ConvResults;
    (* Returns the format of the string value for conversion to LONGREAL. *)

PROCEDURE ValueReal (str: ARRAY OF CHAR): LONGREAL;
    (* Returns the value corresponding to the real number string value
       str if str is well-formed; otherwise raises the LongConv exception.
    *)

PROCEDURE LengthFloatReal (real: LONGREAL; sigFigs: CARDINAL): CARDINAL;
    (* Returns the number of characters in the floating-point string
       representation of real with sigFigs significant figures.
    *)

PROCEDURE LengthEngReal (real: LONGREAL; sigFigs: CARDINAL): CARDINAL;
    (* Returns the number of characters in the floating-point engineering
       string representation of real with sigFigs significant figures.
    *)

PROCEDURE LengthFixedReal (real: LONGREAL; place: INTEGER): CARDINAL;
    (* Returns the number of characters in the fixed-point string
       representation of real rounded to the given place relative to the
       decimal point.
    *)

PROCEDURE IsRConvException (): BOOLEAN;
    (* Returns TRUE if the current coroutine is in the exceptional
       execution state because of the raising of an exception in a

```

```
        routine from this module; otherwise returns FALSE.  
*)  
  
END LongConv.
```

4.4.19 gm2-libs-iso/LongIO

```
DEFINITION MODULE LongIO;
```

```
  (* Input and output of long real numbers in decimal text form
     over specified channels. The read result is of the type
     IOConsts.ReadResults.
  *)
```

```
IMPORT IOChan;
```

```
  (* The text form of a signed fixed-point real number is
     ["+" | "-"], decimal digit, {decimal digit}, [".",
     {decimal digit}]
```

```

     The text form of a signed floating-point real number is
     signed fixed-point real number,
     "E", ["+" | "-"], decimal digit, {decimal digit}
  *)
```

```
PROCEDURE ReadReal (cid: IOChan.ChanId; VAR real: LONGREAL);
```

```
  (* Skips leading spaces, and removes any remaining characters
     from cid that form part of a signed fixed or floating
     point number. The value of this number is assigned to real.
     The read result is set to the value allRight, outOfRange,
     wrongFormat, endOfLine, or endOfInput.
  *)
```

```
PROCEDURE WriteFloat (cid: IOChan.ChanId; real: LONGREAL;
                     sigFigs: CARDINAL; width: CARDINAL);
```

```
  (* Writes the value of real to cid in floating-point text form,
     with sigFigs significant figures, in a field of the given
     minimum width.
  *)
```

```
PROCEDURE WriteEng (cid: IOChan.ChanId; real: LONGREAL;
                   sigFigs: CARDINAL; width: CARDINAL);
```

```
  (* As for WriteFloat, except that the number is scaled with
     one to three digits in the whole number part, and with an
     exponent that is a multiple of three.
  *)
```

```
PROCEDURE WriteFixed (cid: IOChan.ChanId; real: LONGREAL;
                     place: INTEGER; width: CARDINAL);
```

```
  (* Writes the value of real to cid in fixed-point text form,
     rounded to the given place relative to the decimal point,
     in a field of the given minimum width.
```

```
*)  
  
PROCEDURE WriteReal (cid: IOChan.ChanId; real: LONGREAL;  
                    width: CARDINAL);  
  (* Writes the value of real to cid, as WriteFixed if the  
    sign and magnitude can be shown in the given width, or  
    otherwise as WriteFloat. The number of places or  
    significant digits depends on the given width.  
  *)  
  
END LongIO.
```

4.4.20 gm2-libs-iso/LongMath

```

DEFINITION MODULE LongMath;

  (* Mathematical functions for the type LONGREAL *)

CONST
  pi    = 3.1415926535897932384626433832795028841972;
  exp1  = 2.7182818284590452353602874713526624977572;

PROCEDURE __BUILTIN__ sqrt (x: LONGREAL): LONGREAL;
  (* Returns the positive square root of x *)

PROCEDURE __BUILTIN__ exp (x: LONGREAL): LONGREAL;
  (* Returns the exponential of x *)

PROCEDURE __BUILTIN__ ln (x: LONGREAL): LONGREAL;
  (* Returns the natural logarithm of x *)

  (* The angle in all trigonometric functions is measured in radians *)

PROCEDURE __BUILTIN__ sin (x: LONGREAL): LONGREAL;
  (* Returns the sine of x *)

PROCEDURE __BUILTIN__ cos (x: LONGREAL): LONGREAL;
  (* Returns the cosine of x *)

PROCEDURE tan (x: LONGREAL): LONGREAL;
  (* Returns the tangent of x *)

PROCEDURE arcsin (x: LONGREAL): LONGREAL;
  (* Returns the arcsine of x *)

PROCEDURE arccos (x: LONGREAL): LONGREAL;
  (* Returns the arccosine of x *)

PROCEDURE arctan (x: LONGREAL): LONGREAL;
  (* Returns the arctangent of x *)

PROCEDURE power (base, exponent: LONGREAL): LONGREAL;
  (* Returns the value of the number base raised to the power exponent *)■

PROCEDURE round (x: LONGREAL): INTEGER;
  (* Returns the value of x rounded to the nearest integer *)

PROCEDURE IsRMathException (): BOOLEAN;
  (* Returns TRUE if the current coroutine is in the exceptional

```

```
        execution state because of the raising of an exception in a  
        routine from this module; otherwise returns FALSE.  
*)
```

```
END LongMath.
```

4.4.21 gm2-libs-iso/LongStr

```

DEFINITION MODULE LongStr;

  (* LONGREAL/string conversions *)

IMPORT
  ConvTypes;

TYPE
  (* strAllRight, strOutOfRange, strWrongFormat, strEmpty *)
  ConvResults = ConvTypes.ConvResults;

  (* the string form of a signed fixed-point real number is
     ["+" | "-"], decimal digit, {decimal digit}, [".",
     {decimal digit}]
  *)

  (* the string form of a signed floating-point real number is
     signed fixed-point real number, "E", ["+" | "-"],
     decimal digit, {decimal digit}
  *)

PROCEDURE StrToReal (str: ARRAY OF CHAR; VAR real: LONGREAL;
  VAR res: ConvResults);
  (* Ignores any leading spaces in str. If the subsequent characters
     in str are in the format of a signed real number, assigns a
     corresponding value to real. Assigns a value indicating the
     format of str to res.
  *)

PROCEDURE RealToFloat (real: LONGREAL; sigFigs: CARDINAL;
  VAR str: ARRAY OF CHAR);
  (* Converts the value of real to floating-point string form, with
     sigFigs significant figures, and copies the possibly truncated
     result to str.
  *)

PROCEDURE RealToEng (real: LONGREAL; sigFigs: CARDINAL;
  VAR str: ARRAY OF CHAR);
  (* Converts the value of real to floating-point string form, with
     sigFigs significant figures, and copies the possibly truncated
     result to str. The number is scaled with one to three digits
     in the whole number part and with an exponent that is a
     multiple of three.
  *)

```

```
PROCEDURE RealToFixed (real: LONGREAL; place: INTEGER;
                      VAR str: ARRAY OF CHAR);
  (* Converts the value of real to fixed-point string form, rounded
     to the given place relative to the decimal point, and copies
     the possibly truncated result to str.
  *)

PROCEDURE RealToStr (real: LONGREAL; VAR str: ARRAY OF CHAR);
  (* Converts the value of real as RealToFixed if the sign and
     magnitude can be shown within the capacity of str, or
     otherwise as RealToFloat, and copies the possibly truncated
     result to str. The number of places or significant digits
     depend on the capacity of str.
  *)

END LongStr.
```

4.4.22 gm2-libs-iso/LongWholeIO

```

DEFINITION MODULE LongWholeIO;

  (* Input and output of whole numbers in decimal text form
     over specified channels. The read result is of the
     type IOConsts.ReadResults.
  *)

IMPORT IOChan;

  (* The text form of a signed whole number is
     ["+" | "-"], decimal digit, {decimal digit}

     The text form of an unsigned whole number is
     decimal digit, {decimal digit}
  *)

PROCEDURE ReadInt (cid: IOChan.ChanId; VAR int: LONGINT);
  (* Skips leading spaces, and removes any remaining characters
     from cid that form part of a signed whole number. The
     value of this number is assigned to int. The read result
     is set to the value allRight, outOfRange, wrongFormat,
     endOfLine, or endOfInput.
  *)

PROCEDURE WriteInt (cid: IOChan.ChanId; int: LONGINT;
                   width: CARDINAL);
  (* Writes the value of int to cid in text form, in a field of
     the given minimum width. *)

PROCEDURE ReadCard (cid: IOChan.ChanId; VAR card: LONGCARD);
  (* Skips leading spaces, and removes any remaining characters
     from cid that form part of an unsigned whole number. The
     value of this number is assigned to card. The read result
     is set to the value allRight, outOfRange, wrongFormat,
     endOfLine, or endOfInput.
  *)

PROCEDURE WriteCard (cid: IOChan.ChanId; card: LONGCARD;
                   width: CARDINAL);
  (* Writes the value of card to cid in text form, in a field
     of the given minimum width. *)

END LongWholeIO.
```

4.4.23 gm2-libs-iso/LowLong

DEFINITION MODULE LowLong;

(* Access to underlying properties of the type LONGREAL *)

CONST

```

radix      = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, radix> )) ;      (* ZType *)
places     = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, places> )) ;      (* ZType *)
expoMin    = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, expoMin> )) ;      (* ZType *)
expoMax    = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, expoMax> )) ;      (* ZType *)
large      = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, large> )) ;      (* RType *)
small      = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, small> )) ;      (* RType *)
IEC559     = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, IEC559> )) ;      (* BOOLEAN *)
LIA1       = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, LIA1> )) ;      (* BOOLEAN *)
ISO        = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, ISO> )) ;      (* BOOLEAN *)
IEEE       = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, IEEE> )) ;      (* BOOLEAN *)
rounds     = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, rounds> )) ;      (* BOOLEAN *)
gUnderflow = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, gUnderflow> )) ;  (* BOOLEAN *)
exception  = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, exception> )) ;  (* BOOLEAN *)
extend     = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, extend> )) ;      (* BOOLEAN *)
nModes     = __ATTRIBUTE__ __BUILTIN__ (( <LONGREAL, nModes> )) ;      (* ZType *)

```

TYPE

Modes = PACKEDSET OF [0 .. nModes-1];

PROCEDURE exponent (x: LONGREAL): INTEGER;

(* Returns the exponent value of x *)

PROCEDURE fraction (x: LONGREAL): LONGREAL;

(* Returns the significand (or significant part) of x *)

PROCEDURE sign (x: LONGREAL): LONGREAL;

(* Returns the signum of x *)

PROCEDURE succ (x: LONGREAL): LONGREAL;

(* Returns the next value of the type LONGREAL greater than x *)

PROCEDURE ulp (x: LONGREAL): LONGREAL;

(* Returns the value of a unit in the last place of x *)

PROCEDURE pred (x: LONGREAL): LONGREAL;

(* Returns the previous value of the type LONGREAL less than x *)

PROCEDURE intpart (x: LONGREAL): LONGREAL;

(* Returns the integer part of x *)

```
PROCEDURE fractpart (x: LONGREAL): LONGREAL;
  (* Returns the fractional part of x *)

PROCEDURE scale (x: LONGREAL; n: INTEGER): LONGREAL;
  (* Returns the value of x * radix ** n *)

PROCEDURE trunc (x: LONGREAL; n: INTEGER): LONGREAL;
  (* Returns the value of the first n places of x *)

PROCEDURE round (x: LONGREAL; n: INTEGER): LONGREAL;
  (* Returns the value of x rounded to the first n places *)

PROCEDURE synthesize (expart: INTEGER; frapart: LONGREAL): LONGREAL;
  (* Returns a value of the type LONGREAL constructed from the given expart and frapart *)

PROCEDURE setMode (m: Modes);
  (* Sets status flags appropriate to the underlying implementation of the type LONGREAL *)

PROCEDURE currentMode (): Modes;
  (* Returns the current status flags in the form set by setMode *)

PROCEDURE IsLowException (): BOOLEAN;
  (* Returns TRUE if the current coroutine is in the exceptional execution state
     because of the raising of an exception in a routine from this module; otherwise
     returns FALSE.
  *)

END LowLong.
```

4.4.24 gm2-libs-iso/LowReal

DEFINITION MODULE LowReal;

(* Access to underlying properties of the type REAL *)

CONST

radix	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, radix>)) ;	(* ZType *)	■
places	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, places>)) ;	(* ZType *)	■
expoMin	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, expoMin>)) ;	(* ZType *)	■
expoMax	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, expoMax>)) ;	(* ZType *)	■
large	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, large>)) ;	(* RType *)	■
small	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, small>)) ;	(* RType *)	■
IEC559	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, IEC559>)) ;	(* BOOLEAN *)	■
LIA1	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, LIA1>)) ;	(* BOOLEAN *)	■
ISO	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, ISO>)) ;	(* BOOLEAN *)	■
IEEE	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, IEEE>)) ;	(* BOOLEAN *)	■
rounds	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, rounds>)) ;	(* BOOLEAN *)	■
gUnderflow	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, gUnderflow>)) ;	(* BOOLEAN *)	■
exception	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, exception>)) ;	(* BOOLEAN *)	■
extend	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, extend>)) ;	(* BOOLEAN *)	■
nModes	=	__ATTRIBUTE__	__BUILTIN__	((<REAL, nModes>)) ;	(* ZType *)	■

TYPE

Modes = PACKEDSET OF [0..nModes-1];

PROCEDURE exponent (x: REAL): INTEGER;

(* Returns the exponent value of x *)

PROCEDURE fraction (x: REAL): REAL;

(* Returns the significand (or significant part) of x *)

PROCEDURE sign (x: REAL): REAL;

(* Returns the signum of x *)

PROCEDURE succ (x: REAL): REAL;

(* Returns the next value of the type REAL greater than x *)

PROCEDURE ulp (x: REAL): REAL;

(* Returns the value of a unit in the last place of x *)

PROCEDURE pred (x: REAL): REAL;

(* Returns the previous value of the type REAL less than x *)

PROCEDURE intpart (x: REAL): REAL;

(* Returns the integer part of x *)

```
PROCEDURE fractpart (x: REAL): REAL;
  (* Returns the fractional part of x *)

PROCEDURE scale (x: REAL; n: INTEGER): REAL;
  (* Returns the value of x * radix ** n *)

PROCEDURE trunc (x: REAL; n: INTEGER): REAL;
  (* Returns the value of the first n places of x *)

PROCEDURE round (x: REAL; n: INTEGER): REAL;
  (* Returns the value of x rounded to the first n places *)

PROCEDURE synthesize (expart: INTEGER; frapart: REAL): REAL;
  (* Returns a value of the type REAL constructed from the given expart and frapart *)

PROCEDURE setMode (m: Modes);
  (* Sets status flags appropriate to the underlying implementation of the type REAL *)

PROCEDURE currentMode (): Modes;
  (* Returns the current status flags in the form set by setMode *)

PROCEDURE IsLowException (): BOOLEAN;
  (* Returns TRUE if the current coroutine is in the exceptional execution state
    because of the raising of an exception in a routine from this module; otherwise
    returns FALSE.
  *)

END LowReal.
```

4.4.25 gm2-libs-iso/LowShort

```
DEFINITION MODULE LowShort;
```

```
  (* Access to underlying properties of the type SHORTREAL *)
```

```
CONST
```

```
  radix      = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, radix> )) ;      (* ZType *)
  places     = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, places> )) ;      (* ZType *)
  expoMin    = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, expoMin> )) ;      (* ZType *)
  expoMax    = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, expoMax> )) ;      (* ZType *)
  large      = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, large> )) ;        (* RType *)
  small      = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, small> )) ;        (* RType *)
  IEC559     = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, IEC559> )) ;      (* BOOLEAN *)
  LIA1       = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, LIA1> )) ;        (* BOOLEAN *)
  ISO        = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, ISO> )) ;          (* BOOLEAN *)
  IEEE       = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, IEEE> )) ;        (* BOOLEAN *)
  rounds     = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, rounds> )) ;      (* BOOLEAN *)
  gUnderflow = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, gUnderflow> )) ;  (* BOOLEAN *)
  exception  = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, exception> )) ;    (* BOOLEAN *)
  extend     = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, extend> )) ;      (* BOOLEAN *)
  nModes     = __ATTRIBUTE__ __BUILTIN__ (( <SHORTREAL, nModes> )) ;      (* ZType *)
```

```
TYPE
```

```
  Modes = PACKEDSET OF [0 .. nModes-1];
```

```
PROCEDURE exponent (x: SHORTREAL): INTEGER;
```

```
  (* Returns the exponent value of x *)
```

```
PROCEDURE fraction (x: SHORTREAL): SHORTREAL;
```

```
  (* Returns the significand (or significant part) of x *)
```

```
PROCEDURE sign (x: SHORTREAL): SHORTREAL;
```

```
  (* Returns the signum of x *)
```

```
PROCEDURE succ (x: SHORTREAL): SHORTREAL;
```

```
  (* Returns the next value of the type SHORTREAL greater than x *)
```

```
PROCEDURE ulp (x: SHORTREAL): SHORTREAL;
```

```
  (* Returns the value of a unit in the last place of x *)
```

```
PROCEDURE pred (x: SHORTREAL): SHORTREAL;
```

```
  (* Returns the previous value of the type SHORTREAL less than x *)
```

```
PROCEDURE intpart (x: SHORTREAL): SHORTREAL;
```

```
  (* Returns the integer part of x *)
```

```
PROCEDURE fractpart (x: SHORTREAL): SHORTREAL;
  (* Returns the fractional part of x *)

