

Using GNU Fortran

For GCC version 16.0.0 (pre-release)

(GCC)

The gfortran team

7 Coarray Programming

7.1 Type and enum ABI Documentation

7.1.1 `caf_token_t`

Typedef of type `void *` on the compiler side. Can be any data type on the library side.

7.1.2 `caf_register_t`

Indicates which kind of coarray variable should be registered.

```
typedef enum caf_register_t {
    CAF_REGTYPE_COARRAY_STATIC,
    CAF_REGTYPE_COARRAY_ALLOC,
    CAF_REGTYPE_LOCK_STATIC,
    CAF_REGTYPE_LOCK_ALLOC,
    CAF_REGTYPE_CRITICAL,
    CAF_REGTYPE_EVENT_STATIC,
    CAF_REGTYPE_EVENT_ALLOC,
    CAF_REGTYPE_COARRAY_ALLOC_REGISTER_ONLY,
    CAF_REGTYPE_COARRAY_ALLOC_ALLOCATE_ONLY
}
caf_register_t;
```

The values `CAF_REGTYPE_COARRAY_ALLOC_REGISTER_ONLY` and `CAF_REGTYPE_COARRAY_ALLOC_ALLOCATE_ONLY` are for allocatable components in derived type coarrays only. The first one sets up the token without allocating memory for allocatable component. The latter one only allocates the memory for an allocatable component in a derived type coarray. The token needs to be set up previously by the `REGISTER_ONLY`. This allows having allocatable components unallocated on some images. The status of whether an allocatable component is allocated on a remote image can be queried by `_caf_is_present` which used internally by the `ALLOCATED` intrinsic.

7.1.3 `caf_deregister_t`

```
typedef enum caf_deregister_t {
    CAF_DEREGTYPE_COARRAY_DEREGISTER,
    CAF_DEREGTYPE_COARRAY DEALLOCATE_ONLY
}
caf_deregister_t;
```

Allows to specify the type of deregistration of a coarray object. The `CAF_DEREGTYPE_COARRAY DEALLOCATE_ONLY` flag is only allowed for allocatable components in derived type coarrays.

7.1.4 `caf_reference_t`

The structure used for implementing arbitrary reference chains. A `CAF_REFERENCE_T` allows to specify a component reference or any kind of array reference of any rank supported by gfortran. For array references all kinds as known by the compiler/Fortran standard are supported indicated by a `MODE`.

```
typedef enum caf_ref_type_t {
    /* Reference a component of a derived type, either regular one or an
       allocatable or pointer type. For regular ones idx in caf_reference_t is
```

```

        set to -1. */
CAF_REF_COMPONENT,
/* Reference an allocatable array. */
CAF_REF_ARRAY,
/* Reference a non-allocatable/non-pointer array. I.e., the coarray object
   has no array descriptor associated and the addressing is done
   completely using the ref. */
CAF_REF_STATIC_ARRAY
} caf_ref_type_t;

typedef enum caf_array_ref_t {
/* No array ref. This terminates the array ref. */
CAF_ARR_REF_NONE = 0,
/* Reference array elements given by a vector. Only for this mode
   caf_reference_t.u.a.dim[i].v is valid. */
CAF_ARR_REF_VECTOR,
/* A full array ref (:). */
CAF_ARR_REF_FULL,
/* Reference a range on elements given by start, end and stride. */
CAF_ARR_REF_RANGE,
/* Only a single item is referenced given in the start member. */
CAF_ARR_REF_SINGLE,
/* An array ref of the kind (i:), where i is an arbitrary valid index in the
   array. The index i is given in the start member. */
CAF_ARR_REF_OPEN_END,
/* An array ref of the kind (:i), where the lower bound of the array ref
   is given by the remote side. The index i is given in the end member. */
CAF_ARR_REF_OPEN_START
} caf_array_ref_t;

/* References to remote components of a derived type. */
typedef struct caf_reference_t {
/* A pointer to the next ref or NULL. */
struct caf_reference_t *next;
/* The type of the reference. */
/* caf_ref_type_t, replaced by int to allow specification in fortran FE. */
int type;
/* The size of an item referenced in bytes. I.e. in an array ref this is
   the factor to advance the array pointer with to get to the next item.
   For component refs this gives just the size of the element referenced. */
size_t item_size;
union {
    struct {
        /* The offset (in bytes) of the component in the derived type.
           Unused for allocatable or pointer components. */
        ptrdiff_t offset;
        /* The offset (in bytes) to the caf_token associated with this
           component. NULL, when not allocatable/pointer ref. */
        ptrdiff_t caf_token_offset;
    } c;
    struct {
        /* The mode of the array ref. See CAF_ARR_REF*. */
        /* caf_array_ref_t, replaced by unsigned char to allow specification in
           fortran FE. */
        unsigned char mode[GFC_MAX_DIMENSIONS];
        /* The type of a static array. Unset for array's with descriptors. */
        int static_array_type;
        /* Subscript refs (s) or vector refs (v). */
        union {
            struct {

```

```

        /* The start and end boundary of the ref and the stride. */
        index_type start, end, stride;
    } s;
    struct {
        /* nvec entries of kind giving the elements to reference. */
        void *vector;
        /* The number of entries in vector. */
        size_t nvec;
        /* The integer kind used for the elements in vector. */
        int kind;
    } v;
    } dim[GFC_MAX_DIMENSIONS];
    } a;
    } u;
} caf_reference_t;

```

The references make up a single linked list of reference operations. The `NEXT` member links to the next reference or `NULL` to indicate the end of the chain. Component and array refs can be arbitrarily mixed as long as they comply to the Fortran standard.

Notes: The member `STATIC_ARRAY_TYPE` is used only when the `TYPE` is `CAF_REF_STATIC_ARRAY`. The member gives the type of the data referenced. Because no array descriptor is available for a descriptorless array and type conversion still needs to take place the type is transported here.