PROCEDURE scale (x: SHORTREAL; n: INTEGER): SHORTREAL;
  (* Returns the value of x * radix ** n *)

PROCEDURE trunc (x: SHORTREAL; n: INTEGER): SHORTREAL;
  (* Returns the value of the first n places of x *)

PROCEDURE round (x: SHORTREAL; n: INTEGER): SHORTREAL;
  (* Returns the value of x rounded to the first n places *)

PROCEDURE synthesize (expart: INTEGER; frapart: SHORTREAL): SHORTREAL;
  (* Returns a value of the type SHORTREAL constructed from the given expart and frapart *)

PROCEDURE setMode (m: Modes);
  (* Sets status flags appropriate to the underlying implementation of the type SHORTREAL *)

PROCEDURE currentMode (): Modes;
  (* Returns the current status flags in the form set by setMode *)

PROCEDURE IsLowException (): BOOLEAN;
  (* Returns TRUE if the current coroutine is in the exceptional execution state
     because of the raising of an exception in a routine from this module; otherwise
     returns FALSE.
  *)

END LowShort.
```

4.4.26 gm2-libs-iso/M2EXCEPTION

```
DEFINITION MODULE M2EXCEPTION;
```

```
(* Provides facilities for identifying language exceptions *)
```

```
TYPE
```

```
  M2Exceptions =
```

```
    (indexException,      rangeException,      caseSelectException,  invalidLocation
     functionException,   wholeValueException, wholeDivException,  realValueExcept
     realDivException,   complexValueException, complexDivException, protException,
     sysException,       coException,          exException
    );
```

```
PROCEDURE M2Exception (): M2Exceptions;
```

```
(* If the current coroutine is in the exceptional execution state because of the raising
   of a language exception, returns the corresponding enumeration value, and otherwise
   raises an exception.
*)
```

```
PROCEDURE IsM2Exception (): BOOLEAN;
```

```
(* If the current coroutine is in the exceptional execution state because of the raising
   of a language exception, returns TRUE, and otherwise returns FALSE.
*)
```

```
END M2EXCEPTION.
```

4.4.27 gm2-libs-iso/M2RTS

```

DEFINITION MODULE M2RTS ;

FROM SYSTEM IMPORT ADDRESS ;

TYPE
  ArgCEnvP = PROCEDURE (INTEGER, ADDRESS, ADDRESS) ;

PROCEDURE ConstructModules (applicationmodule, libname: ADDRESS;
                           overridesliborder: ADDRESS;
                           argc: INTEGER; argv, envp: ADDRESS) ;

PROCEDURE DeconstructModules (applicationmodule, libname: ADDRESS;
                              argc: INTEGER; argv, envp: ADDRESS) ;

(*
  RegisterModule - adds module name to the list of outstanding
                  modules which need to have their dependencies
                  explored to determine initialization order.
*)

PROCEDURE RegisterModule (name, libname: ADDRESS;
                          init, fini: ArgCEnvP;
                          dependencies: PROC) ;

(*
  RequestDependant - used to specify that modulename is dependant upon
                    module dependantmodule.
*)

PROCEDURE RequestDependant (modulename, libname,
                           dependantmodule, dependantlibname: ADDRESS) ;■

(*
  ExecuteTerminationProcedures - calls each installed termination
                                procedure in reverse order.
*)

PROCEDURE ExecuteTerminationProcedures ;

```

```

(*)
    InstallTerminationProcedure - installs a procedure, p, which will
                                be called when the procedure
                                ExecuteTerminationProcedures
                                is invoked. It returns TRUE is the
                                procedure is installed.
*)

PROCEDURE InstallTerminationProcedure (p: PROC) : BOOLEAN ;

(*)
    ExecuteInitialProcedures - executes the initial procedures installed
                                by InstallInitialProcedure.
*)

PROCEDURE ExecuteInitialProcedures ;

(*)
    InstallInitialProcedure - installs a procedure to be executed just
                                before the BEGIN code section of the main
                                program module.
*)

PROCEDURE InstallInitialProcedure (p: PROC) : BOOLEAN ;

(*)
    HALT - terminate the current program. The procedure
           ExecuteTerminationProcedures
           is called before the program is stopped. The parameter
           exitcode is optional. If the parameter is not supplied
           HALT will call libc 'abort', otherwise it will exit with
           the code supplied. Supplying a parameter to HALT has the
           same effect as calling ExitOnHalt with the same code and
           then calling HALT with no parameter.
*)

PROCEDURE HALT ([exitcode: INTEGER = -1]) <* noreturn *> ;

(*)
    Halt - provides a more user friendly version of HALT, which takes
           four parameters to aid debugging. It writes an error message
           to stderr and calls exit (1).
*)

```

```

PROCEDURE Halt (description, filename, function: ARRAY OF CHAR;
               line: CARDINAL) <* noreturn *> ;

(*
  HaltC - provides a more user friendly version of HALT, which takes
          four parameters to aid debugging. It writes an error message
          to stderr and calls exit (1).
*)

PROCEDURE HaltC (description, filename, function: ADDRESS;
               line: CARDINAL) <* noreturn *> ;

(*
  ExitOnHalt - if HALT is executed then call exit with the exit code, e.
*)

PROCEDURE ExitOnHalt (e: INTEGER) ;

(*
  ErrorMessage - emits an error message to stderr and then calls exit (1).
*)

PROCEDURE ErrorMessage (message: ARRAY OF CHAR;
                       filename: ARRAY OF CHAR;
                       line: CARDINAL;
                       function: ARRAY OF CHAR) <* noreturn *> ;

(*
  IsTerminating - Returns true if any coroutine has started program termination
                  and false otherwise.
*)

PROCEDURE IsTerminating () : BOOLEAN ;

(*
  HasHalted - Returns true if a call to HALT has been made and false
              otherwise.
*)

PROCEDURE HasHalted () : BOOLEAN ;

```

```
(*
  Length - returns the length of a string, a. This is called whenever
           the user calls LENGTH and the parameter cannot be calculated
           at compile time.
*)
```

```
PROCEDURE Length (a: ARRAY OF CHAR) : CARDINAL ;
```

```
(*
  The following are the runtime exception handler routines.
*)
```

```
PROCEDURE AssignmentException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ReturnException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE IncException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE DecException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE InclException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ExclException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ShiftException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE RotateException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE StaticArraySubscriptException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE DynamicArraySubscriptException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ForLoopBeginException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ForLoopToException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ForLoopEndException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE PointerNilException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE NoReturnException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE CaseException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeNonPosDivException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeNonPosModException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeZeroDivException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeZeroRemException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE WholeValueException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE RealValueException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE ParameterException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
PROCEDURE NoException (filename: ADDRESS; line, column: CARDINAL; scope, message: ADDRESS;
```

```
END M2RTS.
```

4.4.28 gm2-libs-iso/MemStream

```
DEFINITION MODULE MemStream ;
```

```
(*
  Description: provides an ISO module which can write to a memory
               buffer or read from a memory buffer.
*)
```

```
FROM IOChan IMPORT ChanId ;
FROM ChanConsts IMPORT FlagSet, OpenResults ;
FROM SYSTEM IMPORT ADDRESS, LOC ;
```

```
(*
  Attempts to obtain and open a channel connected to a contiguous
  buffer in memory. The write flag is implied; without the raw
  flag, text is implied. If successful, assigns to cid the identity of
  the opened channel, assigns the value opened to res.
  If a channel cannot be opened as required,
  the value of res indicates the reason, and cid identifies the
  invalid channel.
```

```

  The parameters, buffer, length and used maybe updated as
  data is written. The buffer maybe reallocated
  and its address might alter, however the parameters will
  always reflect the current active buffer. When this
  channel is closed the buffer is deallocated and
  buffer will be set to NIL, length and used will be set to
  zero.
```

```
*)
```

```
PROCEDURE OpenWrite (VAR cid: ChanId; flags: FlagSet;
                     VAR res: OpenResults;
                     VAR buffer: ADDRESS;
                     VAR length: CARDINAL;
                     VAR used: CARDINAL;
                     deallocOnClose: BOOLEAN) ;
```

```
(*
  Attempts to obtain and open a channel connected to a contiguous
  buffer in memory. The read and old flags are implied; without
  the raw flag, text is implied. If successful, assigns to cid the
  identity of the opened channel, assigns the value opened to res, and
  selects input mode, with the read position corresponding to the start
  of the buffer. If a channel cannot be opened as required, the value of
```

```
    res indicates the reason, and cid identifies the invalid channel.  
*)
```

```
PROCEDURE OpenRead (VAR cid: ChanId; flags: FlagSet;  
    VAR res: OpenResults;  
    buffer: ADDRESS; length: CARDINAL;  
    deallocOnClose: BOOLEAN) ;
```

```
(*  
    Close - if the channel identified by cid is not open to  
            a memory stream, the exception wrongDevice is  
            raised; otherwise closes the channel, and assigns  
            the value identifying the invalid channel to cid.  
*)
```

```
PROCEDURE Close (VAR cid: ChanId) ;
```

```
(*  
    Rewrite - assigns the buffer index to zero. Subsequent  
              writes will overwrite the previous buffer contents.  
*)
```

```
PROCEDURE Rewrite (cid: ChanId) ;
```

```
(*  
    Reread - assigns the buffer index to zero. Subsequent  
             reads will read the previous buffer contents.  
*)
```

```
PROCEDURE Reread (cid: ChanId) ;
```

```
(*  
    IsMem - tests if the channel identified by cid is open as  
            a memory stream.  
*)
```

```
PROCEDURE IsMem (cid: ChanId) : BOOLEAN ;
```

```
END MemStream.
```

4.4.29 gm2-libs-iso/Preemptive

```
DEFINITION MODULE Preemptive ;
```

```
(*  
  initPreemptive - if microsecs > 0 then turn on preemptive scheduling.  
                  if microsecs = 0 then preemptive scheduling is turned off.■  
*)
```

```
PROCEDURE initPreemptive (seconds, microsecs: CARDINAL) ;
```

```
END Preemptive.
```

4.4.30 gm2-libs-iso/Processes

```
DEFINITION MODULE Processes;
```

```
  (* This module allows concurrent algorithms to be expressed using
     processes. A process is a unit of a program that has the
     potential to run in parallel with other processes.
  *)
```

```
IMPORT SYSTEM;
```

```
TYPE
```

```
  ProcessId;                (* Used to identify processes *)
  Parameter    = SYSTEM.ADDRESS; (* Used to pass data between processes *)
  Body         = PROC;        (* Used as the type of a process body *)
  Urgency      = INTEGER;     (* Used by the internal scheduler *)
  Sources       = CARDINAL;   (* Used to identify event sources *)
  ProcessesExceptions =      (* Exceptions raised by this module *)
    (passiveProgram, processError);
```

```
  (* The following procedures create processes and switch control between
     them. *)
```

```
PROCEDURE Create (procBody: Body; extraSpace: CARDINAL; procUrg: Urgency;
                 procParams: Parameter; VAR procId: ProcessId);
```

```
  (* Creates a new process with procBody as its body, and with urgency
     and parameters given by procUrg and procParams. At least as
     much workspace (in units of SYSTEM.LOC) as is specified by
     extraSpace is allocated to the process.
     An identity for the new process is returned in procId.
     The process is created in the passive state; it will not run
     until activated.
  *)
```

```
PROCEDURE Start (procBody: Body; extraSpace: CARDINAL; procUrg: Urgency;
                procParams: Parameter; VAR procId: ProcessId);
```

```
  (* Creates a new process, with parameters as for Create.
     The process is created in the ready state; it is eligible to
     run immediately.
  *)
```

```
PROCEDURE StopMe ();
```

```
  (* Terminates the calling process.
     The process must not be associated with a source of events.
  *)
```

```
PROCEDURE SuspendMe ();
```

```
(* Causes the calling process to enter the passive state. The
  procedure only returns when the calling process is again
  activated by another process.
*)

PROCEDURE Activate (procId: ProcessId);
  (* Causes the process identified by procId to enter the ready
    state, and thus to become eligible to run again.
  *)

PROCEDURE SuspendMeAndActivate (procId: ProcessId);
  (* Executes an atomic sequence of SuspendMe() and
    Activate(procId). *)

PROCEDURE Switch (procId: ProcessId; VAR info: Parameter);
  (* Causes the calling process to enter the passive state; the
    process identified by procId becomes the currently executing
    process. info is used to pass parameter information from the
    calling to the activated process. On return, info will
    contain information from the process that chooses to switch
    back to this one (or will be NIL if Activate or
    SuspendMeAndActivate are used instead of Switch).
  *)

PROCEDURE Wait ();
  (* Causes the calling process to enter the waiting state.
    The procedure will return when the calling process is
    activated by another process, or when one of its associated
    eventSources has generated an event.
  *)

(* The following procedures allow the association of processes
  with sources of external events.
*)

PROCEDURE Attach (eventSource: Sources);
  (* Associates the specified eventSource with the calling
    process. *)

PROCEDURE Detach (eventSource: Sources);
  (* Dissociates the specified eventSource from the program. *)

PROCEDURE IsAttached (eventSource: Sources): BOOLEAN;
  (* Returns TRUE if and only if the specified eventSource is
    currently associated with one of the processes of the
    program.
  *)
```

```
PROCEDURE Handler (eventSource: Sources): ProcessId;
    (* Returns the identity of the process, if any, that is
       associated with the specified eventSource.
    *)

(* The following procedures allow processes to obtain their
   identity, parameters, and urgency.
*)

PROCEDURE Me (): ProcessId;
    (* Returns the identity of the calling process (as assigned
       when the process was first created).
    *)

PROCEDURE MyParam (): Parameter;
    (* Returns the value specified as procParams when the calling
       process was created. *)

PROCEDURE UrgencyOf (procId: ProcessId): Urgency;
    (* Returns the urgency established when the process identified
       by procId was first created.
    *)

(* The following procedure provides facilities for exception
   handlers. *)

PROCEDURE ProcessesException (): ProcessesExceptions;
    (* If the current coroutine is in the exceptional execution state
       because of the raising of a language exception, returns the
       corresponding enumeration value, and otherwise raises an
       exception.
    *)

PROCEDURE IsProcessesException (): BOOLEAN;
    (* Returns TRUE if the current coroutine is in the exceptional
       execution state because of the raising of an exception in
       a routine from this module; otherwise returns FALSE.
    *)

(*
   Reschedule - rotates the ready queue and transfers to the process
                 with the highest run priority.
*)

PROCEDURE Reschedule ;
```

```
(*  
    displayProcesses -  
*)  
  
PROCEDURE displayProcesses (message: ARRAY OF CHAR) ;  
  
END Processes.
```

4.4.31 gm2-libs-iso/ProgramArgs

```
DEFINITION MODULE ProgramArgs;

    (* Access to program arguments *)

IMPORT IOChan;

TYPE
    ChanId = IOChan.ChanId;

PROCEDURE ArgChan (): ChanId;
    (* Returns a value that identifies a channel for reading
       program arguments *)

PROCEDURE IsArgPresent (): BOOLEAN;
    (* Tests if there is a current argument to read from.  If not,
       read <= IOChan.CurrentFlags() will be FALSE, and attempting
       to read from the argument channel will raise the exception
       notAvailable.
    *)

PROCEDURE NextArg ();
    (* If there is another argument, causes subsequent input from the
       argument device to come from the start of the next argument.
       Otherwise there is no argument to read from, and a call of
       IsArgPresent will return FALSE.
    *)

END ProgramArgs.
```

4.4.32 gm2-libs-iso/RTco

```

DEFINITION MODULE FOR "C" RTco ;

FROM SYSTEM IMPORT ADDRESS ;

IMPORT RTentity ;  (* Imported so the initialization call graph
                    understands that RTco.cc depends upon RTentity.  *)

(* init initializes the module and allows the application to lazily invoke threads.  *)

PROCEDURE init () : INTEGER ;

PROCEDURE initThread (p: PROC; stackSize: CARDINAL; interruptLevel: CARDINAL) : INTEGER ;

PROCEDURE initSemaphore (value: CARDINAL) : INTEGER ;

PROCEDURE wait (semaphore: INTEGER) ;

PROCEDURE signal (semaphore: INTEGER) ;

PROCEDURE transfer (VAR p1: INTEGER; p2: INTEGER) ;

PROCEDURE waitThread (tid: INTEGER) ;

PROCEDURE signalThread (tid: INTEGER) ;

PROCEDURE currentThread () : INTEGER ;

(* currentInterruptLevel returns the interrupt level of the current thread.  *)

PROCEDURE currentInterruptLevel () : CARDINAL ;

(* turninterrupts returns the old interrupt level and assigns the interrupt level
   to newLevel.  *)

PROCEDURE turnInterrupts (newLevel: CARDINAL) : CARDINAL ;

(*
   select access to the select system call which will be thread safe.
   This is typically called from the idle process to wait for an interrupt.
*)

PROCEDURE select (p1: INTEGER;
```

```
p2: ADDRESS;  
p3: ADDRESS;  
p4: ADDRESS;  
p5: ADDRESS) : INTEGER ;
```

```
END RTco.
```

4.4.33 gm2-libs-iso/RTdata

```

DEFINITION MODULE RTdata ;

  (*
    Description: provides a mechanism whereby devices can store
                data attached to a device.
  *)

  FROM SYSTEM IMPORT ADDRESS ;
  FROM IOLink IMPORT DeviceTablePtr ;

  TYPE
    ModuleId ;
    FreeProcedure = PROCEDURE (ADDRESS) ;

  (*
    MakeModuleId - creates a unique module Id.
  *)

  PROCEDURE MakeModuleId (VAR m: ModuleId) ;

  (*
    InitData - adds, datum, to the device, d. The datum
              is associated with ModuleID, m.
  *)

  PROCEDURE InitData (d: DeviceTablePtr; m: ModuleId;
                    datum: ADDRESS; f: FreeProcedure) ;

  (*
    GetData - returns the datum associated with ModuleId, m.
  *)

  PROCEDURE GetData (d: DeviceTablePtr; m: ModuleId) : ADDRESS ;

  (*
    KillData - destroys the datum associated with ModuleId, m,
              in device, d. It invokes the free procedure
              given during InitData.
  *)

  PROCEDURE KillData (d: DeviceTablePtr; m: ModuleId) ;

```

```
END RTdata.
```

4.4.34 gm2-libs-iso/RTentity

```
DEFINITION MODULE RTentity ;
```

```
(*
```

```
  Description: provides a set of routines for maintaining an
               efficient mechanism to group opaque (or pointer)
               data structures together.  Internally the
               entities are grouped together using a binary
               tree.  It does not use Storage - and instead
               uses malloc, free from libc as Storage uses the
               module to detect erroneous deallocations.
```

```
*)
```

```
IMPORT SYSTEM ;
```

```
TYPE
```

```
  Group ;
```

```
PROCEDURE InitGroup () : Group ;
```

```
PROCEDURE KillGroup (g: Group) : Group ;
```

```
PROCEDURE GetKey (g: Group; a: SYSTEM.ADDRESS) : CARDINAL ;
```

```
PROCEDURE PutKey (g: Group; a: SYSTEM.ADDRESS; key: CARDINAL) ;
```

```
PROCEDURE DelKey (g: Group; a: SYSTEM.ADDRESS) ;
```

```
PROCEDURE IsIn (g: Group; a: SYSTEM.ADDRESS) : BOOLEAN ;
```

```
END RTentity.
```

4.4.35 gm2-libs-iso/RTfio

```
DEFINITION MODULE RTfio ;
```

```
(*
  Description: provides default FIO based methods for the RTgenif
               procedures. These will be used by StreamFile,
               SeqFile, StdChans, TermFile and RndFile.
*)
```

```
FROM SYSTEM IMPORT ADDRESS ;
FROM IOLink IMPORT DeviceTablePtr;
FROM RTgenif IMPORT GenDevIF ;
```

```
(*
  doreadchar - returns a CHAR from the file associated with, g.
*)
```

```
PROCEDURE doreadchar (g: GenDevIF; d: DeviceTablePtr) : CHAR ;
```

```
(*
  dounreadchar - pushes a CHAR back onto the file associated
                 with, g.
*)
```

```
PROCEDURE dounreadchar (g: GenDevIF; d: DeviceTablePtr; ch: CHAR) : CHAR ;■
```

```
(*
  dogeterrno - returns the errno relating to the generic device.
*)
```

```
PROCEDURE dogeterrno (g: GenDevIF; d: DeviceTablePtr) : INTEGER ;
```

```
(*
  dorbytes - reads upto, max, bytes setting, actual, and
             returning FALSE if an error (not due to eof)
             occurred.
*)
```

```
PROCEDURE dorbytes (g: GenDevIF;
                   d: DeviceTablePtr;
                   to: ADDRESS;
                   max: CARDINAL;
```

```
        VAR actual: CARDINAL) : BOOLEAN ;

(*
   dowbytes - writes up to, nBytes.  It returns FALSE
              if an error occurred and it sets actual
              to the amount of data written.
*)

PROCEDURE dowbytes (g: GenDevIF;
                   d: DeviceTablePtr;
                   from: ADDRESS;
                   nBytes: CARDINAL;
                   VAR actual: CARDINAL) : BOOLEAN ;

(*
   dowriteln - attempt to write an end of line marker to the
               file and returns TRUE if successful.
*)

PROCEDURE dowriteln (g: GenDevIF; d: DeviceTablePtr) : BOOLEAN ;

(*
   iseof - returns TRUE if end of file has been seen.
*)

PROCEDURE iseof (g: GenDevIF; d: DeviceTablePtr) : BOOLEAN ;

(*
   iseoln - returns TRUE if end of line has been seen.
*)

PROCEDURE iseoln (g: GenDevIF; d: DeviceTablePtr) : BOOLEAN ;

(*
   iserror - returns TRUE if an error was seen on the device.
             Note that reaching EOF is not classified as an
             error.
*)

PROCEDURE iserror (g: GenDevIF; d: DeviceTablePtr) : BOOLEAN ;

END RTfio.
```

4.4.36 gm2-libs-iso/RTgen

```
DEFINITION MODULE RTgen ;
```

```

(*
    Description: provides a generic device interface between
                ISO channels and the underlying PIM style
                FIO procedure calls.
*)
```

```

FROM RTgenif IMPORT GenDevIF ;
FROM IOLink IMPORT DeviceId, DeviceTablePtr;
FROM IOConsts IMPORT ReadResults ;
FROM SYSTEM IMPORT ADDRESS ;
```

```
TYPE
```

```
    ChanDev ;
```

```
    DeviceType = (seqfile, streamfile, programargs, stdchans, term, socket, rndfile) ;
```

```

(*
    InitChanDev - initialize and return a ChanDev.
*)
```

```
PROCEDURE InitChanDev (t: DeviceType; d: DeviceId; g: GenDevIF) : ChanDev ;
```

```

(*
    KillChanDev - deallocates, g.
*)
```

```
PROCEDURE KillChanDev (g: GenDevIF) : GenDevIF ;
```

```

(*
    RaiseEOFInLook - returns TRUE if the Look procedure
                    should raise an exception if it
                    sees end of file.
*)
```

```
PROCEDURE RaiseEOFInLook (g: ChanDev) : BOOLEAN ;
```

```

(*
    RaiseEOFInSkip - returns TRUE if the Skip procedure
                    should raise an exception if it

```

```

                                sees end of file.
*)

PROCEDURE RaiseEOFInSkip (g: ChanDev) : BOOLEAN ;

PROCEDURE doLook (g: ChanDev;
                  d: DeviceTablePtr;
                  VAR ch: CHAR;
                  VAR r: ReadResults) ;

PROCEDURE doSkip (g: ChanDev;
                  d: DeviceTablePtr) ;

PROCEDURE doSkipLook (g: ChanDev;
                      d: DeviceTablePtr;
                      VAR ch: CHAR;
                      VAR r: ReadResults) ;

PROCEDURE doWriteLn (g: ChanDev;
                    d: DeviceTablePtr) ;

PROCEDURE doReadText (g: ChanDev;
                     d: DeviceTablePtr;
                     to: ADDRESS;
                     maxChars: CARDINAL;
                     VAR charsRead: CARDINAL) ;

PROCEDURE doWriteText (g: ChanDev;
                      d: DeviceTablePtr;
                      from: ADDRESS;
                      charsToWrite: CARDINAL) ;

PROCEDURE doReadLocs (g: ChanDev;
                     d: DeviceTablePtr;
                     to: ADDRESS;
                     maxLocs: CARDINAL;
                     VAR locsRead: CARDINAL) ;

PROCEDURE doWriteLocs (g: ChanDev;
                      d: DeviceTablePtr;
                      from: ADDRESS;
                      locsToWrite: CARDINAL) ;

(*
  checkErrno - checks a number of errno conditions and raises
               appropriate ISO exceptions if they occur.

```

*)

```
PROCEDURE checkErrno (g: ChanDev; d: DeviceTablePtr) ;
```

```
END RTgen.
```

4.4.37 gm2-libs-iso/RTgenif

```

DEFINITION MODULE RTgenif ;

(*
    Description: provides a generic interface mechanism used
                by RTgen. This is not an ISO module but rather
                a runtime support module.
*)

FROM SYSTEM IMPORT ADDRESS ;
FROM IOLink IMPORT DeviceId, DeviceTablePtr ;

TYPE
    GenDevIF ;
    readchar   = PROCEDURE (GenDevIF, DeviceTablePtr) : CHAR ;
    unreadchar = PROCEDURE (GenDevIF, DeviceTablePtr, CHAR) : CHAR ;
    geterrno   = PROCEDURE (GenDevIF, DeviceTablePtr) : INTEGER ;
    readbytes  = PROCEDURE (GenDevIF, DeviceTablePtr, ADDRESS, CARDINAL, VAR CARDINAL)
    writebytes = PROCEDURE (GenDevIF, DeviceTablePtr, ADDRESS, CARDINAL, VAR CARDINAL)
    writeln    = PROCEDURE (GenDevIF, DeviceTablePtr) : BOOLEAN ;
    iseof      = PROCEDURE (GenDevIF, DeviceTablePtr) : BOOLEAN ;
    iseoln     = PROCEDURE (GenDevIF, DeviceTablePtr) : BOOLEAN ;
    iserror    = PROCEDURE (GenDevIF, DeviceTablePtr) : BOOLEAN ;

(*
    InitGenDevIF - initializes a generic device.
*)

PROCEDURE InitGenDevIF (d      : DeviceId;
                       rc      : readchar;
                       urc     : unreadchar;
                       geterr  : geterrno;
                       rbytes  : readbytes;
                       wbytes  : writebytes;
                       wl      : writeln;
                       eof     : iseof;
                       eoln    : iseoln;
                       iserr   : iserror) : GenDevIF ;

(*
    getDID - returns the device id this generic interface.
*)

PROCEDURE getDID (g: GenDevIF) : DeviceId ;

```

```
(*
  doReadChar - returns the next character from the generic
                device.
*)
```

```
PROCEDURE doReadChar (g: GenDevIF; d: DeviceTablePtr) : CHAR ;
```

```
(*
  doUnReadChar - pushes back a character to the generic device.
*)
```

```
PROCEDURE doUnReadChar (g: GenDevIF; d: DeviceTablePtr; ch: CHAR) : CHAR ;■
```

```
(*
  doGetErrno - returns the errno relating to the generic device.
*)
```

```
PROCEDURE doGetErrno (g: GenDevIF; d: DeviceTablePtr) : INTEGER ;
```

```
(*
  doRBytes - attempts to read, n, bytes from the generic device.
             It set the actual amount read and returns a boolean
             to determine whether an error occurred.
*)
```

```
PROCEDURE doRBytes (g: GenDevIF; d: DeviceTablePtr;
                   to: ADDRESS; max: CARDINAL;
                   VAR actual: CARDINAL) : BOOLEAN ;
```

```
(*
  doWBytes - attempts to write, n, bytes to the generic device.
             It sets the actual amount written and returns a
             boolean to determine whether an error occurred.
*)
```

```
PROCEDURE doWBytes (g: GenDevIF; d: DeviceTablePtr;
                   from: ADDRESS; max: CARDINAL;
                   VAR actual: CARDINAL) : BOOLEAN ;
```

```
(*
```

```
        doWrLn - writes an end of line marker and returns
                  TRUE if successful.
    *)

PROCEDURE doWrLn (g: GenDevIF; d: DeviceTablePtr) : BOOLEAN ;

(*
    isEOF - returns true if the end of file was reached.
    *)

PROCEDURE isEOF (g: GenDevIF; d: DeviceTablePtr) : BOOLEAN ;

(*
    isEOLN - returns true if the end of line was reached.
    *)

PROCEDURE isEOLN (g: GenDevIF; d: DeviceTablePtr) : BOOLEAN ;

(*
    isError - returns true if an error was seen in the device.
    *)

PROCEDURE isError (g: GenDevIF; d: DeviceTablePtr) : BOOLEAN ;

(*
    KillGenDevIF - deallocates a generic device.
    *)

PROCEDURE KillGenDevIF (g: GenDevIF) : GenDevIF ;

END RTgenif.
```

4.4.38 gm2-libs-iso/RTio

```
DEFINITION MODULE RTio ;
```

```

(*
    Description: provides low level routines for creating and destroying
                ChanIds. This is necessary to allow multiple modules
                to create, ChanId values, where ChanId is an opaque
                type.
*)
```

```
IMPORT FIO, IOLink ;
```

```

TYPE
    ChanId ;
```

```

(*
    InitChanId - return a new ChanId.
*)
```

```
PROCEDURE InitChanId () : ChanId ;
```

```

(*
    KillChanId - deallocate a ChanId.
*)
```

```
PROCEDURE KillChanId (c: ChanId) : ChanId ;
```

```

(*
    NilChanId - return a NIL pointer.
*)
```

```
PROCEDURE NilChanId () : ChanId ;
```

```

(*
    GetDeviceId - returns the device id, from, c.
*)
```

```
PROCEDURE GetDeviceId (c: ChanId) : IOLink.DeviceId ;
```

```

(*
    SetDeviceId - sets the device id in, c.
*)
```

```
*)

PROCEDURE SetDeviceId (c: ChanId; d: IOLink.DeviceId) ;

(*
  GetDevicePtr - returns the device table ptr, from, c.
*)

PROCEDURE GetDevicePtr (c: ChanId) : IOLink.DeviceTablePtr ;

(*
  SetDevicePtr - sets the device table ptr in, c.
*)

PROCEDURE SetDevicePtr (c: ChanId; p: IOLink.DeviceTablePtr) ;

(*
  GetFile - returns the file field from, c.
*)

PROCEDURE GetFile (c: ChanId) : FIO.File ;

(*
  SetFile - sets the file field in, c.
*)

PROCEDURE SetFile (c: ChanId; f: FIO.File) ;

END RTio.
```

4.4.39 gm2-libs-iso/RandomNumber

```

DEFINITION MODULE RandomNumber ;

  (*
    Description: provides primitives for obtaining random numbers on
                pervasive data types.
  *)

  FROM SYSTEM IMPORT BYTE ;
  EXPORT QUALIFIED Randomize, RandomInit, RandomBytes,
                  RandomCard, RandomShortCard, RandomLongCard,
                  RandomInt, RandomShortInt, RandomLongInt,
                  RandomReal, RandomLongReal, RandomShortReal ;

  (*
    Randomize - initialize the random number generator with a seed
                based on the microseconds.
  *)

  PROCEDURE Randomize ;

  (*
    RandomInit - initialize the random number generator with value, seed.
  *)

  PROCEDURE RandomInit (seed: CARDINAL) ;

  (*
    RandomBytes - fills in an array with random values.
  *)

  PROCEDURE RandomBytes (VAR a: ARRAY OF BYTE) ;

  (*
    RandomInt - return an INTEGER in the range [low .. high].
  *)

  PROCEDURE RandomInt (low, high: INTEGER) : INTEGER ;

  (*
    RandomShortInt - return an SHORTINT in the range [low..high].
  *)

```

*)

PROCEDURE RandomShortInt (low, high: SHORTINT) : SHORTINT ;

(*

RandomLongInt - return an LONGINT in the range [low..high].

*)

PROCEDURE RandomLongInt (low, high: LONGINT) : LONGINT ;

(*

RandomShortCard - return a SHORTCARD in the range [low..high].

*)

PROCEDURE RandomShortCard (low, high: CARDINAL) : CARDINAL ;

(*

RandomCard - return a CARDINAL in the range [low..high].

*)

PROCEDURE RandomCard (low, high: CARDINAL) : CARDINAL ;

(*

RandomLongCard - return an LONGCARD in the range [low..high].

*)

PROCEDURE RandomLongCard (low, high: LONGCARD) : LONGCARD ;

(*

RandomReal - return a REAL number in the range 0.0..1.0

*)

PROCEDURE RandomReal () : REAL ;

(*

RandomShortReal - return a SHORTREAL number in the range 0.0..1.0

*)

PROCEDURE RandomShortReal () : SHORTREAL ;

```
(*  
  RandomLongReal - return a LONGREAL number in the range 0.0..1.0  
*)  
  
PROCEDURE RandomLongReal () : LONGREAL ;  
  
END RandomNumber.
```

4.4.40 gm2-libs-iso/RawIO

```
DEFINITION MODULE RawIO;
```

```
    (* Reading and writing data over specified channels using raw
       operations, that is, with no conversion or interpretation.
       The read result is of the type IOConsts.ReadResults.
    *)
```

```
IMPORT IOChan, SYSTEM;
```

```
PROCEDURE Read (cid: IOChan.ChanId; VAR to: ARRAY OF SYSTEM.LOC);
```

```
    (* Reads storage units from cid, and assigns them to
       successive components of to. The read result is set
       to the value allRight, wrongFormat, or endOfInput.
    *)
```

```
PROCEDURE Write (cid: IOChan.ChanId; from: ARRAY OF SYSTEM.LOC);
```

```
    (* Writes storage units to cid from successive components
       of from. *)
```