At the moment `CAF_ARR_REF_VECTOR` is not implemented in the front end for descriptorless arrays. The library `caf_single` has untested support for it.

7.1.5 `caf_team_t`

Opaque pointer to represent a team-handle. This type is a stand-in for the future implementation of teams. It is about to change without further notice.

7.2 Function ABI Documentation

7.2.1 `_gfortran_caf_init` — Initialization function

Synopsis: `void _gfortran_caf_init (int *argc, char ***argv)`

Description:

This function is called at startup of the program before the Fortran main program, if the latter has been compiled with `-fcoarray=lib`. It takes as arguments the command-line arguments of the program. It is permitted to pass two `NULL` pointers as argument; if non-`NULL`, the library is permitted to modify the arguments.

Arguments:

<code>argc</code>	intent(inout) An integer pointer with the number of arguments passed to the program or <code>NULL</code> .
<code>argv</code>	intent(inout) A pointer to an array of strings with the command-line arguments or <code>NULL</code> .

Notes: The function is modelled after the initialization function of the Message Passing Interface (MPI) specification. Due to the way coarray registration works, it might not be the first call to the library. If the main program is not written

in Fortran and only a library uses coarrays, it can happen that this function is never called. Therefore, it is recommended that the library does not rely on the passed arguments and whether the call has been done.

7.2.2 `_gfortran_caf_finish` — Finalization function

Synopsis: `void _gfortran_caf_finish (void)`

Description:

This function is called at the end of the Fortran main program, if it has been compiled with the `-fcoarray=lib` option.

Notes: For non-Fortran programs, it is recommended to call the function at the end of the main program. To ensure that the shutdown is also performed for programs where this function is not explicitly invoked, for instance non-Fortran programs or calls to the system's `exit()` function, the library can use a destructor function. Note that programs can also be terminated using the `STOP` and `ERROR STOP` statements; those use different library calls.

7.2.3 `_gfortran_caf_this_image` — Querying the image number

Synopsis: `int _gfortran_caf_this_image (caf_team_t team)`

Description:

Return the current image number in the *team*, or in the current team, if no *team* is given.

Arguments:

team intent(in), optional; The team this image's number is requested for. If null, the image number in the current team is returned.

Notes: Available since Fortran 2008 without argument; Since Fortran 2018 with optional team argument. Fortran 2008 uses 0 as argument for team, which is permissible, because a team handle is always an opaque pointer, which as a special case can be null here.

7.2.4 `_gfortran_caf_num_images` — Querying the maximal number of images

Synopsis: `int _gfortran_caf_num_images (caf_team_t team, int32_t *team_number)`

Description:

This function returns the number of images in the team given by *team* or *team_number*, if either one is present. If both are null, then the number of images in the current team is returned.

Arguments:

team intent(in), optional; The team the number of images is requested for. If null, the number of images in the current team is returned.

team_number intent(in), optional; The team id for which the number of teams is requested; if unset, then number of images in the current team is returned.

Notes: When both argument are given, then it is caf-library dependent which argument is examined first. Current implementations prioritize the *team* argument, because it is easier to retrieve the number of images from it.

Fortran 2008 or later, with no arguments; Fortran 2018 or later with two arguments.

7.2.5 `_gfortran_caf_image_status` — Query the status of an image

Synopsis: `int _gfortran_caf_image_status (int image, caf_team_t * team)`

Description:

Get the status of the image given by the id *image* of the team given by *team*. Valid results are zero, for image is ok, `STAT_STOPPED_IMAGE` from the `ISO_FORTRAN_ENV` module to indicate that the image has been stopped and `STAT_FAILED_IMAGE` also from `ISO_FORTRAN_ENV` to indicate that the image has executed a `FAIL IMAGE` statement.

Arguments:

<i>image</i>	the positive scalar id of the image in the current TEAM.
<i>team</i>	optional; team on the which the inquiry is to be performed.

Notes: This function follows TS18508. Because team-functionality is not yet implemented a null pointer is passed for the *team* argument at the moment.

7.2.6 `_gfortran_caf_failed_images` — Get an array of the indexes of the failed images

Synopsis: `int _gfortran_caf_failed_images (caf_team_t * team, int * kind)`

Description:

Get an array of image indexes in the current *team* that have failed. The array is sorted ascendingly. When *team* is not provided the current team is to be used. When *kind* is provided then the resulting array is of that integer kind else it is of default integer kind. The returns an unallocated size zero array when no images have failed.

Arguments:

<i>team</i>	optional; team on the which the inquiry is to be performed.
<i>image</i>	optional; the kind of the resulting integer array.

Notes: This function follows TS18508. Because team-functionality is not yet implemented a null pointer is passed for the *team* argument at the moment.

7.2.7 `_gfortran_caf_stopped_images` — Get an array of the indexes of the stopped images

Synopsis: `int _gfortran_caf_stopped_images (caf_team_t * team, int * kind)`

Description:

Get an array of image indexes in the current *team* that have stopped. The array is sorted ascendingly. When *team* is not provided the current team is to be used. When *kind* is provided then the resulting array is of that integer kind else it is of default integer kind. The returns an unallocated size zero array when no images have failed.

Arguments:

team optional; team on the which the inquiry is to be performed.
image optional; the kind of the resulting integer array.

Notes: This function follows TS18508. Because team-functionality is not yet implemented a null pointer is passed for the *team* argument at the moment.