```
END RawIO.
```

4.4.41 gm2-libs-iso/RealConv

```

DEFINITION MODULE RealConv;

    (* Low-level REAL/string conversions *)

IMPORT
    ConvTypes;

TYPE
    (* strAllRight, strOutOfRange, strWrongFormat, strEmpty *)
    ConvResults = ConvTypes.ConvResults;

PROCEDURE ScanReal (inputCh: CHAR; VAR chClass: ConvTypes.ScanClass;
                    VAR nextState: ConvTypes.ScanState);
    (* Represents the start state of a finite state scanner for real
       numbers - assigns class of inputCh to chClass and a procedure
       representing the next state to nextState.
    *)

PROCEDURE FormatReal (str: ARRAY OF CHAR): ConvResults;
    (* Returns the format of the string value for conversion to REAL. *)

PROCEDURE ValueReal (str: ARRAY OF CHAR): REAL;
    (* Returns the value corresponding to the real number string value
       str if str is well-formed; otherwise raises the RealConv
       exception.
    *)

PROCEDURE LengthFloatReal (real: REAL; sigFigs: CARDINAL): CARDINAL;
    (* Returns the number of characters in the floating-point string
       representation of real with sigFigs significant figures.
    *)

PROCEDURE LengthEngReal (real: REAL; sigFigs: CARDINAL): CARDINAL;
    (* Returns the number of characters in the floating-point engineering
       string representation of real with sigFigs significant figures.
    *)

PROCEDURE LengthFixedReal (real: REAL; place: INTEGER): CARDINAL;
    (* Returns the number of characters in the fixed-point string
       representation of real rounded to the given place relative to the
       decimal point.
    *)

PROCEDURE IsRConvException (): BOOLEAN;
    (* Returns TRUE if the current coroutine is in the exceptional

```

```
        execution state because of the raising of an exception in a  
        routine from this module; otherwise returns FALSE.  
*)
```

```
END RealConv.
```

4.4.42 gm2-libs-iso/RealIO

```
DEFINITION MODULE RealIO;
```

```
  (* Input and output of real numbers in decimal text form
     over specified channels. The read result is of the
     type IOConsts.ReadResults.
  *)
```

```
IMPORT IOChan;
```

```
  (* The text form of a signed fixed-point real number is
     ["+" | "-"], decimal digit, {decimal digit},
     [".", {decimal digit}]
  *)
```

```
  The text form of a signed floating-point real number is
  signed fixed-point real number,
  "E", ["+" | "-"], decimal digit, {decimal digit}
  *)
```

```
PROCEDURE ReadReal (cid: IOChan.ChanId; VAR real: REAL);
```

```
  (* Skips leading spaces, and removes any remaining characters
     from cid that form part of a signed fixed or floating
     point number. The value of this number is assigned to real.
     The read result is set to the value allRight, outOfRange,
     wrongFormat, endOfLine, or endOfInput.
  *)
```

```
PROCEDURE WriteFloat (cid: IOChan.ChanId; real: REAL;
                     sigFigs: CARDINAL; width: CARDINAL);
```

```
  (* Writes the value of real to cid in floating-point text form,
     with sigFigs significant figures, in a field of the given
     minimum width.
  *)
```

```
PROCEDURE WriteEng (cid: IOChan.ChanId; real: REAL;
                   sigFigs: CARDINAL; width: CARDINAL);
```

```
  (* As for WriteFloat, except that the number is scaled with
     one to three digits in the whole number part, and with an
     exponent that is a multiple of three.
  *)
```

```
PROCEDURE WriteFixed (cid: IOChan.ChanId; real: REAL;
                     place: INTEGER; width: CARDINAL);
```

```
  (* Writes the value of real to cid in fixed-point text form,
     rounded to the given place relative to the decimal point,
     in a field of the given minimum width.
  *)
```

```
*)  
  
PROCEDURE WriteReal (cid: IOChan.ChanId;  
                    real: REAL; width: CARDINAL);  
  (* Writes the value of real to cid, as WriteFixed if the sign  
    and magnitude can be shown in the given width, or otherwise  
    as WriteFloat. The number of places or significant digits  
    depends on the given width.  
  *)  
  
END RealIO.
```

4.4.43 gm2-libs-iso/RealMath

```

DEFINITION MODULE RealMath;

  (* Mathematical functions for the type REAL *)

CONST
  pi    = 3.1415926535897932384626433832795028841972;
  exp1  = 2.7182818284590452353602874713526624977572;

PROCEDURE __BUILTIN__ sqrt (x: REAL): REAL;
  (* Returns the positive square root of x *)

PROCEDURE __BUILTIN__ exp (x: REAL): REAL;
  (* Returns the exponential of x *)

PROCEDURE __BUILTIN__ ln (x: REAL): REAL;
  (* Returns the natural logarithm of x *)

  (* The angle in all trigonometric functions is measured in radians *)

PROCEDURE __BUILTIN__ sin (x: REAL): REAL;
  (* Returns the sine of x *)

PROCEDURE __BUILTIN__ cos (x: REAL): REAL;
  (* Returns the cosine of x *)

PROCEDURE tan (x: REAL): REAL;
  (* Returns the tangent of x *)

PROCEDURE arcsin (x: REAL): REAL;
  (* Returns the arcsine of x *)

PROCEDURE arccos (x: REAL): REAL;
  (* Returns the arccosine of x *)

PROCEDURE arctan (x: REAL): REAL;
  (* Returns the arctangent of x *)

PROCEDURE power (base, exponent: REAL) : REAL;
  (* Returns the value of the number base raised to the power exponent *)■

PROCEDURE round (x: REAL) : INTEGER;
  (* Returns the value of x rounded to the nearest integer *)

PROCEDURE IsRMathException () : BOOLEAN;
  (* Returns TRUE if the current coroutine is in the exceptional execution state■

```

```
because of the raising of an exception in a routine from this module; otherwise  
returns FALSE.
```

```
*)
```

```
END RealMath.
```

4.4.44 gm2-libs-iso/RealStr

```

DEFINITION MODULE RealStr;

    (* REAL/string conversions *)

IMPORT
    ConvTypes;

TYPE
    (* strAllRight, strOutOfRange, strWrongFormat, strEmpty *)
    ConvResults = ConvTypes.ConvResults;

    (* the string form of a signed fixed-point real number is
       ["+" | "-"], decimal digit, {decimal digit}, [".",
       {decimal digit}]
    *)

    (* the string form of a signed floating-point real number is
       signed fixed-point real number, "E", ["+" | "-"],
       decimal digit, {decimal digit}
    *)

PROCEDURE StrToReal (str: ARRAY OF CHAR; VAR real: REAL;
                    VAR res: ConvResults);
    (* Ignores any leading spaces in str. If the subsequent characters
       in str are in the format of a signed real number, assigns a
       corresponding value to real. Assigns a value indicating the
       format of str to res.
    *)

PROCEDURE RealToFloat (real: REAL; sigFigs: CARDINAL;
                      VAR str: ARRAY OF CHAR);
    (* Converts the value of real to floating-point string form, with
       sigFigs significant figures, and copies the possibly truncated
       result to str.
    *)

PROCEDURE RealToEng (real: REAL; sigFigs: CARDINAL;
                    VAR str: ARRAY OF CHAR);
    (* Converts the value of real to floating-point string form, with
       sigFigs significant figures, and copies the possibly truncated
       result to str. The number is scaled with one to three digits
       in the whole number part and with an exponent that is a multiple
       of three.
    *)

```

```
PROCEDURE RealToFixed (real: REAL; place: INTEGER;
                      VAR str: ARRAY OF CHAR);
  (* Converts the value of real to fixed-point string form, rounded
     to the given place relative to the decimal point, and copies
     the possibly truncated result to str.
  *)

PROCEDURE RealToStr (real: REAL; VAR str: ARRAY OF CHAR);
  (* Converts the value of real as RealToFixed if the sign and
     magnitude can be shown within the capacity of str, or
     otherwise as RealToFloat, and copies the possibly truncated
     result to str. The number of places or significant digits are
     implementation-defined.
  *)

END RealStr.
```

4.4.45 gm2-libs-iso/RndFile

```

DEFINITION MODULE RndFile;

  (* Random access files *)

IMPORT IOChan, ChanConsts, SYSTEM;

TYPE
  ChanId = IOChan.ChanId;
  FlagSet = ChanConsts.FlagSet;
  OpenResults = ChanConsts.OpenResults;

  (* Accepted singleton values of FlagSet *)

CONST
  (* input operations are requested/available *)
  read = FlagSet{ChanConsts.readFlag};
  (* output operations are requested/available *)
  write = FlagSet{ChanConsts.writeFlag};
  (* a file may/must/did exist before the channel is opened *)
  old = FlagSet{ChanConsts.oldFlag};
  (* text operations are requested/available *)
  text = FlagSet{ChanConsts.textFlag};
  (* raw operations are requested/available *)
  raw = FlagSet{ChanConsts.rawFlag};

PROCEDURE OpenOld (VAR cid: ChanId; name: ARRAY OF CHAR; flags: FlagSet;
                  VAR res: OpenResults);
  (* Attempts to obtain and open a channel connected to a stored random
   access file of the given name.
   The old flag is implied; without the write flag, read is implied;
   without the text flag, raw is implied.
   If successful, assigns to cid the identity of the opened channel,
   assigns the value opened to res, and sets the read/write position
   to the start of the file.
   If a channel cannot be opened as required, the value of res indicates
   the reason, and cid identifies the invalid channel.
  *)

PROCEDURE OpenClean (VAR cid: ChanId; name: ARRAY OF CHAR; flags: FlagSet;
                    VAR res: OpenResults);
  (* Attempts to obtain and open a channel connected to a stored random
   access file of the given name.
   The write flag is implied; without the text flag, raw is implied.
   If successful, assigns to cid the identity of the opened channel,
   assigns the value opened to res, and truncates the file to zero length.

```

If a channel cannot be opened as required, the value of res indicates the reason, and cid identifies the invalid channel.

*)

```
PROCEDURE IsRndFile (cid: ChanId): BOOLEAN;
```

(* Tests if the channel identified by cid is open to a random access file. *)

```
PROCEDURE IsRndFileException (): BOOLEAN;
```

(* Returns TRUE if the current coroutine is in the exceptional execution state because of the raising of a RndFile exception; otherwise returns FALSE.

*)

```
CONST
```

```
FilePosSize = SIZE(LONGINT) ;
```

(* <implementation-defined whole number greater than zero>; *)

```
TYPE
```

```
FilePos = LONGINT ; (* ARRAY [1 .. FilePosSize] OF SYSTEM.LOC; *)
```

```
PROCEDURE StartPos (cid: ChanId): FilePos;
```

(* If the channel identified by cid is not open to a random access file, the exception wrongDevice is raised; otherwise returns the position of the start of the file.

*)

```
PROCEDURE CurrentPos (cid: ChanId): FilePos;
```

(* If the channel identified by cid is not open to a random access file, the exception wrongDevice is raised; otherwise returns the position of the current read/write position.

*)

```
PROCEDURE EndPos (cid: ChanId): FilePos;
```

(* If the channel identified by cid is not open to a random access file, the exception wrongDevice is raised; otherwise returns the first position after which there have been no writes.

*)

```
PROCEDURE NewPos (cid: ChanId; chunks: INTEGER; chunkSize: CARDINAL;
                  from: FilePos): FilePos;
```

(* If the channel identified by cid is not open to a random access file, the exception wrongDevice is raised; otherwise returns the position (chunks * chunkSize) relative to the position given by from, or raises the exception posRange if the required position cannot be represented as a value of type FilePos.

*)

```
PROCEDURE SetPos (cid: ChanId; pos: FilePos);
  (* If the channel identified by cid is not open to a random access file,
    the exception wrongDevice is raised; otherwise sets the read/write
    position to the value given by pos.
  *)

PROCEDURE Close (VAR cid: ChanId);
  (* If the channel identified by cid is not open to a random access file,
    the exception wrongDevice is raised; otherwise closes the channel,
    and assigns the value identifying the invalid channel to cid.
  *)

END RndFile.
```

4.4.46 gm2-libs-iso/SIOResult

```

DEFINITION MODULE SIOResult;

    (* Read results for the default input channel *)

IMPORT IOConsts;

TYPE
    ReadResults = IOConsts.ReadResults;

    (*
    ReadResults =    (* This type is used to classify the result of an input operation
    (
        notKnown,      (* no read result is set *)
        allRight,      (* data is as expected or as required *)
        outOfRange,    (* data cannot be represented *)
        wrongFormat,   (* data not in expected format *)
        endOfLine,     (* end of line seen before expected data *)
        endOfInput     (* end of input seen before expected data *)
    );
    *)

PROCEDURE ReadResult (): ReadResults;
    (* Returns the result for the last read operation on the default input channel. *)

END SIOResult.

```

4.4.47 gm2-libs-iso/SLongIO

```
DEFINITION MODULE SLongIO;
```

```
(* Input and output of long real numbers in decimal text form
   using default channels. The read result is of the type
   IOConsts.ReadResults.
*)
```

```
(* The text form of a signed fixed-point real number is
   ["+" | "-"], decimal digit, {decimal digit},
   [".", {decimal digit}]
```

```
   The text form of a signed floating-point real number is
   signed fixed-point real number,
   "E", ["+" | "-"], decimal digit, {decimal digit}
*)
```

```
PROCEDURE ReadReal (VAR real: LONGREAL);
```

```
(* Skips leading spaces, and removes any remaining characters
   from the default input channel that form part of a signed
   fixed or floating point number. The value of this number
   is assigned to real. The read result is set to the value
   allRight, outOfRange, wrongFormat, endOfLine, or endOfInput.
*)
```

```
PROCEDURE WriteFloat (real: LONGREAL; sigFigs: CARDINAL;
                     width: CARDINAL);
```

```
(* Writes the value of real to the default output channel in
   floating-point text form, with sigFigs significant figures,
   in a field of the given minimum width.
*)
```

```
PROCEDURE WriteEng (real: LONGREAL; sigFigs: CARDINAL;
                   width: CARDINAL);
```

```
(* As for WriteFloat, except that the number is scaled with
   one to three digits in the whole number part, and with an
   exponent that is a multiple of three.
*)
```

```
PROCEDURE WriteFixed (real: LONGREAL; place: INTEGER;
                     width: CARDINAL);
```

```
(* Writes the value of real to the default output channel in
   fixed-point text form, rounded to the given place relative
   to the decimal point, in a field of the given minimum width.
*)
```

```
PROCEDURE WriteReal (real: LONGREAL; width: CARDINAL);  
  (* Writes the value of real to the default output channel, as  
    WriteFixed if the sign and magnitude can be shown in the  
    given width, or otherwise as WriteFloat. The number of  
    places or significant digits depends on the given width.  
  *)  
  
END SLongIO.
```

4.4.48 gm2-libs-iso/SLongWholeIO

```
DEFINITION MODULE SLongWholeIO;
```

```
  (* Input and output of whole numbers in decimal text form over
     default channels. The read result is of the type
     IOConsts.ReadResults.
  *)
```

```
  (* The text form of a signed whole number is
     ["+" | "-"], decimal digit, {decimal digit}
  *)
```

```
  The text form of an unsigned whole number is
    decimal digit, {decimal digit}
  *)
```

```
PROCEDURE ReadInt (VAR int: LONGINT);
```

```
  (* Skips leading spaces, and removes any remaining characters
     from the default input channel that form part of a signed
     whole number. The value of this number is assigned
     to int. The read result is set to the value allRight,
     outOfRange, wrongFormat, endOfLine, or endOfInput.
  *)
```

```
PROCEDURE WriteInt (int: LONGINT; width: CARDINAL);
```

```
  (* Writes the value of int to the default output channel in
     text form, in a field of the given minimum width.
  *)
```

```
PROCEDURE ReadCard (VAR card: LONGCARD);
```

```
  (* Skips leading spaces, and removes any remaining characters
     from the default input channel that form part of an
     unsigned whole number. The value of this number is
     assigned to card. The read result is set to the value
     allRight, outOfRange, wrongFormat, endOfLine, or endOfInput.
  *)
```

```
PROCEDURE WriteCard (card: LONGCARD; width: CARDINAL);
```

```
  (* Writes the value of card to the default output channel in
     text form, in a field of the given minimum width.
  *)
```

```
END SLongWholeIO.
```

4.4.49 gm2-libs-iso/SRawIO

```
DEFINITION MODULE SRawIO;
```

```
    (* Reading and writing data over default channels using raw operations, that is, with  
       conversion or interpretation. The read result is of the type IOConsts.ReadResults.  
    *)
```

```
IMPORT SYSTEM;
```

```
PROCEDURE Read (VAR to: ARRAY OF SYSTEM.LOC);
```

```
    (* Reads storage units from the default input channel, and assigns them to successive  
       components of to. The read result is set to the value allRight, wrongFormat, or  
       endOfInput.  
    *)
```

```
PROCEDURE Write (from: ARRAY OF SYSTEM.LOC);
```

```
    (* Writes storage units to the default output channel from successive components of  
       from.  
    *)
```

```
END SRawIO.
```

4.4.50 gm2-libs-iso/SRealIO

DEFINITION MODULE SRealIO;

(* Input and output of real numbers in decimal text form over default channels. The read result is of the type IOConsts.ReadResults.
*)

(* The text form of a signed fixed-point real number is
["+" | "-"], decimal digit, {decimal digit},
[".", {decimal digit}]

The text form of a signed floating-point real number is
signed fixed-point real number,
"E", ["+" | "-"], decimal digit, {decimal digit}
*)

PROCEDURE ReadReal (VAR real: REAL);

(* Skips leading spaces, and removes any remaining characters from the default input channel that form part of a signed fixed or floating point number. The value of this number is assigned to real. The read result is set to the value allRight, outOfRange, wrongFormat, endOfLine, or endOfInput.
*)

PROCEDURE WriteFloat (real: REAL; sigFigs: CARDINAL; width: CARDINAL);

(* Writes the value of real to the default output channel in floating-point text form, with sigFigs significant figures, in a field of the given minimum width.
*)

PROCEDURE WriteEng (real: REAL; sigFigs: CARDINAL; width: CARDINAL);

(* As for WriteFloat, except that the number is scaled with one to three digits in the whole number part, and with an exponent that is a multiple of three.
*)

PROCEDURE WriteFixed (real: REAL; place: INTEGER; width: CARDINAL);

(* Writes the value of real to the default output channel in fixed-point text form, rounded to the given place relative to the decimal point, in a field of the given minimum width.
*)

PROCEDURE WriteReal (real: REAL; width: CARDINAL);

(* Writes the value of real to the default output channel, as WriteFixed if the sign and magnitude can be shown in the

```
        given width, or otherwise as WriteFloat. The number of  
        places or significant digits depends on the given width.  
*)
```

```
END SRealIO.
```

4.4.51 gm2-libs-iso/SShortIO

DEFINITION MODULE SShortIO;

(* Input and output of short real numbers in decimal text form using default channels. The read result is of the type IOConsts.ReadResults.
*)

(* The text form of a signed fixed-point real number is
["+" | "-"], decimal digit, {decimal digit},
[".", {decimal digit}]

The text form of a signed floating-point real number is
signed fixed-point real number,
"E", ["+" | "-"], decimal digit, {decimal digit}
*)

PROCEDURE ReadReal (VAR real: SHORTREAL);

(* Skips leading spaces, and removes any remaining characters from the default input channel that form part of a signed fixed or floating point number. The value of this number is assigned to real. The read result is set to the value allRight, outOfRange, wrongFormat, endOfLine, or endOfInput.
*)

PROCEDURE WriteFloat (real: SHORTREAL; sigFigs: CARDINAL;
width: CARDINAL);

(* Writes the value of real to the default output channel in floating-point text form, with sigFigs significant figures, in a field of the given minimum width.
*)

PROCEDURE WriteEng (real: SHORTREAL; sigFigs: CARDINAL;
width: CARDINAL);

(* As for WriteFloat, except that the number is scaled with one to three digits in the whole number part, and with an exponent that is a multiple of three.
*)

PROCEDURE WriteFixed (real: SHORTREAL; place: INTEGER;
width: CARDINAL);

(* Writes the value of real to the default output channel in fixed-point text form, rounded to the given place relative to the decimal point, in a field of the given minimum width.
*)

```
PROCEDURE WriteReal (real: SHORTREAL; width: CARDINAL);  
  (* Writes the value of real to the default output channel, as  
    WriteFixed if the sign and magnitude can be shown in the  
    given width, or otherwise as WriteFloat. The number of  
    places or significant digits depends on the given width.  
  *)  
  
END SShortIO.
```

4.4.52 gm2-libs-iso/SShortWholeIO

```
DEFINITION MODULE SShortWholeIO;
```

```
  (* Input and output of whole numbers in decimal text form over
     default channels. The read result is of the type
     IOConsts.ReadResults.
  *)
```

```
  (* The text form of a signed whole number is
     ["+" | "-"], decimal digit, {decimal digit}

```

```

     The text form of an unsigned whole number is
     decimal digit, {decimal digit}
  *)
```

```
PROCEDURE ReadInt (VAR int: SHORTINT);
```

```
  (* Skips leading spaces, and removes any remaining characters
     from the default input channel that form part of a signed
     whole number. The value of this number is assigned
     to int. The read result is set to the value allRight,
     outOfRange, wrongFormat, endOfLine, or endOfInput.
  *)
```

```
PROCEDURE WriteInt (int: SHORTINT; width: CARDINAL);
```

```
  (* Writes the value of int to the default output channel in
     text form, in a field of the given minimum width.
  *)
```

```
PROCEDURE ReadCard (VAR card: SHORTCARD);
```

```
  (* Skips leading spaces, and removes any remaining characters
     from the default input channel that form part of an
     unsigned whole number. The value of this number is
     assigned to card. The read result is set to the value
     allRight, outOfRange, wrongFormat, endOfLine, or endOfInput.
  *)
```

```
PROCEDURE WriteCard (card: SHORTCARD; width: CARDINAL);
```

```
  (* Writes the value of card to the default output channel in
     text form, in a field of the given minimum width.
  *)
```

```
END SShortWholeIO.
```

4.4.53 gm2-libs-iso/STextIO

DEFINITION MODULE STextIO;

(* Input and output of character and string types over default channels. The read result is of the type IOConsts.ReadResults.
*)

(* The following procedures do not read past line marks *)

PROCEDURE ReadChar (VAR ch: CHAR);

(* If possible, removes a character from the default input stream, and assigns the corresponding value to ch. The read result is set to allRight, endOfLine or endOfInput.
*)

PROCEDURE ReadRestLine (VAR s: ARRAY OF CHAR);

(* Removes any remaining characters from the default input stream before the next line mark, copying to s as many as can be accommodated as a string value. The read result is set to the value allRight, outOfRange, endOfLine, or endOfInput.
*)

PROCEDURE ReadString (VAR s: ARRAY OF CHAR);

(* Removes only those characters from the default input stream before the next line mark that can be accommodated in s as a string value, and copies them to s. The read result is set to the value allRight, endOfLine, or endOfInput.
*)

PROCEDURE ReadToken (VAR s: ARRAY OF CHAR);

(* Skips leading spaces, and then removes characters from the default input stream before the next space or line mark, copying to s as many as can be accommodated as a string value. The read result is set to the value allRight, outOfRange, endOfLine, or endOfInput.
*)

(* The following procedure reads past the next line mark *)

PROCEDURE SkipLine;

(* Removes successive items from the default input stream up to and including the next line mark or until the end of input is reached. The read result is set to the value allRight, or endOfInput.
*)

(* Output procedures *)

PROCEDURE WriteChar (ch: CHAR);

```
      (* Writes the value of ch to the default output stream. *)

PROCEDURE WriteLn;
  (* Writes a line mark to the default output stream. *)

PROCEDURE WriteString (s: ARRAY OF CHAR);
  (* Writes the string value of s to the default output stream. *)

END STextIO.
```

4.4.54 gm2-libs-iso/SWholeIO

DEFINITION MODULE SWholeIO;

(* Input and output of whole numbers in decimal text form over default channels. The read result is of the type IOConsts.ReadResults.
*)

(* The text form of a signed whole number is
["+" | "-"], decimal digit, {decimal digit}

The text form of an unsigned whole number is
decimal digit, {decimal digit}
*)

PROCEDURE ReadInt (VAR int: INTEGER);

(* Skips leading spaces, and removes any remaining characters from the default input channel that form part of a signed whole number. The value of this number is assigned to int. The read result is set to the value allRight, outOfRange, wrongFormat, endOfLine, or endOfInput.
*)

PROCEDURE WriteInt (int: INTEGER; width: CARDINAL);

(* Writes the value of int to the default output channel in text form, in a field of the given minimum width.
*)

PROCEDURE ReadCard (VAR card: CARDINAL);

(* Skips leading spaces, and removes any remaining characters from the default input channel that form part of an unsigned whole number. The value of this number is assigned to card. The read result is set to the value allRight, outOfRange, wrongFormat, endOfLine, or endOfInput.
*)

PROCEDURE WriteCard (card: CARDINAL; width: CARDINAL);

(* Writes the value of card to the default output channel in text form, in a field of the given minimum width.
*)

END SWholeIO.

4.4.55 gm2-libs-iso/SYSTEM

```
DEFINITION MODULE SYSTEM;
```

```
    (* Gives access to system programming facilities that are probably
       non portable. *)
```

```
    (* The constants and types define underlying properties of storage *)
```

```
EXPORT QUALIFIED BITS_PERLOC, LOCSPERWORD,
    LOC, BYTE, WORD, ADDRESS, C_SIZE_T, CSSIZE_T, COFF_T, (*
       Target specific data types. *)
    ADDADR, SUBADR, DIFADR, MAKEADR, ADR, ROTATE,
    SHIFT, CAST, TSIZE,
```

```
    (* Internal GM2 compiler functions *)
    ShiftVal, ShiftLeft, ShiftRight,
    RotateVal, RotateLeft, RotateRight,
    THROW, TBITSIZE ;
```

```
CONST
```

```
    (* <implementation-defined constant> ; *)
    BITS_PERLOC    = __ATTRIBUTE__ __BUILTIN__ ((BITS_PER_UNIT)) ;
    (* <implementation-defined constant> ; *)
    LOCSPERWORD    = __ATTRIBUTE__ __BUILTIN__ ((UNITS_PER_WORD)) ;
    (* <implementation-defined constant> ; *)
    LOCSPERBYTE = 8 DIV BITS_PERLOC ;
```

```
(* Note that the full list of system and sized datatypes include:
   LOC, WORD, BYTE, ADDRESS,
```

```
(and the non language standard target types)
```

```
INTEGER8, INTEGER16, INTEGER32, INTEGER64,
CARDINAL8, CARDINAL16, CARDINAL32, CARDINAL64,
WORD16, WORD32, WORD64, BITSET8, BITSET16,
BITSET32, REAL32, REAL64, REAL128, COMPLEX32,
COMPLEX64, COMPLEX128, C_SIZE_T, CSSIZE_T.
```

```
Also note that the non-standard data types will
move into another module in the future. *)
```

```
(*
   All the data types and procedures below are declared internally.
   =====
```

```
TYPE
```

(* Target specific data types. *)

TYPE

LOC; (* A system basic type. Values are the uninterpreted
contents of the smallest addressable unit of storage *)
ADDRESS = POINTER TO LOC;
WORD = ARRAY [0 .. LOCSPERWORD-1] OF LOC;

(* BYTE and LOCSPERBYTE are provided if appropriate for machine *)

TYPE

BYTE = ARRAY [0 .. LOCSPERBYTE-1] OF LOC;

PROCEDURE ADDADR (addr: ADDRESS; offset: CARDINAL): ADDRESS;

(* Returns address given by (addr + offset), or may raise
an exception if this address is not valid.

*)

PROCEDURE SUBADR (addr: ADDRESS; offset: CARDINAL): ADDRESS;

(* Returns address given by (addr - offset), or may raise an
exception if this address is not valid.

*)

PROCEDURE DIFADR (addr1, addr2: ADDRESS): INTEGER;

(* Returns the difference between addresses (addr1 - addr2),
or may raise an exception if the arguments are invalid
or address space is non-contiguous.

*)

PROCEDURE MAKEADR (high: <some type>; ...): ADDRESS;

(* Returns an address constructed from a list of values whose
types are implementation-defined, or may raise an
exception if this address is not valid.

In GNU Modula-2, MAKEADR can take any number of arguments
which are mapped onto the type ADDRESS. The first parameter
maps onto the high address bits and subsequent parameters map
onto lower address bits. For example:

```
a := MAKEADR(BYTE(OFEH), BYTE(ODCH), BYTE(OBAH), BYTE(O98H),
             BYTE(O76H), BYTE(O54H), BYTE(O32H), BYTE(O10H)) ;
```

then the value of, a, on a 64 bit machine is: 0FEDCBA9876543210H

The parameters do not have to be the same type, but constants
must be typed.

*)

```

PROCEDURE ADR (VAR v: <anytype>): ADDRESS;
  (* Returns the address of variable v. *)

PROCEDURE ROTATE (val: <a packedset type>;
                  num: INTEGER): <type of first parameter>;
  (* Returns a bit sequence obtained from val by rotating up/right
     or down/right by the absolute value of num. The direction is
     down/right if the sign of num is negative, otherwise the direction
     is up/left.
  *)

PROCEDURE SHIFT (val: <a packedset type>;
                 num: INTEGER): <type of first parameter>;
  (* Returns a bit sequence obtained from val by shifting up/left
     or down/right by the absolute value of num, introducing
     zeros as necessary. The direction is down/right if the sign of
     num is negative, otherwise the direction is up/left.
  *)

PROCEDURE CAST (<targettype>; val: <anytype>): <targettype>;
  (* CAST is a type transfer function. Given the expression
     denoted by val, it returns a value of the type <targettype>.
     An invalid value for the target value or a
     physical address alignment problem may raise an exception.
  *)

PROCEDURE TSIZE (<type>; ... ): CARDINAL;
  (* Returns the number of LOCS used to store a value of the
     specified <type>. The extra parameters, if present,
     are used to distinguish variants in a variant record.
  *)

PROCEDURE THROW (i: INTEGER) <* noreturn *> ;
  (*
     THROW is a GNU extension and was not part of the PIM or ISO
     standards. It throws an exception which will be caught by the
     EXCEPT block (assuming it exists). This is a compiler builtin
     function which interfaces to the GCC exception handling runtime
     system.
     GCC uses the term throw, hence the naming distinction between
     the GCC builtin and the Modula-2 runtime library procedure Raise.
     The later library procedure Raise will call SYSTEM.THROW after
     performing various housekeeping activities.
  *)

PROCEDURE TBITSIZE (<type>) : CARDINAL ;

```

```

    (* Returns the minimum number of bits necessary to represent
       <type>. This procedure function is only useful for determining
       the number of bits used for any type field within a packed RECORD.
       It is not particularly useful elsewhere since <type> might be
       optimized for speed, for example a BOOLEAN could occupy a WORD.
    *)
*)

(* The following procedures are invoked by GNU Modula-2 to
   shift non word set types. They are not part of ISO Modula-2
   but are used to implement the SHIFT procedure defined above. *)

(*
   ShiftVal - is a runtime procedure whose job is to implement
               the SHIFT procedure of ISO SYSTEM. GNU Modula-2 will
               inline a SHIFT of a single WORD sized set and will only
               call this routine for larger sets.
*)

PROCEDURE ShiftVal (VAR s, d: ARRAY OF BITSET;
                   SetSizeInBits: CARDINAL;
                   ShiftCount: INTEGER) ;

(*
   ShiftLeft - performs the shift left for a multi word set.
               This procedure might be called by the back end of
               GNU Modula-2 depending whether amount is known at
               compile time.
*)

PROCEDURE ShiftLeft (VAR s, d: ARRAY OF BITSET;
                    SetSizeInBits: CARDINAL;
                    ShiftCount: CARDINAL) ;

(*
   ShiftRight - performs the shift left for a multi word set.
                This procedure might be called by the back end of
                GNU Modula-2 depending whether amount is known at
                compile time.
*)

PROCEDURE ShiftRight (VAR s, d: ARRAY OF BITSET;
                     SetSizeInBits: CARDINAL;
                     ShiftCount: CARDINAL) ;

```

END SYSTEM.

4.4.56 gm2-libs-iso/Semaphores

DEFINITION MODULE Semaphores;

(* Provides mutual exclusion facilities for use by processes. *)

TYPE

SEMAPHORE;

PROCEDURE Create (VAR s: SEMAPHORE; initialCount: CARDINAL);

(* Creates and returns s as the identity of a new semaphore that has its associated count initialized to initialCount, and has no processes yet waiting on it.

*)

PROCEDURE Destroy (VAR s: SEMAPHORE);

(* Recovers the resources used to implement the semaphore s, provided that no process is waiting for s to become free.

*)

PROCEDURE Claim (s: SEMAPHORE);

(* If the count associated with the semaphore s is non-zero, decrements this count and allows the calling process to continue; otherwise suspends the calling process until s is released.

*)

PROCEDURE Release (s: SEMAPHORE);

(* If there are any processes waiting on the semaphore s, allows one of them to enter the ready state; otherwise increments the count associated with s.

*)

PROCEDURE CondClaim (s: SEMAPHORE): BOOLEAN;

(* Returns FALSE if the call Claim(s) would cause the calling process to be suspended; in this case the count associated with s is not changed. Otherwise returns TRUE and the associated count is decremented.

*)

END Semaphores.

4.4.57 gm2-libs-iso/SeqFile

```

DEFINITION MODULE SeqFile;

    (* Rewindable sequential files *)

IMPORT IOChan, ChanConsts;

TYPE
    ChanId = IOChan.ChanId;
    FlagSet = ChanConsts.FlagSet;
    OpenResults = ChanConsts.OpenResults;

    (* Accepted singleton values of FlagSet *)

CONST
    (* input operations are requested/available *)
    read = FlagSet{ChanConsts.readFlag};

    (* output operations are requested/available *)
    write = FlagSet{ChanConsts.writeFlag};

    (* a file may/must/did exist before the channel is opened *)
    old = FlagSet{ChanConsts.oldFlag};

    (* text operations are requested/available *)
    text = FlagSet{ChanConsts.textFlag};