7.2.8 `_gfortran_caf_register` — Registering coarrays

Synopsis: `void _gfortran_caf_register (size_t size, caf_register_t type, caf_token_t *token, gfc_descriptor_t *desc, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Registers memory for a coarray and creates a token to identify the coarray. The routine is called for both coarrays with `SAVE` attribute and using an explicit `ALLOCATE` statement. If an error occurs and *STAT* is a `NULL` pointer, the function shall abort with printing an error message and starting the error termination. If no error occurs and *STAT* is present, it shall be set to zero. Otherwise, it shall be set to a positive value and, if not-`NULL`, *ERRMSG* shall be set to a string describing the failure. The routine shall register the memory provided in the *DATA*-component of the array descriptor *DESC*, when that component is non-`NULL`, else it shall allocate sufficient memory and provide a pointer to it in the *DATA*-component of *DESC*. The array descriptor has rank zero, when a scalar object is to be registered and the array descriptor may be invalid after the call to `_gfortran_caf_register`. When an array is to be allocated the descriptor persists.

For `CAF_REGTYPE_COARRAY_STATIC` and `CAF_REGTYPE_COARRAY_ALLOC`, the passed size is the byte size requested. For `CAF_REGTYPE_LOCK_STATIC`, `CAF_REGTYPE_LOCK_ALLOC` and `CAF_REGTYPE_CRITICAL` it is the array size or one for a scalar.

When `CAF_REGTYPE_COARRAY_ALLOC_REGISTER_ONLY` is used, then only a token for an allocatable or pointer component is created. The *SIZE* parameter is not used then. On the contrary when `CAF_REGTYPE_COARRAY_ALLOC_ALLOCATE_ONLY` is specified, then the *token* needs to be registered by a previous call with regtype `CAF_REGTYPE_COARRAY_ALLOC_REGISTER_ONLY` and either the memory specified in the *DESC*'s data-ptr is registered or allocate when the data-ptr is `NULL`.

Arguments:

<i>size</i>	For normal coarrays, the byte size of the coarray to be allocated; for lock types and event types, the number of elements.
<i>type</i>	one of the <code>caf_register_t</code> types.
<i>token</i>	intent(out) An opaque pointer identifying the coarray.
<i>desc</i>	intent(inout) The (pseudo) array descriptor.
<i>stat</i>	intent(out) For allocatable coarrays, stores the <code>STAT=</code> ; may be <code>NULL</code>
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be <code>NULL</code>
<i>errmsg_len</i>	the buffer size of <code>errmsg</code> .

Notes: Nonallocatable coarrays have to be registered prior use from remote images. In order to guarantee this, they have to be registered before the main program. This can be achieved by creating constructor functions. That is what GCC does such that also for nonallocatable coarrays the memory is allocated and no static memory is used. The token permits to identify the coarray; to the processor, the token is a nonaliasing pointer. The library can, for instance, store the base address of the coarray in the token, some handle or a more complicated struct. The library may also store the array descriptor *DESC* when its rank is nonzero. For lock types, the value shall only be used for checking the allocation status. Note that for critical blocks, the locking is only required on one image; in the locking statement, the processor shall always pass an image index of one for critical-block lock variables (`CAF_REGTYPE_CRITICAL`). For lock types and critical-block variables, the initial value shall be unlocked (or, respectively, not in critical section) such as the value `false`; for event types, the initial state should be no event, e.g. zero.

7.2.9 `_gfortran_caf_deregister` — Deregistering coarrays

Synopsis: `void _gfortran_caf_deregister (caf_token_t *token, caf_deregister_t type, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Called to free or deregister the memory of a coarray; the processor calls this function for automatic and explicit deallocation. In case of an error, this function shall fail with an error message, unless the *STAT* variable is not null. The library is only expected to free memory it allocated itself during a call to `_gfortran_caf_register`.

Arguments:

<i>token</i>	the token to free.
<i>type</i>	the type of action to take for the coarray. A <code>CAF_DEREGTYPE_COARRAY_DEALLOCATE_ONLY</code> is allowed only for allocatable or pointer components of derived type coarrays. The action only deallocates the local memory without deleting the token.

<i>stat</i>	intent(out) Stores the STAT=; may be NULL
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL
<i>errmsg_len</i>	the buffer size of errmsg.

Notes: For nonallocatable coarrays this function is never called. If a cleanup is required, it has to be handled via the finish, stop and error stop functions, and via destructors.

7.2.10 `_gfortran_caf_register_accessor` — Register an accessor for remote access

Synopsis: `void _gfortran_caf_register_accessor (const int hash, void (*accessor)(void **, int32_t *, void *, void *, size_t *, size_t *))`

Description:

Identification of access functions across images is done using a unique hash. For each given hash an accessor has to be registered. This routine is expected to register an accessor function pointer for the given hash in nearly constant time. I.e. it is expected to add the hash and accessor to a buffer and return. Sorting shall be done in `_gfortran_caf_register_accessors_finish`.

Arguments:

<i>hash</i>	intent(in) The unique hash value this accessor is to be identified by.
<i>accessor</i>	intent(in) A pointer to the function on this image. The function has the signature <code>void accessor (void **dst_ptr, int32_t *free_dst, void *src_ptr, void *get_data, size_t *opt_src_charlen, size_t *opt_dst_charlen)</code> . GFortran ensures that functions provided to <code>_gfortran_caf_register_accessor</code> adhere to this interface.

Notes: This function is required to have a nearly constant runtime complexity, because it will be called to register multiple accessor in a sequence. GFortran ensures that before the first remote accesses commences `_gfortran_caf_register_accessors_finish` is called at least once. It is valid to register further accessors after a call to `_gfortran_caf_register_accessors_finish`. It is invalid to call `_gfortran_caf_register_accessor` after the first remote access has been done. See also Section 7.2.11 [`_gfortran_caf_register_accessors_finish`], page 96, and Section 7.2.12 [`_gfortran_caf_get_remote_function_index`], page 97,

7.2.11 `_gfortran_caf_register_accessors_finish` — Finish registering accessor functions

Synopsis: `void _gfortran_caf_register_accessors_finish ()`

Description:

Called to finalize registering of accessor functions. This function is expected to prepare a lookup table that has fast lookup time for the hash supplied to

`_gfortran_caf_get_remote_function_index` and constant access time for indexing operations.