    (* raw operations are requested/available *)
    raw = FlagSet{ChanConsts.rawFlag};

PROCEDURE OpenWrite (VAR cid: ChanId; name: ARRAY OF CHAR;
                    flags: FlagSet; VAR res: OpenResults);
    (*
        Attempts to obtain and open a channel connected to a stored
        rewindable file of the given name.
        The write flag is implied; without the raw flag, text is
        implied. If successful, assigns to cid the identity of
        the opened channel, assigns the value opened to res, and
        selects output mode, with the write position at the start
        of the file (i.e. the file is of zero length).
        If a channel cannot be opened as required, the value of
        res indicates the reason, and cid identifies the invalid
        channel.
    *)

PROCEDURE OpenAppend (VAR cid: ChanId; name: ARRAY OF CHAR;

```

```

                                flags: FlagSet; VAR res: OpenResults);
(*
    Attempts to obtain and open a channel connected to a stored
    rewindable file of the given name. The write and old flags
    are implied; without the raw flag, text is implied. If
    successful, assigns to cid the identity of the opened channel,
    assigns the value opened to res, and selects output mode,
    with the write position corresponding to the length of the
    file. If a channel cannot be opened as required, the value
    of res indicates the reason, and cid identifies the invalid
    channel.
*)

PROCEDURE OpenRead (VAR cid: ChanId; name: ARRAY OF CHAR;
                    flags: FlagSet; VAR res: OpenResults);
(* Attempts to obtain and open a channel connected to a stored
    rewindable file of the given name.
    The read and old flags are implied; without the raw flag,
    text is implied. If successful, assigns to cid the
    identity of the opened channel, assigns the value opened to
    res, and selects input mode, with the read position
    corresponding to the start of the file.
    If a channel cannot be opened as required, the value of
    res indicates the reason, and cid identifies the invalid
    channel.
*)

PROCEDURE IsSeqFile (cid: ChanId): BOOLEAN;
(* Tests if the channel identified by cid is open to a
    rewindable sequential file. *)

PROCEDURE Reread (cid: ChanId);
(* If the channel identified by cid is not open to a rewindable
    sequential file, the exception wrongDevice is raised;
    otherwise attempts to set the read position to the
    start of the file, and to select input mode.
    If the operation cannot be performed (perhaps because of
    insufficient permissions) neither input mode nor output
    mode is selected.
*)

PROCEDURE Rewrite (cid: ChanId);
(* If the channel identified by cid is not open to a
    rewindable sequential file, the exception wrongDevice is
    raised; otherwise, attempts to truncate the file to zero
    length, and to select output mode. If the operation
    cannot be performed (perhaps because of insufficient

```

```
        permissions) neither input mode nor output mode is selected.
    *)

PROCEDURE Close (VAR cid: ChanId);
    (* If the channel identified by cid is not open to a rewindable
       sequential file, the exception wrongDevice is raised;
       otherwise closes the channel, and assigns the value
       identifying the invalid channel to cid.
    *)

END SeqFile.
```

4.4.58 gm2-libs-iso/ShortComplexMath

```

DEFINITION MODULE ShortComplexMath;

  (* Mathematical functions for the type SHORTCOMPLEX *)

CONST
  i =      CMPLX (0.0, 1.0);
  one =    CMPLX (1.0, 0.0);
  zero =   CMPLX (0.0, 0.0);

PROCEDURE abs (z: SHORTCOMPLEX): SHORTREAL;
  (* Returns the length of z *)

PROCEDURE arg (z: SHORTCOMPLEX): SHORTREAL;
  (* Returns the angle that z subtends to the positive real axis *)

PROCEDURE conj (z: SHORTCOMPLEX): SHORTCOMPLEX;
  (* Returns the complex conjugate of z *)

PROCEDURE power (base: SHORTCOMPLEX; exponent: SHORTREAL): SHORTCOMPLEX;
  (* Returns the value of the number base raised to the power exponent *)

PROCEDURE sqrt (z: SHORTCOMPLEX): SHORTCOMPLEX;
  (* Returns the principal square root of z *)

PROCEDURE exp (z: SHORTCOMPLEX): SHORTCOMPLEX;
  (* Returns the complex exponential of z *)

PROCEDURE ln (z: SHORTCOMPLEX): SHORTCOMPLEX;
  (* Returns the principal value of the natural logarithm of z *)

PROCEDURE sin (z: SHORTCOMPLEX): SHORTCOMPLEX;
  (* Returns the sine of z *)

PROCEDURE cos (z: SHORTCOMPLEX): SHORTCOMPLEX;
  (* Returns the cosine of z *)

PROCEDURE tan (z: SHORTCOMPLEX): SHORTCOMPLEX;
  (* Returns the tangent of z *)

PROCEDURE arcsin (z: SHORTCOMPLEX): SHORTCOMPLEX;
  (* Returns the arcsine of z *)

PROCEDURE arccos (z: SHORTCOMPLEX): SHORTCOMPLEX;
  (* Returns the arccosine of z *)

```

```
PROCEDURE arctan (z: SHORTCOMPLEX): SHORTCOMPLEX;
    (* Returns the arctangent of z *)

PROCEDURE polarToComplex (abs, arg: SHORTREAL): SHORTCOMPLEX;
    (* Returns the complex number with the specified polar coordinates *)

PROCEDURE scalarMult (scalar: SHORTREAL; z: SHORTCOMPLEX): SHORTCOMPLEX;
    (* Returns the scalar product of scalar with z *)

PROCEDURE IsCMathException (): BOOLEAN;
    (* Returns TRUE if the current coroutine is in the exceptional execution state
       because of the raising of an exception in a routine from this module; otherwise
       returns FALSE.
    *)

END ShortComplexMath.
```

4.4.59 gm2-libs-iso/ShortConv

```

DEFINITION MODULE ShortConv;

IMPORT
    ConvTypes;

TYPE
    ConvResults = ConvTypes.ConvResults; (* strAllRight, strOutOfRange,
                                           strWrongFormat, strEmpty *)

PROCEDURE ScanReal (inputCh: CHAR; VAR chClass: ConvTypes.ScanClass;
                   VAR nextState: ConvTypes.ScanState);
    (* Represents the start state of a finite state scanner for real
       numbers - assigns class of inputCh to chClass and a procedure
       representing the next state to nextState.
    *)

PROCEDURE FormatReal (str: ARRAY OF CHAR): ConvResults;
    (* Returns the format of the string value for conversion to LONGREAL. *)

PROCEDURE ValueReal (str: ARRAY OF CHAR): SHORTREAL;
    (* Returns the value corresponding to the real number string value
       str if str is well-formed; otherwise raises the ShortConv exception.
    *)

PROCEDURE LengthFloatReal (real: SHORTREAL; sigFigs: CARDINAL): CARDINAL;
    (* Returns the number of characters in the floating-point string
       representation of real with sigFigs significant figures.
    *)

PROCEDURE LengthEngReal (real: SHORTREAL; sigFigs: CARDINAL): CARDINAL;
    (* Returns the number of characters in the floating-point engineering
       string representation of real with sigFigs significant figures.
    *)

PROCEDURE LengthFixedReal (real: SHORTREAL; place: INTEGER): CARDINAL;
    (* Returns the number of characters in the fixed-point string
       representation of real rounded to the given place relative to the
       decimal point.
    *)

PROCEDURE IsRConvException (): BOOLEAN;
    (* Returns TRUE if the current coroutine is in the exceptional
       execution state because of the raising of an exception in a
       routine from this module; otherwise returns FALSE.
    *)

```

END ShortConv.

4.4.60 gm2-libs-iso/ShortIO

```
DEFINITION MODULE ShortIO;
```

```
  (* Input and output of short real numbers in decimal text form
     over specified channels. The read result is of the type
     IOConsts.ReadResults.
  *)
```

```
IMPORT IOChan;
```

```
  (* The text form of a signed fixed-point real number is
     ["+" | "-"], decimal digit, {decimal digit}, [".",
     {decimal digit}]
```

```

     The text form of a signed floating-point real number is
     signed fixed-point real number,
     "E", ["+" | "-"], decimal digit, {decimal digit}
  *)
```

```
PROCEDURE ReadReal (cid: IOChan.ChanId; VAR real: SHORTREAL);
```

```
  (* Skips leading spaces, and removes any remaining characters
     from cid that form part of a signed fixed or floating
     point number. The value of this number is assigned to real.
     The read result is set to the value allRight, outOfRange,
     wrongFormat, endOfLine, or endOfInput.
  *)
```

```
PROCEDURE WriteFloat (cid: IOChan.ChanId; real: SHORTREAL;
                     sigFigs: CARDINAL; width: CARDINAL);
```

```
  (* Writes the value of real to cid in floating-point text form,
     with sigFigs significant figures, in a field of the given
     minimum width.
  *)
```

```
PROCEDURE WriteEng (cid: IOChan.ChanId; real: SHORTREAL;
                   sigFigs: CARDINAL; width: CARDINAL);
```

```
  (* As for WriteFloat, except that the number is scaled with
     one to three digits in the whole number part, and with an
     exponent that is a multiple of three.
  *)
```

```
PROCEDURE WriteFixed (cid: IOChan.ChanId; real: SHORTREAL;
                    place: INTEGER; width: CARDINAL);
```

```
  (* Writes the value of real to cid in fixed-point text form,
     rounded to the given place relative to the decimal point,
     in a field of the given minimum width.
```

```
*)  
  
PROCEDURE WriteReal (cid: IOChan.ChanId; real: SHORTREAL;  
                    width: CARDINAL);  
  (* Writes the value of real to cid, as WriteFixed if the  
    sign and magnitude can be shown in the given width, or  
    otherwise as WriteFloat. The number of places or  
    significant digits depends on the given width.  
  *)  
  
END ShortIO.
```

4.4.61 gm2-libs-iso/ShortMath

```

DEFINITION MODULE ShortMath;

    (* Mathematical functions for the type LONGREAL *)

CONST
    pi    = 3.1415926535897932384626433832795028841972;
    exp1  = 2.7182818284590452353602874713526624977572;

PROCEDURE __BUILTIN__ sqrt (x: SHORTREAL): SHORTREAL;
    (* Returns the positive square root of x *)

PROCEDURE __BUILTIN__ exp (x: SHORTREAL): SHORTREAL;
    (* Returns the exponential of x *)

PROCEDURE __BUILTIN__ ln (x: SHORTREAL): SHORTREAL;
    (* Returns the natural logarithm of x *)

    (* The angle in all trigonometric functions is measured in radians *)

PROCEDURE __BUILTIN__ sin (x: SHORTREAL): SHORTREAL;
    (* Returns the sine of x *)

PROCEDURE __BUILTIN__ cos (x: SHORTREAL): SHORTREAL;
    (* Returns the cosine of x *)

PROCEDURE tan (x: SHORTREAL): SHORTREAL;
    (* Returns the tangent of x *)

PROCEDURE arcsin (x: SHORTREAL): SHORTREAL;
    (* Returns the arcsine of x *)

PROCEDURE arccos (x: SHORTREAL): SHORTREAL;
    (* Returns the arccosine of x *)

PROCEDURE arctan (x: SHORTREAL): SHORTREAL;
    (* Returns the arctangent of x *)

PROCEDURE power (base, exponent: SHORTREAL): SHORTREAL;
    (* Returns the value of the number base raised to the power exponent *)■

PROCEDURE round (x: SHORTREAL): INTEGER;
    (* Returns the value of x rounded to the nearest integer *)

PROCEDURE IsRMathException (): BOOLEAN;
    (* Returns TRUE if the current coroutine is in the exceptional

```

```
        execution state because of the raising of an exception in a  
        routine from this module; otherwise returns FALSE.  
*)
```

```
END ShortMath.
```

4.4.62 gm2-libs-iso/ShortStr

```

DEFINITION MODULE ShortStr;

  (* SHORTREAL/string conversions *)

IMPORT
  ConvTypes;

TYPE
  (* strAllRight, strOutOfRange, strWrongFormat, strEmpty *)
  ConvResults = ConvTypes.ConvResults;

  (* the string form of a signed fixed-point real number is
     ["+" | "-"], decimal digit, {decimal digit}, [".",
     {decimal digit}]
  *)

  (* the string form of a signed floating-point real number is
     signed fixed-point real number, "E", ["+" | "-"],
     decimal digit, {decimal digit}
  *)

PROCEDURE StrToReal (str: ARRAY OF CHAR; VAR real: SHORTREAL;
  VAR res: ConvResults);
  (* Ignores any leading spaces in str. If the subsequent characters
     in str are in the format of a signed real number, assigns a
     corresponding value to real. Assigns a value indicating the
     format of str to res.
  *)

PROCEDURE RealToFloat (real: SHORTREAL; sigFigs: CARDINAL;
  VAR str: ARRAY OF CHAR);
  (* Converts the value of real to floating-point string form, with
     sigFigs significant figures, and copies the possibly truncated
     result to str.
  *)

PROCEDURE RealToEng (real: SHORTREAL; sigFigs: CARDINAL;
  VAR str: ARRAY OF CHAR);
  (* Converts the value of real to floating-point string form, with
     sigFigs significant figures, and copies the possibly truncated
     result to str. The number is scaled with one to three digits
     in the whole number part and with an exponent that is a
     multiple of three.
  *)

```

```
PROCEDURE RealToFixed (real: SHORTREAL; place: INTEGER;
                      VAR str: ARRAY OF CHAR);
  (* Converts the value of real to fixed-point string form, rounded
     to the given place relative to the decimal point, and copies
     the possibly truncated result to str.
  *)

PROCEDURE RealToStr (real: SHORTREAL; VAR str: ARRAY OF CHAR);
  (* Converts the value of real as RealToFixed if the sign and
     magnitude can be shown within the capacity of str, or
     otherwise as RealToFloat, and copies the possibly truncated
     result to str. The number of places or significant digits
     depend on the capacity of str.
  *)

END ShortStr.
```

4.4.63 gm2-libs-iso/ShortWholeIO

```

DEFINITION MODULE ShortWholeIO;

  (* Input and output of whole numbers in decimal text form
     over specified channels. The read result is of the
     type IOConsts.ReadResults.
  *)

IMPORT IOChan;

  (* The text form of a signed whole number is
     ["+" | "-"], decimal digit, {decimal digit}

     The text form of an unsigned whole number is
     decimal digit, {decimal digit}
  *)

PROCEDURE ReadInt (cid: IOChan.ChanId; VAR int: SHORTINT);
  (* Skips leading spaces, and removes any remaining characters
     from cid that form part of a signed whole number. The
     value of this number is assigned to int. The read result
     is set to the value allRight, outOfRange, wrongFormat,
     endOfLine, or endOfInput.
  *)

PROCEDURE WriteInt (cid: IOChan.ChanId; int: SHORTINT;
                   width: CARDINAL);
  (* Writes the value of int to cid in text form, in a field of
     the given minimum width. *)

PROCEDURE ReadCard (cid: IOChan.ChanId; VAR card: SHORTCARD);
  (* Skips leading spaces, and removes any remaining characters
     from cid that form part of an unsigned whole number. The
     value of this number is assigned to card. The read result
     is set to the value allRight, outOfRange, wrongFormat,
     endOfLine, or endOfInput.
  *)

PROCEDURE WriteCard (cid: IOChan.ChanId; card: SHORTCARD;
                   width: CARDINAL);
  (* Writes the value of card to cid in text form, in a field
     of the given minimum width. *)

END ShortWholeIO.

```

4.4.64 gm2-libs-iso/SimpleCipher

```
DEFINITION MODULE SimpleCipher ;

(*
   Description: provides a simple Caesar cipher layer which
               can be attached to any channel device.  This,
               pedagogical, module is designed to show how
               it is possible to add further layers underneath
               the channel devices.
*)

FROM IOChan IMPORT ChanId ;

(*
   InsertCipherLayer - inserts a caesar cipher below channel, cid.
                     The encryption, key, is specified.
*)

PROCEDURE InsertCipherLayer (cid: ChanId; key: INTEGER) ;

(*
   RemoveCipherLayer - removes a Caesar cipher below channel, cid.
*)

PROCEDURE RemoveCipherLayer (cid: ChanId) ;

END SimpleCipher.
```

4.4.65 gm2-libs-iso/StdChans

```
DEFINITION MODULE StdChans;
```

```
    (* Access to standard and default channels *)
```

```
IMPORT IOChan;
```

```
TYPE
```

```
    ChanId = IOChan.ChanId;
```

```
    (* Values of this type are used to identify channels *)
```

```
    (* The following functions return the standard channel values.
       These channels cannot be closed.
    *)
```

```
PROCEDURE StdInChan (): ChanId;
```

```
    (* Returns the identity of the implementation-defined standard source for
program
       input.
    *)
```

```
PROCEDURE StdOutChan (): ChanId;
```

```
    (* Returns the identity of the implementation-defined standard source for program
       output.
    *)
```

```
PROCEDURE StdErrChan (): ChanId;
```

```
    (* Returns the identity of the implementation-defined standard destination for program
       error messages.
    *)
```

```
PROCEDURE NullChan (): ChanId;
```

```
    (* Returns the identity of a channel open to the null device. *)
```

```
    (* The following functions return the default channel values *)
```

```
PROCEDURE InChan (): ChanId;
```

```
    (* Returns the identity of the current default input channel. *)
```

```
PROCEDURE OutChan (): ChanId;
```

```
    (* Returns the identity of the current default output channel. *)
```

```
PROCEDURE ErrChan (): ChanId;
```

```
    (* Returns the identity of the current default error message channel. *)
```

```
    (* The following procedures allow for redirection of the default channels *)
```

```
PROCEDURE SetInChan (cid: ChanId);  
    (* Sets the current default input channel to that identified by cid. *)  
  
PROCEDURE SetOutChan (cid: ChanId);  
    (* Sets the current default output channel to that identified by cid. *)  
  
PROCEDURE SetErrChan (cid: ChanId);  
    (* Sets the current default error channel to that identified by cid. *)  
  
END StdChans.
```

4.4.66 gm2-libs-iso/Storage

```
DEFINITION MODULE Storage;
```

```
    (* Facilities for dynamically allocating and deallocating storage *)
```

```
IMPORT SYSTEM;
```

```
PROCEDURE ALLOCATE (VAR addr: SYSTEM.ADDRESS; amount: CARDINAL);
    (* Allocates storage for a variable of size amount and assigns
       the address of this variable to addr. If there is insufficient
       unallocated storage to do this, the value NIL is assigned to addr.
    *)
```

```
PROCEDURE DEALLOCATE (VAR addr: SYSTEM.ADDRESS; amount: CARDINAL);
    (* Deallocates amount locations allocated by ALLOCATE for
       the storage of the variable addressed by addr and assigns
       the value NIL to addr.
    *)
```

```
PROCEDURE REALLOCATE (VAR addr: SYSTEM.ADDRESS; amount: CARDINAL);
    (* Attempts to reallocate, amount of storage. Effectively it
       calls ALLOCATE, copies the amount of data pointed to by
       addr into the new space and DEALLOCATES the addr.
       This procedure is a GNU extension.
    *)
```

```
TYPE
```

```
    StorageExceptions = (
        nilDeallocation,           (* first argument to DEALLOCATE is NIL *)
        pointerToUnallocatedStorage, (* storage to deallocate not allocated by ALLOCATE *)
        wrongStorageToUnallocate    (* amount to deallocate is not amount allocated *)
    );
```

```
PROCEDURE IsStorageException (): BOOLEAN;
    (* Returns TRUE if the current coroutine is in the exceptional
       execution state because of the raising of an exception from
       StorageExceptions; otherwise returns FALSE.
    *)
```

```
PROCEDURE StorageException (): StorageExceptions;
    (* If the current coroutine is in the exceptional execution
       state because of the raising of an exception from
       StorageExceptions, returns the corresponding
       enumeration value, and otherwise raises an exception.
    *)
```

END Storage.

4.4.67 gm2-libs-iso/StreamFile

```
DEFINITION MODULE StreamFile;
```

```
    (* Independent sequential data streams *)
```

```
IMPORT IOChan, ChanConsts;
```

```
TYPE
```

```
    ChanId = IOChan.ChanId;
```

```
    FlagSet = ChanConsts.FlagSet;
```

```
    OpenResults = ChanConsts.OpenResults;
```

```
    (* Accepted singleton values of FlagSet *)
```

```
CONST
```

```
    read = FlagSet{ChanConsts.readFlag};    (* input operations are requested/available *)
    write = FlagSet{ChanConsts.writeFlag};    (* output operations are requested/available *)
    old = FlagSet{ChanConsts.oldFlag};    (* a file may/must/did exist before the channel
                                           opened *)
```

```
    text = FlagSet{ChanConsts.textFlag};    (* text operations are requested/available *)
```

```
    raw = FlagSet{ChanConsts.rawFlag};    (* raw operations are requested/available *)
```

```
PROCEDURE Open (VAR cid: ChanId; name: ARRAY OF CHAR;
                flags: FlagSet; VAR res: OpenResults);
```

```
    (* Attempts to obtain and open a channel connected to a
       sequential stream of the given name.
```

```
    The read flag implies old; without the raw flag, text is
    implied. If successful, assigns to cid the identity of
    the opened channel, and assigns the value opened to res.
    If a channel cannot be opened as required, the value of
    res indicates the reason, and cid identifies the invalid
    channel.
```

```
    *)
```

```
PROCEDURE IsStreamFile (cid: ChanId): BOOLEAN;
```

```
    (* Tests if the channel identified by cid is open to a sequential stream. *)
```

```
PROCEDURE Close (VAR cid: ChanId);
```

```
    (* If the channel identified by cid is not open to a sequential stream, the exception
       wrongDevice is raised; otherwise closes the channel, and assigns the value identified
       the invalid channel to cid.
```

```
    *)
```

```
END StreamFile.
```

4.4.68 gm2-libs-iso/StringChan

```
DEFINITION MODULE StringChan ;

(*
   Description: provides a set of Channel and String
               input and output procedures.
*)

FROM DynamicStrings IMPORT String ;
IMPORT IOChan;

(*
   writeString - writes a string, s, to ChanId, cid.
                 The string, s, is not destroyed.
*)

PROCEDURE writeString (cid: IOChan.ChanId; s: String) ;

(*
   writeFieldWidth - writes a string, s, to ChanId, cid.
                     The string, s, is not destroyed and it
                     is prefixed by spaces so that at least,
                     width, characters are written. If the
                     string, s, is longer than width then
                     no spaces are prefixed to the output
                     and the entire string is written.
*)

PROCEDURE writeFieldWidth (cid: IOChan.ChanId;
                           s: String; width: CARDINAL) ;

END StringChan.
```

4.4.69 gm2-libs-iso/Strings

DEFINITION MODULE Strings;

(* Facilities for manipulating strings *)

TYPE

String1 = ARRAY [0..0] OF CHAR;

(* String1 is provided for constructing a value of a single-character string type. A single character value in order to pass CHAR values to ARRAY OF CHAR parameters *)

PROCEDURE Length (stringVal: ARRAY OF CHAR): CARDINAL;

(* Returns the length of stringVal (the same value as would be returned by the pervasive function LENGTH). *)

(* The following seven procedures construct a string value, and attempt to assign it to a variable parameter. They all have the property that if the length of the constructed value exceeds the capacity of the variable parameter, a truncated value is assigned. If the length of the constructed string value is less than the capacity of the variable parameter, a string terminator is appended before assignment is performed. *)

PROCEDURE Assign (source: ARRAY OF CHAR; VAR destination: ARRAY OF CHAR);

(* Copies source to destination *)

PROCEDURE Extract (source: ARRAY OF CHAR; startIndex, numberToExtract: CARDINAL; VAR destination: ARRAY OF CHAR);

(* Copies at most numberToExtract characters from source to destination, starting at startIndex in source. *)

PROCEDURE Delete (VAR stringVar: ARRAY OF CHAR; startIndex, numberToDelete: CARDINAL);

(* Deletes at most numberToDelete characters from stringVar, starting at position startIndex. *)

PROCEDURE Insert (source: ARRAY OF CHAR; startIndex: CARDINAL; VAR destination: ARRAY OF CHAR);

(* Inserts source into destination at position startIndex *)

PROCEDURE Replace (source: ARRAY OF CHAR; startIndex: CARDINAL; VAR destination: ARRAY OF CHAR);

(* Copies source into destination, starting at position startIndex. Copying stops when

all of source has been copied, or when the last character of the string value in destination has been replaced.

*)

```
PROCEDURE Append (source: ARRAY OF CHAR; VAR destination: ARRAY OF CHAR);
  (* Appends source to destination. *)
```

```
PROCEDURE Concat (source1, source2: ARRAY OF CHAR; VAR destination: ARRAY OF CHAR);
  (* Concatenates source2 onto source1 and copies the result into destination. *)
```

(* The following predicates provide for pre-testing of the operation-completion conditions for the procedures above.

*)

```
PROCEDURE CanAssignAll (sourceLength: CARDINAL; VAR destination: ARRAY OF CHAR): BOOLEAN;
  (* Returns TRUE if a number of characters, indicated by sourceLength, will fit into destination; otherwise returns FALSE.
```

*)

```
PROCEDURE CanExtractAll (sourceLength, startIndex, numberToExtract: CARDINAL;
  VAR destination: ARRAY OF CHAR): BOOLEAN;
```

(* Returns TRUE if there are numberToExtract characters starting at startIndex and within the sourceLength of some string, and if the capacity of destination is sufficient to hold numberToExtract characters; otherwise returns FALSE.

*)

```
PROCEDURE CanDeleteAll (stringLength, startIndex, numberToDelete: CARDINAL): BOOLEAN;
  (* Returns TRUE if there are numberToDelete characters starting at startIndex and within the stringLength of some string; otherwise returns FALSE.
```

*)

```
PROCEDURE CanInsertAll (sourceLength, startIndex: CARDINAL;
  VAR destination: ARRAY OF CHAR): BOOLEAN;
```

(* Returns TRUE if there is room for the insertion of sourceLength characters from some string into destination starting at startIndex; otherwise returns FALSE.

*)

```
PROCEDURE CanReplaceAll (sourceLength, startIndex: CARDINAL;
  VAR destination: ARRAY OF CHAR): BOOLEAN;
```

(* Returns TRUE if there is room for the replacement of sourceLength characters in destination starting at startIndex; otherwise returns FALSE.

*)

```
PROCEDURE CanAppendAll (sourceLength: CARDINAL; VAR destination: ARRAY OF CHAR): BOOLEAN;
  (* Returns TRUE if there is sufficient room in destination to append a string of length sourceLength to the string in destination; otherwise returns FALSE.
```

*)

```

PROCEDURE CanConcatAll (source1Length, source2Length: CARDINAL;
                        VAR destination: ARRAY OF CHAR): BOOLEAN;
    (* Returns TRUE if there is sufficient room in destination for a two strings of
       lengths source1Length and source2Length; otherwise returns FALSE.
    *)

(* The following type and procedures provide for the comparison of string values, and
   location of substrings within strings.
*)

TYPE
    CompareResults = (less, equal, greater);

PROCEDURE Compare (stringVal1, stringVal2: ARRAY OF CHAR): CompareResults;
    (* Returns less, equal, or greater, according as stringVal1 is lexically less than,
       equal to, or greater than stringVal2.
    *)

PROCEDURE Equal (stringVal1, stringVal2: ARRAY OF CHAR): BOOLEAN;
    (* Returns Strings.Compare(stringVal1, stringVal2) = Strings.equal *)

PROCEDURE FindNext (pattern, stringToSearch: ARRAY OF CHAR; startIndex: CARDINAL;
                   VAR patternFound: BOOLEAN; VAR posOfPattern: CARDINAL);
    (* Looks forward for next occurrence of pattern in stringToSearch, starting the search
       position startIndex. If startIndex < LENGTH(stringToSearch) and pattern is found,
       patternFound is returned as TRUE, and posOfPattern contains the start position in
       stringToSearch of pattern. Otherwise patternFound is returned as FALSE, and posOfPattern
       is unchanged.
    *)

PROCEDURE FindPrev (pattern, stringToSearch: ARRAY OF CHAR; startIndex: CARDINAL;
                   VAR patternFound: BOOLEAN; VAR posOfPattern: CARDINAL);
    (* Looks backward for the previous occurrence of pattern in stringToSearch and returns
       position of the first character of the pattern if found. The search for the pattern
       begins at startIndex. If pattern is found, patternFound is returned as TRUE, and
       posOfPattern contains the start position in stringToSearch of pattern in the range
       [0..startIndex]. Otherwise patternFound is returned as FALSE, and posOfPattern is
       unchanged.
    *)

PROCEDURE FindDiff (stringVal1, stringVal2: ARRAY OF CHAR;
                   VAR differenceFound: BOOLEAN; VAR posOfDifference: CARDINAL);
    (* Compares the string values in stringVal1 and stringVal2 for differences. If they
       are equal, differenceFound is returned as FALSE, and TRUE otherwise. If
       differenceFound is TRUE, posOfDifference is set to the position of the first
       difference; otherwise posOfDifference is unchanged.
    *)

```

```
PROCEDURE Capitalize (VAR stringVar: ARRAY OF CHAR);  
    (* Applies the function CAP to each character of the string value in stringVar. *)  
  
END Strings.
```

4.4.70 gm2-libs-iso/SysClock

```
DEFINITION MODULE SysClock;
```

```
(* Facilities for accessing a system clock that records the date
   and time of day *)
```

```
CONST
```

```
    maxSecondParts = 1000000 ;
```

```
TYPE
```

```
    Month      = [1 .. 12];
```

```
    Day        = [1 .. 31];
```

```
    Hour       = [0 .. 23];
```

```
    Min        = [0 .. 59];
```

```
    Sec        = [0 .. 59];
```

```
    Fraction   = [0 .. maxSecondParts];
```

```
    UTCDiff    = [-780 .. 720];
```

```
    DateTime =
```

```
        RECORD
```

```
            year:      CARDINAL;
```

```
            month:     Month;
```

```
            day:       Day;
```

```
            hour:      Hour;
```

```
            minute:    Min;
```

```
            second:    Sec;
```

```
            fractions: Fraction;      (* parts of a second *)
```

```
            zone:      UTCDiff;      (* Time zone differential
                                       factor which is the number
                                       of minutes to add to local
                                       time to obtain UTC. *)
```

```
            summerTimeFlag: BOOLEAN; (* Interpretation of flag
                                       depends on local usage. *)
```

```
        END;
```

```
PROCEDURE CanGetClock(): BOOLEAN;
```

```
(* Tests if the clock can be read *)
```

```
PROCEDURE CanSetClock(): BOOLEAN;
```

```
(* Tests if the clock can be set *)
```

```
PROCEDURE IsValidDateTime(userData: DateTime): BOOLEAN;
```

```
(* Tests if the value of userData is a valid *)
```

```
PROCEDURE GetClock(VAR userData: DateTime);
```

```
(* Assigns local date and time of the day to userData *)
```

```
PROCEDURE SetClock(userData: DateTime);  
(* Sets the system time clock to the given local date and  
   time *)  
  
END SysClock.
```

4.4.71 gm2-libs-iso/TERMINATION

```
DEFINITION MODULE TERMINATION;
```

```
  (* Provides facilities for enquiries concerning the occurrence of termination events.
```

```
PROCEDURE IsTerminating (): BOOLEAN ;
```

```
  (* Returns true if any coroutine has started program termination and false otherwise.
```

```
PROCEDURE HasHalted (): BOOLEAN ;
```

```
  (* Returns true if a call to HALT has been made and false otherwise. *)■
```

```
END TERMINATION.
```

4.4.72 gm2-libs-iso/TermFile

```
DEFINITION MODULE TermFile;
```

```
  (* Access to the terminal device *)
```

```
  (* Channels opened by this module are connected to a single
     terminal device; typed characters are distributed between
     channels according to the sequence of read requests.
  *)
```

```
IMPORT IOChan, ChanConsts;
```

```
TYPE
```

```
  ChanId = IOChan.ChanId;
  FlagSet = ChanConsts.FlagSet;
  OpenResults = ChanConsts.OpenResults;
```

```
  (* Accepted singleton values of FlagSet *)
```

```
CONST
```

```
  read = FlagSet{ChanConsts.readFlag};
  (* input operations are requested/available *)
  write = FlagSet{ChanConsts.writeFlag};
  (* output operations are requested/available *)
  text = FlagSet{ChanConsts.textFlag};
  (* text operations are requested/available *)
  raw = FlagSet{ChanConsts.rawFlag};
  (* raw operations are requested/available *)
  echo = FlagSet{ChanConsts.echoFlag};
  (* echoing by interactive device on reading of
     characters from input stream requested/applies
  *)
```

```
PROCEDURE Open (VAR cid: ChanId; flagset: FlagSet; VAR res: OpenResults);
```

```
  (* Attempts to obtain and open a channel connected to
     the terminal. Without the raw flag, text is implied.
     Without the echo flag, line mode is requested,
     otherwise single character mode is requested.
     If successful, assigns to cid the identity of
     the opened channel, and assigns the value opened to res.
     If a channel cannot be opened as required, the value of
     res indicates the reason, and cid identifies the
     invalid channel.
  *)
```

```
PROCEDURE IsTermFile (cid: ChanId): BOOLEAN;
```

```
    (* Tests if the channel identified by cid is open to
       the terminal. *)

PROCEDURE Close (VAR cid: ChanId);
    (* If the channel identified by cid is not open to the terminal,
       the exception wrongDevice is raised; otherwise closes the
       channel and assigns the value identifying the invalid channel
       to cid.
    *)

END TermFile.
```

4.4.73 gm2-libs-iso/TextIO

```
DEFINITION MODULE TextIO;
```

```
  (* Input and output of character and string types over
     specified channels. The read result is of the type
     IOConsts.ReadResults.
  *)
```

```
IMPORT IOChan;
```

```
  (* The following procedures do not read past line marks *)
```

```
PROCEDURE ReadChar (cid: IOChan.ChanId; VAR ch: CHAR);
  (* If possible, removes a character from the input stream
     cid and assigns the corresponding value to ch. The
     read result is set to the value allRight, endOfLine, or
     endOfInput.
  *)
```

```
PROCEDURE ReadRestLine (cid: IOChan.ChanId; VAR s: ARRAY OF CHAR);
  (* Removes any remaining characters from the input stream
     cid before the next line mark, copying to s as many as
     can be accommodated as a string value. The read result is
     set to the value allRight, outOfRange, endOfLine, or
     endOfInput.
  *)
```