Arguments:

No arguments.

Notes: This function may be called multiple times with and without new hash-accessors- pairs being added. The post-condition after each call has to be that hashes can be looked up quickly and indexing on the lookup table of hash-accessor-pairs is a constant time operation.

7.2.12 `_gfortran_caf_get_remote_function_index` — Get the index of an accessor

Synopsis: `int _gfortran_caf_get_remote_function_index (const int hash)`

Description:

Return the index of the accessor in the lookup table build by Section 7.2.10 [`_gfortran_caf_register_accessor`], page 96, and Section 7.2.11 [`_gfortran_caf_register_accessors_finish`], page 96. This function is expected to be fast, because it may be called often. A $\log(N)$ lookup time for a given hash is preferred. The reference implementation uses `bsearch()`, for example. The index returned shall be an array index to be used by Section 7.2.13 [`_gfortran_caf_get_from_remote`], page 97, i.e. a constant time operation is mandatory for quick access.

The GFortran compiler ensures that `_gfortran_caf_get_remote_function_index` is called once only for each hash and the result be stored in a static variable to prevent future redundant lookups.

Arguments:

`hash` intent(in) The hash of the accessor desired.

Result: The zero based index to access the accessor function in a lookup table. On error, -1 can be returned.

Notes: The function's complexity is expected to be significantly smaller than N , where N is the number of all accessors registered. Although returning -1 is valid, will this most likely crash the Fortran program when accessing the -1-th accessor function. It is therefore advised to terminate with an error message, when the hash could not be found.

7.2.13 `_gfortran_caf_get_from_remote` — Getting data from a remote image using a remote side accessor

Synopsis: `void _gfortran_caf_get_from_remote (caf_token_t token, const gfc_descriptor_t *opt_src_desc, const size_t *opt_src_charlen, const int image_index, const size_t dst_size, void **dst_data, size_t *opt_dst_charlen, gfc_descriptor_t *opt_dst_desc, const bool may_realloc_dst, const int getter_index, void *get_data, const size_t get_data_size, int *stat, caf_team_t *team, int *team_number)`

Description:

Called to get a scalar, an array section or a whole array from a remote image identified by the *image_index*.

Arguments:

<i>token</i>	intent(in) An opaque pointer identifying the coarray.
<i>opt_src_desc</i>	intent(in) A pointer to the descriptor when the object identified by <i>token</i> is an array with a descriptor. The parameter needs to be set to NULL, when <i>token</i> identifies a scalar.
<i>opt_src_charlen</i>	intent(in) When the object to get is a char array with deferred length, then this parameter needs to be set to point to its length. Else the parameter needs to be set to NULL.
<i>image_index</i>	intent(in) The ID of the remote image; must be a positive number. this_image () is valid.
<i>dst_size</i>	intent(in) The size of data expected to be transferred from the remote image. If the data type to get is a string or string array, then this needs to be set to the byte size of each character, i.e. 4 for a CHARACTER (KIND=4) string. The length of the string is then returned in opt_dst_charlen (also for string arrays).
<i>dst_data</i>	intent(inout) A pointer to the address the data is stored. To prevent copying of data into an output buffer the address to the live data is returned here. When a descriptor is provided also its data-member is set to that address. When <i>may_realloc_dst</i> is set, then the memory may be reallocated by the remote function, which needs to be replicated by this function.
<i>opt_dst_charlen</i>	intent(inout) When a char array is returned, this parameter is set to the length where applicable. The value can also be read to prevent reallocation in the accessor.
<i>opt_dst_desc</i>	intent(inout) When a descriptor array is returned, it is stored in the memory pointed to by this optional parameter. When <i>may_realloc_dst</i> is set, then the descriptor may be changed, i.e. its bounds, but upto now not its rank.
<i>may_realloc_dst</i>	intent(in) Set when the returned data may require reallocation of the output buffer in <i>dst_data</i> or <i>opt_dst_desc</i> .
<i>getter_index</i>	intent(in) The index of the accessor to execute as returned by _gfortran_caf_get_remote_function_index ().

<i>get_data</i>	intent(inout) Additional data needed in the accessor. I.e., when an array reference uses a local variable <i>v</i> , it is transported in this structure and all references in the accessor are rewritten to access the member. The data in the structure of <i>get_data</i> may be changed by the accessor, but these changes are lost to the calling Fortran program.
<i>get_data_size</i>	intent(in) The size of the <i>get_data</i> structure.
<i>stat</i>	intent(out) When non-NULL give the result of the operation, i.e., zero on success and non-zero on error. When NULL and an error occurs, then an error message is printed and the program is terminated.
<i>team</i>	intent(in) The opaque team handle as returned by <code>FORM TEAM</code> .
<i>team_number</i>	intent(in) The number of the team this access is to be part of.

Notes: It is permitted to have `image_index` equal the current image; the memory to get and the memory to store the data may (partially) overlap. The implementation has to take care that it handles this case, e.g. using `memmove` which handles (partially) overlapping memory.

7.2.14 `_gfortran_caf_is_present_on_remote` — Check that a coarray or a part of it is allocated on the remote image

Synopsis: `int32_t _gfortran_caf_is_present_on_remote (caf_token_t token, const int image_index, const int is_present_index, void *add_data, const size_t add_data_size)`

Description:

Check if an allocatable coarray or a component of a derived type coarray is allocated on the remote image identified by the *image_index*. The check is done by calling routine on the remote side.