```
PROCEDURE ReadString (cid: IOChan.ChanId; VAR s: ARRAY OF CHAR);
  (* Removes only those characters from the input stream cid
     before the next line mark that can be accommodated in s
     as a string value, and copies them to s. The read result
     is set to the value allRight, endOfLine, or endOfInput.
  *)
```

```
PROCEDURE ReadToken (cid: IOChan.ChanId; VAR s: ARRAY OF CHAR);
  (* Skips leading spaces, and then removes characters from
     the input stream cid before the next space or line mark,
     copying to s as many as can be accommodated as a string
     value. The read result is set to the value allRight,
     outOfRange, endOfLine, or endOfInput.
  *)
```

```
  (* The following procedure reads past the next line mark *)
```

```
PROCEDURE SkipLine (cid: IOChan.ChanId);
  (* Removes successive items from the input stream cid up
```

```
        to and including the next line mark, or until the end
        of input is reached. The read result is set to the
        value allRight, or endOfInput.
    *)

    (* Output procedures *)

    PROCEDURE WriteChar (cid: IOChan.ChanId; ch: CHAR);
        (* Writes the value of ch to the output stream cid. *)

    PROCEDURE WriteLn (cid: IOChan.ChanId);
        (* Writes a line mark to the output stream cid. *)

    PROCEDURE WriteString (cid: IOChan.ChanId; s: ARRAY OF CHAR);
        (* Writes the string value in s to the output stream cid. *)

    END TextIO.
```

4.4.74 gm2-libs-iso/TextUtil

```
DEFINITION MODULE TextUtil ;

(*
  Description: provides text manipulation routines.
*)

IMPORT IOChan ;

(*
  SkipSpaces - skips any spaces.
*)

PROCEDURE SkipSpaces (cid: IOChan.ChanId) ;

(* CharAvailable returns TRUE if IOChan.ReadResult is notKnown or
   allRight. *)

PROCEDURE CharAvailable (cid: IOChan.ChanId) : BOOLEAN ;

(* EofOrEoln returns TRUE if IOChan.ReadResult is endOfLine or
   endOfInput. *)

PROCEDURE EofOrEoln (cid: IOChan.ChanId) : BOOLEAN ;

END TextUtil.
```

4.4.75 gm2-libs-iso/WholeConv

```

DEFINITION MODULE WholeConv;

    (* Low-level whole-number/string conversions *)

IMPORT
    ConvTypes;

TYPE
    ConvResults = ConvTypes.ConvResults;
    (* strAllRight, strOutOfRange, strWrongFormat, strEmpty *)

PROCEDURE ScanInt (inputCh: CHAR;
    VAR chClass: ConvTypes.ScanClass;
    VAR nextState: ConvTypes.ScanState) ;
    (* Represents the start state of a finite state scanner for signed
       whole numbers - assigns class of inputCh to chClass and a
       procedure representing the next state to nextState.
    *)

PROCEDURE FormatInt (str: ARRAY OF CHAR): ConvResults;
    (* Returns the format of the string value for conversion to INTEGER. *)

PROCEDURE ValueInt (str: ARRAY OF CHAR): INTEGER;
    (* Returns the value corresponding to the signed whole number string
       value str if str is well-formed; otherwise raises the WholeConv
       exception.
    *)

PROCEDURE LengthInt (int: INTEGER): CARDINAL;
    (* Returns the number of characters in the string representation of
       int.
    *)

PROCEDURE ScanCard (inputCh: CHAR; VAR chClass: ConvTypes.ScanClass;
    VAR nextState: ConvTypes.ScanState);
    (* Represents the start state of a finite state scanner for unsigned
       whole numbers - assigns class of inputCh to chClass and a procedure
       representing the next state to nextState.
    *)

PROCEDURE FormatCard (str: ARRAY OF CHAR): ConvResults;
    (* Returns the format of the string value for conversion to CARDINAL.
    *)

PROCEDURE ValueCard (str: ARRAY OF CHAR): CARDINAL;

```

```
(* Returns the value corresponding to the unsigned whole number string
   value str if str is well-formed; otherwise raises the WholeConv
   exception.
*)

PROCEDURE LengthCard (card: CARDINAL): CARDINAL;
  (* Returns the number of characters in the string representation of
     card.
  *)

PROCEDURE IsWholeConvException (): BOOLEAN;
  (* Returns TRUE if the current coroutine is in the exceptional execution
     state because of the raising of an exception in a routine from this
     module; otherwise returns FALSE.
  *)

END WholeConv.
```

4.4.76 gm2-libs-iso/WholeIO

```

DEFINITION MODULE WholeIO;

  (* Input and output of whole numbers in decimal text form
     over specified channels. The read result is of the
     type IOConsts.ReadResults.
  *)

IMPORT IOChan;

  (* The text form of a signed whole number is
     ["+" | "-"], decimal digit, {decimal digit}

     The text form of an unsigned whole number is
     decimal digit, {decimal digit}
  *)

PROCEDURE ReadInt (cid: IOChan.ChanId; VAR int: INTEGER);
  (* Skips leading spaces, and removes any remaining characters
     from cid that form part of a signed whole number. The
     value of this number is assigned to int. The read result
     is set to the value allRight, outOfRange, wrongFormat,
     endOfLine, or endOfInput.
  *)

PROCEDURE WriteInt (cid: IOChan.ChanId; int: INTEGER;
                   width: CARDINAL);
  (* Writes the value of int to cid in text form, in a field of
     the given minimum width. *)

PROCEDURE ReadCard (cid: IOChan.ChanId; VAR card: CARDINAL);
  (* Skips leading spaces, and removes any remaining characters
     from cid that form part of an unsigned whole number. The
     value of this number is assigned to card. The read result
     is set to the value allRight, outOfRange, wrongFormat,
     endOfLine, or endOfInput.
  *)

PROCEDURE WriteCard (cid: IOChan.ChanId; card: CARDINAL;
                   width: CARDINAL);
  (* Writes the value of card to cid in text form, in a field
     of the given minimum width. *)

END WholeIO.
```

4.4.77 gm2-libs-iso/WholeStr

```

DEFINITION MODULE WholeStr;

    (* Whole-number/string conversions *)

IMPORT
    ConvTypes;

TYPE
    ConvResults = ConvTypes.ConvResults;
    (* strAllRight, strOutOfRange, strWrongFormat, strEmpty *)

    (* the string form of a signed whole number is
       ["+" | "-"], decimal digit, {decimal digit}
    *)

PROCEDURE StrToInt (str: ARRAY OF CHAR; VAR int: INTEGER;
                    VAR res: ConvResults);
    (* Ignores any leading spaces in str. If the subsequent
       characters in str are in the format of a signed whole
       number, assigns a corresponding value to int. Assigns
       a value indicating the format of str to res.
    *)

PROCEDURE IntToStr (int: INTEGER; VAR str: ARRAY OF CHAR);
    (* Converts the value of int to string form and copies the
       possibly truncated result to str. *)

    (* the string form of an unsigned whole number is
       decimal digit, {decimal digit}
    *)

PROCEDURE StrToCard (str: ARRAY OF CHAR;
                    VAR card: CARDINAL;
                    VAR res: ConvResults);
    (* Ignores any leading spaces in str. If the subsequent
       characters in str are in the format of an unsigned
       whole number, assigns a corresponding value to card.
       Assigns a value indicating the format of str to res.
    *)

PROCEDURE CardToStr (card: CARDINAL; VAR str: ARRAY OF CHAR);
    (* Converts the value of card to string form and copies the
       possibly truncated result to str. *)

END WholeStr.

```

4.4.78 gm2-libs-iso/wrapclock

```

DEFINITION MODULE wrapclock ;

FROM SYSTEM IMPORT ADDRESS ;

TYPE
    timespec = ADDRESS ;

(*
    timezone - return the glibc timezone value.
               This contains the difference between UTC and the latest
               local standard time, in seconds west of UTC.
               If the underlying timezone is unavailable and
               clock_gettime, localtime_r, tm_gmtoff
               is unavailable then 0 is returned.
*)

PROCEDURE timezone () : LONGINT ;

(*
    istimezone returns 1 if timezone in wrapclock.cc can resolve the
               timezone value using the timezone C library call or by using
               clock_gettime, localtime_r and tm_gmtoff.
*)

PROCEDURE istimezone () : INTEGER ;

(*
    daylight - return the glibc daylight value.
               This variable has a nonzero value if Daylight Saving
               Time rules apply.
               A nonzero value does not necessarily mean that Daylight
               Saving Time is now in effect; it means only that Daylight
               Saving Time is sometimes in effect.
*)

PROCEDURE daylight () : INTEGER ;

(*
    isdst - returns 1 if daylight saving time is currently in effect and
            returns 0 if it is not.
*)

```

```
PROCEDURE isdst () : INTEGER ;
```

```
(*  
    tzname - returns the string associated with the local timezone.  
             The daylight value is 0 or 1. The value 0 returns the non  
             daylight saving timezone string and the value of 1 returns  
             the daylight saving timezone string.  
*)
```

```
PROCEDURE tzname (daylight: INTEGER) : ADDRESS ;
```

```
(*  
    InitTimespec - returns a newly created opaque type.  
*)
```

```
PROCEDURE InitTimespec () : timespec ;
```

```
(*  
    KillTimespec - deallocates the memory associated with an  
                  opaque type.  
*)
```

```
PROCEDURE KillTimespec (tv: timespec) : timespec ;
```

```
(*  
    GetTimespec - retrieves the number of seconds and nanoseconds  
                 from the timespec. A return value of 0 means timespec  
                 is unavailable and a return value of 1 indicates success.■  
*)
```

```
PROCEDURE GetTimespec (ts: timespec; VAR sec, nano: LONGCARD) : INTEGER ;■
```

```
(*  
    SetTimespec - sets the number of seconds and nanoseconds  
                 into timespec. A return value of 0 means timespec  
                 is unavailable and a return value of 1 indicates success.■  
*)
```

```
PROCEDURE SetTimespec (ts: timespec; sec, nano: LONGCARD) : INTEGER ;
```

```
(*  
  GetTimeRealtime - performs return gettimeofday (CLOCK_REALTIME, ts).  
                   gettimeofday returns 0 on success and -1 on failure.  
                   If the underlying system does not have gettimeofday  
                   then GetTimeRealtime returns 1.  
*)
```

```
PROCEDURE GetTimeRealtime (ts: timespec) : INTEGER ;
```

```
(*  
  SetTimeRealtime - performs return settimeofday (CLOCK_REALTIME, ts).  
                   gettimeofday returns 0 on success and -1 on failure.  
                   If the underlying system does not have gettimeofday  
                   then SetTimeRealtime returns 1.  
*)
```

```
PROCEDURE SetTimeRealtime (ts: timespec) : INTEGER ;
```

```
END wrapclock.
```

4.4.79 gm2-libs-iso/wrapsock

```

DEFINITION MODULE wrapsock ;

(*
   Description: provides a set of wrappers to some client side
                tcp socket primitives.
*)

FROM SYSTEM IMPORT ADDRESS ;
FROM ChanConsts IMPORT OpenResults ;

TYPE
  clientInfo = ADDRESS ;

(*
   clientOpen - returns an ISO Modula-2 OpenResult.
                It attempts to connect to:  hostname:portNo.
                If successful then the data structure, c,
                will have its fields initialized.
*)

PROCEDURE clientOpen (c: clientInfo;
                     hostname: ADDRESS;
                     length: CARDINAL;
                     portNo: CARDINAL) : OpenResults ;

(*
   clientOpenIP - returns an ISO Modula-2 OpenResult.
                  It attempts to connect to:  ipaddress:portNo.
                  If successful then the data structure, c,
                  will have its fields initialized.
*)

PROCEDURE clientOpenIP (c: clientInfo;
                       ip: CARDINAL;
                       portNo: CARDINAL) : OpenResults ;

(*
   getClientPortNo - returns the portNo from structure, c.
*)

PROCEDURE getClientPortNo (c: clientInfo) : CARDINAL ;

```

```
(*
  getClientHostname - fills in the hostname of the server
                    the to which the client is connecting.
*)

PROCEDURE getClientHostname (c: clientInfo;
                           hostname: ADDRESS; high: CARDINAL) ;

(*
  getClientSocketFd - returns the sockFd from structure, c.
*)

PROCEDURE getClientSocketFd (c: clientInfo) : INTEGER ;

(*
  getClientIP - returns the sockFd from structure, s.
*)

PROCEDURE getClientIP (c: clientInfo) : CARDINAL ;

(*
  getPushBackChar - returns TRUE if a pushed back character
                  is available.
*)

PROCEDURE getPushBackChar (c: clientInfo; VAR ch: CHAR) : BOOLEAN ;

(*
  setPushBackChar - returns TRUE if it is able to push back a
                  character.
*)

PROCEDURE setPushBackChar (c: clientInfo; ch: CHAR) : BOOLEAN ;

(*
  getsizeofClientInfo - returns the sizeof (opaque data type).
*)

PROCEDURE getsizeofClientInfo () : CARDINAL ;
```

```
END wrapsock.
```

4.4.80 gm2-libs-iso/wraptime

```
DEFINITION MODULE wraptime ;

(*
   Description: provides an interface to various time related
                entities on the underlying host operating system.
                It provides access to the glibc/libc functions:
                gettimeofday, settimeofday and localtime_r.
*)

FROM SYSTEM IMPORT ADDRESS ;

TYPE
    timeval  = ADDRESS ;
    timezone = ADDRESS ;
    tm       = ADDRESS ;

(*
   InitTimeval - returns a newly created opaque type.
*)

PROCEDURE InitTimeval () : timeval ;

(*
   KillTimeval - deallocates the memory associated with an
                opaque type.
*)

PROCEDURE KillTimeval (tv: timeval) : timeval ;

(*
   InitTimezone - returns a newly created opaque type.
*)

PROCEDURE InitTimezone () : timezone ;

(*
   KillTimezone - deallocates the memory associated with an
                opaque type.
*)

PROCEDURE KillTimezone (tv: timezone) : timezone ;
```

```
(*  
    InitTM - returns a newly created opaque type.  
*)
```

```
PROCEDURE InitTM () : tm ;
```

```
(*  
    KillTM - deallocates the memory associated with an  
             opaque type.  
*)
```

```
PROCEDURE KillTM (tv: tm) : tm ;
```

```
(*  
    gettimeofday - calls gettimeofday(2) with the same parameters, tv,  
                  and, tz. It returns 0 on success.  
*)
```

```
PROCEDURE gettimeofday (tv: timeval; tz: timezone) : INTEGER ;
```

```
(*  
    settimeofday - calls settimeofday(2) with the same parameters, tv,  
                  and, tz. It returns 0 on success.  
*)
```

```
PROCEDURE settimeofday (tv: timeval; tz: timezone) : INTEGER ;
```

```
(*  
    GetFractions - returns the tv_usec field inside the timeval structure  
                  as a CARDINAL.  
*)
```

```
PROCEDURE GetFractions (tv: timeval) : CARDINAL ;
```

```
(*  
    localtime_r - returns the tm parameter, m, after it has been assigned with  
                  appropriate contents determined by, tv. Notice that  
                  this procedure function expects, timeval, as its first  
                  parameter and not a time_t (as expected by the posix  
                  equivalent). This avoids having to expose a time_t
```

```
                                system dependant definition.
*)

PROCEDURE localtime_r (tv: timeval; m: tm) : tm ;

(*
  GetYear - returns the year from the structure, m.
*)

PROCEDURE GetYear (m: tm) : CARDINAL ;

(*
  GetMonth - returns the month from the structure, m.
*)

PROCEDURE GetMonth (m: tm) : CARDINAL ;

(*
  GetDay - returns the day of the month from the structure, m.
*)

PROCEDURE GetDay (m: tm) : CARDINAL ;

(*
  GetHour - returns the hour of the day from the structure, m.
*)

PROCEDURE GetHour (m: tm) : CARDINAL ;

(*
  GetMinute - returns the minute within the hour from the structure, m.
*)

PROCEDURE GetMinute (m: tm) : CARDINAL ;

(*
  GetSecond - returns the seconds in the minute from the structure, m.
                The return value will always be in the range 0..59.
                A leap minute of value 60 will be truncated to 59.
*)
```

```
PROCEDURE GetSecond (m: tm) : CARDINAL ;

(*
  GetSummerTime - returns a boolean indicating whether summer time is
                  set.
*)

PROCEDURE GetSummerTime (tz: timezone) : BOOLEAN ;

(*
  GetDST - returns the number of minutes west of GMT.
*)

PROCEDURE GetDST (tz: timezone) : INTEGER ;

(*
  SetTimeval - sets the fields in timeval, tv, with:
               second, minute, hour, day, month, year, fractions.
*)

PROCEDURE SetTimeval (tv: timeval;
                    second, minute, hour, day,
                    month, year, yday, wday, isdst: CARDINAL) ;

(*
  SetTimezone - set the timezone field inside timeval, tv.
*)

PROCEDURE SetTimezone (tv: timeval;
                    zone: CARDINAL; minuteswest: INTEGER) ;

END wraptime.
```

4.5 Indices

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