Arguments:

<i>token</i>	intent(in) An opaque pointer identifying the coarray.
<i>image_index</i>	intent(in) The ID of the remote image; must be a positive number. <code>this_image ()</code> is valid.
<i>is_present_index</i>	intent(in) The index of the accessor to execute as returned by <code>_gfortran_caf_get_remote_function_index ()</code> .
<i>add_data</i>	intent(inout) Additional data needed in the accessor. I.e., when an array reference uses a local variable <i>v</i> , it is transported in this structure and all references in the accessor are rewritten to access the member. The data in the structure of <i>add_data</i> may be changed by the accessor, but these changes are lost to the calling Fortran program.
<i>add_data_size</i>	intent(in) The size of the <i>add_data</i> structure.

7.2.15 `_gfortran_caf_send_to_remote` — Send data to a remote image using a remote side accessor to store it

Synopsis: `void _gfortran_caf_send_to_remote (caf_token_t token, gfc_descriptor_t *opt_dst_desc, const size_t *opt_dst_charlen, const int image_index, const size_t src_size, const void *src_data, size_t *opt_src_charlen, const gfc_descriptor_t *opt_src_desc, const int setter_index, void *add_data, const size_t add_data_size, int *stat, caf_team_t *team, int *team_number)`

Description:

Called to send a scalar, an array section or a whole array to a remote image identified by the *image_index*. The call modifies the memory of the remote image.

Arguments:

<i>token</i>	intent(in) An opaque pointer identifying the coarray.
<i>opt_dst_desc</i>	intent(inout) A pointer to the descriptor when the object identified by <i>token</i> is an array with a descriptor. The parameter needs to be set to NULL, when <i>token</i> identifies a scalar or is an array without a descriptor.
<i>opt_dst_charlen</i>	intent(in) When the object to send is a char array with deferred length, then this parameter needs to be set to point to its length. Else the parameter needs to be set to NULL.
<i>image_index</i>	intent(in) The ID of the remote image; must be a positive number. <code>this_image ()</code> is valid.
<i>src_size</i>	intent(in) The size of data expected to be transferred to the remote image. If the data type to get is a string or string array, then this needs to be set to the byte size of each character, i.e. 4 for a CHARACTER (KIND=4) string. The length of the string is then given in <i>opt_src_charlen</i> (also for string arrays).
<i>src_data</i>	intent(in) A pointer the data to be send to the remote image. When a descriptor is provided in <i>opt_src_desc</i> then this parameter can be ignored by the library implementing the coarray functionality.
<i>opt_src_charlen</i>	intent(in) When a char array is send, this parameter is set to its length.
<i>opt_src_desc</i>	intent(in) When a descriptor array is send, then this parameter gives the handle.
<i>setter_index</i>	intent(in) The index of the accessor to execute as returned by <code>_gfortran_caf_get_remote_function_index ()</code> .

<i>add_data</i>	intent(inout) Additional data needed in the accessor. I.e., when an array reference uses a local variable <i>v</i> , it is transported in this structure and all references in the accessor are rewritten to access the member. The data in the structure of <i>add_data</i> may be changed by the accessor, but these changes are lost to the calling Fortran program.
<i>add_data_size</i>	intent(in) The size of the <i>add_data</i> structure.
<i>stat</i>	intent(out) When non-NULL give the result of the operation, i.e., zero on success and non-zero on error. When NULL and an error occurs, then an error message is printed and the program is terminated.
<i>team</i>	intent(in) The opaque team handle as returned by FORM TEAM .
<i>team_number</i>	intent(in) The number of the team this access is to be part of.

Notes: It is permitted to have *image_index* equal the current image; the memory to send the data to and the memory to read for the data may (partially) overlap. The implementation has to take care that it handles this case, e.g. using **memmove** which handles (partially) overlapping memory.

7.2.16 **_gfortran_caf_transfer_between_remotes** — Initiate data transfer between to remote images

Synopsis: `void _gfortran_caf_transfer_between_remotes (caf_token_t dst_token, gfc_descriptor_t *opt_dst_desc, size_t *opt_dst_charlen, const int dst_image_index, const int dst_access_index, void *dst_add_data, const size_t dst_add_data_size, caf_token_t src_token, const gfc_descriptor_t *opt_src_desc, const size_t *opt_src_charlen, const int src_image_index, const int src_access_index, void *src_add_data, const size_t src_add_data_size, const size_t src_size, const bool scalar_transfer, int *dst_stat, int *src_stat, caf_team_t *dst_team, int *dst_team_number, caf_team_t *src_team, int *src_team_number)`

Description:

Initiates a transfer of data from one remote image to another remote image. The call modifies the memory of the receiving remote image given by *dst_image_index*. The *src_image_index*'s memory is not modified. The call returns when the transfer has commenced.

Arguments:

<i>dst_token</i>	intent(in) An opaque pointer identifying the coarray on the receiving image.
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- opt_dst_desc* intent(inout) A pointer to the descriptor when the object identified by *dst_token* is an array with a descriptor. The parameter needs to be set to NULL, when *dst_token* identifies a scalar or is an array without a descriptor.
- opt_dst_charlen* intent(in) When the object to modify on the receiving image is a char array with deferred length, then this parameter needs to be set to point to its length. Else the parameter needs to be set to NULL.
- dst_image_index* intent(in) The ID of the receiving/destination remote image; must be a positive number. `this_image ()` is valid.
- dst_access_index* intent(in) The index of the accessor to execute on the receiving image as returned by `_gfortran_caf_get_remote_function_index ()`.
- dst_add_data* intent(inout) Additional data needed in the accessor on the receiving side. I.e., when an array reference uses a local variable *v*, it is transported in this structure and all references in the accessor are rewritten to access the member. The data in the structure of *dst_add_data* may be changed by the accessor, but these changes are lost to the calling Fortran program.
- dst_add_data_size* intent(in) The size of the *dst_add_data* structure.
- src_token* intent(in) An opaque pointer identifying the coarray on the sending image.
- opt_src_desc* intent(inout) A pointer to the descriptor when the object identified by *src_token* is an array with a descriptor. The parameter needs to be set to NULL, when *src_token* identifies a scalar or is an array without a descriptor.
- opt_src_charlen* intent(in) When the object to get from the source image is a char array with deferred length, then this parameter needs to be set to point to its length. Else the parameter needs to be set to NULL.
- src_image_index* intent(in) The ID of the sending/source remote image; must be a positive number. `this_image ()` is valid.
- src_access_index* intent(in) The index of the accessor to execute on the sending image as returned by `_gfortran_caf_get_remote_function_index ()`.

<i>src_add_data</i>	intent(inout) Additional data needed in the accessor on the sending side. I.e., when an array reference uses a local variable <i>v</i> , it is transported in this structure and all references in the accessor are rewritten to access the member. The data in the structure of <i>src_add_data</i> may be changed by the accessor, but these changes are lost to the calling Fortran program.
<i>src_add_data_size</i>	intent(in) The size of the <i>src_add_data</i> structure.
<i>src_size</i>	intent(in) The size of data expected to be transferred between the images. If the data type to get is a string or string array, then this needs to be set to the byte size of each character, i.e. 4 for a CHARACTER (KIND=4) string. The length of the string is then given in <i>opt_src_charlen</i> and <i>opt_dst_charlen</i> (also for string arrays).
<i>scalar_transfer</i>	intent(in) Is set to true when the data to be transferred between the two images is not an array with a descriptor.
<i>dst_stat</i>	intent(out) When non-NULL give the result of the operation on the receiving side, i.e., zero on success and non-zero on error. When NULL and an error occurs, then an error message is printed and the program is terminated.
<i>src_stat</i>	intent(out) When non-NULL give the result of the operation on the sending side, i.e., zero on success and non-zero on error. When NULL and an error occurs, then an error message is printed and the program is terminated.
<i>dst_team</i>	intent(in) The opaque team handle as returned by FORM TEAM.
<i>dst_team_number</i>	intent(in) The number of the team this access is to be part of.
<i>src_team</i>	intent(in) The opaque team handle as returned by FORM TEAM.
<i>src_team_number</i>	intent(in) The number of the team this access is to be part of.

Notes: It is permitted to have both *dst_image_index* and *src_image_index* equal the current image; the memory to send the data to and the memory to read for the data may (partially) overlap. The implementation has to take care that it handles this case, e.g. using *memmove* which handles (partially) overlapping memory.

7.2.17 `_gfortran_caf_sendget_by_ref` — Sending data between remote images using enhanced references on both sides

Synopsis: `void _gfortran_caf_sendget_by_ref (caf_token_t dst_token, int dst_image_index, caf_reference_t *dst_refs, caf_token_t src_token, int src_image_index, caf_reference_t *src_refs, int dst_kind, int src_kind, bool may_require_tmp, int *dst_stat, int *src_stat, int dst_type, int src_type)`

Description:

Called to send a scalar, an array section or a whole array from a remote image identified by the `src_image_index` to a remote image identified by the `dst_image_index`.

Arguments:

<code>dst_token</code>	intent(in) An opaque pointer identifying the destination coarray.
<code>dst_image_index</code>	intent(in) The ID of the destination remote image; must be a positive number.
<code>dst_refs</code>	intent(in) The references on the remote array to store the data given by the source. Guaranteed to have at least one entry.
<code>src_token</code>	intent(in) An opaque pointer identifying the source coarray.
<code>src_image_index</code>	intent(in) The ID of the source remote image; must be a positive number.
<code>src_refs</code>	intent(in) The references to apply to the remote structure to get the data.
<code>dst_kind</code>	intent(in) Kind of the destination argument
<code>src_kind</code>	intent(in) Kind of the source argument
<code>may_require_tmp</code>	intent(in) The variable is false when it is known at compile time that the <code>dest</code> and <code>src</code> either cannot overlap or overlap (fully or partially) such that walking <code>src</code> and <code>dest</code> in elementwise order (honoring the stride value) does not lead to wrong results. Otherwise, the value is true .
<code>dst_stat</code>	intent(out) when non-NULL give the result of the send-operation, i.e., zero on success and nonzero on error. When NULL and an error occurs, then an error message is printed and the program is terminated.
<code>src_stat</code>	intent(out) When non-NULL give the result of the get-operation, i.e., zero on success and nonzero on error. When NULL and an error occurs, then an error message is printed and the program is terminated.
<code>dst_type</code>	intent(in) Give the type of the destination. When the destination is not an array, than the precise type, e.g. of a component in a derived type, is not known, but provided here.

src_type intent(in) Give the type of the source. When the source is not an array, than the precise type, e.g. of a component in a derived type, is not known, but provided here.

Notes: It is permitted to have the same image index for both *src_image_index* and *dst_image_index*; the memory of the send-to and the send-from might (partially) overlap in that case. The implementation has to take care that it handles this case, e.g. using `memmove` which handles (partially) overlapping memory. If *may_require_tmp* is true, the library might additionally create a temporary variable, unless additional checks show that this is not required (e.g. because walking backward is possible or because both arrays are contiguous and `memmove` takes care of overlap issues).

Note that the assignment of a scalar to an array is permitted. In addition, the library has to handle numeric-type conversion and for strings, padding and different character kinds.

Because of the more complicated references possible some operations may be unsupported by certain libraries. The library is expected to issue a precise error message why the operation is not permitted.

7.2.18 `_gfortran_caf_lock` — Locking a lock variable

Synopsis: `void _gfortran_caf_lock (caf_token_t token, size_t index, int image_index, int *acquired_lock, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Acquire a lock on the given image on a scalar locking variable or for the given array element for an array-valued variable. If the *acquired_lock* is NULL, the function returns after having obtained the lock. If it is non-NULL, then *acquired_lock* is assigned the value true (one) when the lock could be obtained and false (zero) otherwise. Locking a lock variable that has already been locked by the same image is an error.

Arguments:

token intent(in) An opaque pointer identifying the coarray.
index intent(in) Array index; first array index is 0. For scalars, it is always 0.
image_index intent(in) The ID of the remote image; must be a positive number.
acquired_lock intent(out) If not NULL, it returns whether lock could be obtained.
stat intent(out) Stores the STAT=; may be NULL.
errmsg intent(out) When an error occurs, this is set to an error message; may be NULL.
errmsg_len intent(in) the buffer size of errmsg

Notes: This function is also called for critical blocks; for those, the array index is always zero and the image index is one. Libraries are permitted to use other images for critical-block locking variables.

7.2.19 `_gfortran_caf_lock` — Unlocking a lock variable

Synopsis: `void _gfortran_caf_unlock (caf_token_t token, size_t index, int image_index, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Release a lock on the given image on a scalar locking variable or for the given array element for an array-valued variable. Unlocking a lock variable that is unlocked or has been locked by a different image is an error.

Arguments:

<i>token</i>	intent(in) An opaque pointer identifying the coarray.
<i>index</i>	intent(in) Array index; first array index is 0. For scalars, it is always 0.
<i>image_index</i>	intent(in) The ID of the remote image; must be a positive number.
<i>stat</i>	intent(out) For allocatable coarrays, stores the STAT=; may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>errmsg_len</i>	intent(in) the buffer size of errmsg

Notes: This function is also called for critical block; for those, the array index is always zero and the image index is one. Libraries are permitted to use other images for critical-block locking variables.

7.2.20 `_gfortran_caf_event_post` — Post an event

Synopsis: `void _gfortran_caf_event_post (caf_token_t token, size_t index, int image_index, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Increment the event count of the specified event variable.

Arguments:

<i>token</i>	intent(in) An opaque pointer identifying the coarray.
<i>index</i>	intent(in) Array index; first array index is 0. For scalars, it is always 0.
<i>image_index</i>	intent(in) The ID of the remote image; must be a positive number; zero indicates the current image, when accessed noncoindexed.
<i>stat</i>	intent(out) Stores the STAT=; may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>errmsg_len</i>	intent(in) the buffer size of errmsg

Notes: This acts like an atomic add of one to the remote image's event variable. The statement is an image-control statement but does not imply sync memory. Still, all preceding push communications of this image to the specified remote image have to be completed before `event_wait` on the remote image returns.

7.2.21 `_gfortran_caf_event_wait` — Wait that an event occurred

Synopsis: `void _gfortran_caf_event_wait (caf_token_t token, size_t index, int until_count, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Wait until the event count has reached at least the specified *until_count*; if so, atomically decrement the event variable by this amount and return.

Arguments:

<i>token</i>	intent(in) An opaque pointer identifying the coarray.
<i>index</i>	intent(in) Array index; first array index is 0. For scalars, it is always 0.
<i>until_count</i>	intent(in) The number of events that have to be available before the function returns.
<i>stat</i>	intent(out) Stores the STAT=; may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>errmsg_len</i>	intent(in) the buffer size of errmsg

Notes: This function only operates on a local coarray. It acts like a loop checking atomically the value of the event variable, breaking if the value is greater or equal the requested number of counts. Before the function returns, the event variable has to be decremented by the requested *until_count* value. A possible implementation would be a busy loop for a certain number of spins (possibly depending on the number of threads relative to the number of available cores) followed by another waiting strategy such as a sleeping wait (possibly with an increasing number of sleep time) or, if possible, a `futex` wait.

The statement is an image-control statement but does not imply sync memory. Still, all preceding push communications of this image to the specified remote image have to be completed before `event_wait` on the remote image returns.

7.2.22 `_gfortran_caf_event_query` — Query event count

Synopsis: `void _gfortran_caf_event_query (caf_token_t token, size_t index, int image_index, int *count, int *stat)`

Description:

Return the event count of the specified event variable.

Arguments:

<i>token</i>	intent(in) An opaque pointer identifying the coarray.
<i>index</i>	intent(in) Array index; first array index is 0. For scalars, it is always 0.
<i>image_index</i>	intent(in) The ID of the remote image; must be a positive number; zero indicates the current image when accessed noncoindexed.
<i>count</i>	intent(out) The number of events currently posted to the event variable.
<i>stat</i>	intent(out) Stores the STAT=; may be NULL.

Notes: The typical use is to check the local event variable to only call `event_wait` when the data is available. However, a coindexed variable is permitted; there is no ordering or synchronization implied. It acts like an atomic fetch of the value of the event variable.

7.2.23 `_gfortran_caf_sync_all` — All-image barrier

Synopsis: `void _gfortran_caf_sync_all (int *stat, char *errmsg, size_t errmsg_len)`

Description:

Synchronization of all images in the current team; the program only continues on a given image after this function has been called on all images of the current team. Additionally, it ensures that all pending data transfers of previous segment have completed.

Arguments:

<i>stat</i>	intent(out) Stores the status <code>STAT=</code> and may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>errmsg_len</i>	intent(in) the buffer size of <i>errmsg</i>

7.2.24 `_gfortran_caf_sync_images` — Barrier for selected images

Synopsis: `void _gfortran_caf_sync_images (int count, int images[], int *stat, char *errmsg, size_t errmsg_len)`

Description:

Synchronization between the specified images; the program only continues on a given image after this function has been called on all images specified for that image. Note that one image can wait for all other images in the current team (e.g. via `sync images(*)`) while those only wait for that specific image. Additionally, `sync images` ensures that all pending data transfers of previous segments have completed.

Arguments:

<i>count</i>	intent(in) The number of images that are provided in the next argument. For a zero-sized array, the value is zero. For <code>sync images (*)</code> , the value is <code>-1</code> .
<i>images</i>	intent(in) An array with the images provided by the user. If <i>count</i> is zero, a NULL pointer is passed.
<i>stat</i>	intent(out) Stores the status <code>STAT=</code> and may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>errmsg_len</i>	intent(in) the buffer size of <i>errmsg</i>

7.2.25 `_gfortran_caf_sync_memory` — Wait for completion of segment-memory operations

Synopsis: `void _gfortran_caf_sync_memory (int *stat, char *errmsg, size_t errmsg_len)`

Description:

Acts as optimization barrier between different segments. It also ensures that all pending memory operations of this image have been completed.

Arguments:

`stat` intent(out) Stores the status `STAT=` and may be NULL.
`errmsg` intent(out) When an error occurs, this is set to an error message; may be NULL.
`errmsg_len` intent(in) the buffer size of `errmsg`

Notes: A simple implementation could be `__asm__ __volatile__ (""::"memory")` to prevent code movements.

7.2.26 `_gfortran_caf_error_stop` — Error termination with exit code

Synopsis: `void _gfortran_caf_error_stop (int error)`

Description:

Invoked for an `ERROR STOP` statement that has an integer argument. The function should terminate the program with the specified exit code.

Arguments:

`error` intent(in) The exit status to be used.

7.2.27 `_gfortran_caf_error_stop_str` — Error termination with string

Synopsis: `void _gfortran_caf_error_stop (const char *string, size_t len)`

Description:

Invoked for an `ERROR STOP` statement that has a string as argument. The function should terminate the program with a nonzero-exit code.

Arguments:

`string` intent(in) the error message (not zero terminated)
`len` intent(in) the length of the string

7.2.28 `_gfortran_caf_fail_image` — Mark the image failed and end its execution

Synopsis: `void _gfortran_caf_fail_image ()`

Description:

Invoked for an `FAIL IMAGE` statement. The function should terminate the current image.

Notes: This function follows TS18508.

7.2.29 `_gfortran_caf_atomic_define` — Atomic variable assignment

Synopsis: `void _gfortran_caf_atomic_define (caf_token_t token, size_t offset, int image_index, void *value, int *stat, int type, int kind)`

Description:

Assign atomically a value to an integer or logical variable.

Arguments:

<code>token</code>	intent(in) An opaque pointer identifying the coarray.
<code>offset</code>	intent(in) The number of bytes the actual data is shifted compared to the base address of the coarray.
<code>image_index</code>	intent(in) The ID of the remote image; must be a positive number; zero indicates the current image when used noncoindexed.
<code>value</code>	intent(in) the value to be assigned, passed by reference
<code>stat</code>	intent(out) Stores the status <code>STAT=</code> and may be <code>NULL</code> .
<code>type</code>	intent(in) The data type, i.e. <code>BT_INTEGER</code> (1) or <code>BT_LOGICAL</code> (2).
<code>kind</code>	intent(in) The kind value (only 4; always <code>int</code>)

7.2.30 `_gfortran_caf_atomic_ref` — Atomic variable reference

Synopsis: `void _gfortran_caf_atomic_ref (caf_token_t token, size_t offset, int image_index, void *value, int *stat, int type, int kind)`

Description:

Reference atomically a value of a kind-4 integer or logical variable.

Arguments:

<code>token</code>	intent(in) An opaque pointer identifying the coarray.
<code>offset</code>	intent(in) The number of bytes the actual data is shifted compared to the base address of the coarray.
<code>image_index</code>	intent(in) The ID of the remote image; must be a positive number; zero indicates the current image when used noncoindexed.
<code>value</code>	intent(out) The variable assigned the atomically referenced variable.
<code>stat</code>	intent(out) Stores the status <code>STAT=</code> and may be <code>NULL</code> .
<code>type</code>	the data type, i.e. <code>BT_INTEGER</code> (1) or <code>BT_LOGICAL</code> (2).
<code>kind</code>	The kind value (only 4; always <code>int</code>)

7.2.31 `_gfortran_caf_atomic_cas` — Atomic compare and swap

Synopsis: `void _gfortran_caf_atomic_cas (caf_token_t token, size_t offset, int image_index, void *old, void *compare, void *new_val, int *stat, int type, int kind)`

Description:

Atomic compare and swap of a kind-4 integer or logical variable. Assigns atomically the specified value to the atomic variable, if the latter has the value specified by the passed condition value.

Arguments:

<i>token</i>	intent(in) An opaque pointer identifying the coarray.
<i>offset</i>	intent(in) The number of bytes the actual data is shifted compared to the base address of the coarray.
<i>image_index</i>	intent(in) The ID of the remote image; must be a positive number; zero indicates the current image when used noncoindexed.
<i>old</i>	intent(out) The value the atomic variable had just before the cas operation.
<i>compare</i>	intent(in) The value used for comparison.
<i>new_val</i>	intent(in) The new value for the atomic variable, assigned to the atomic variable, if compare equals the value of the atomic variable.
<i>stat</i>	intent(out) Stores the status STAT= and may be NULL.
<i>type</i>	intent(in) the data type, i.e. BT_INTEGER (1) or BT_LOGICAL (2).
<i>kind</i>	intent(in) The kind value (only 4; always int)

7.2.32 _gfortran_caf_atomic_op — Atomic operation

Synopsis: `void _gfortran_caf_atomic_op (int op, caf_token_t token, size_t offset, int image_index, void *value, void *old, int *stat, int type, int kind)`

Description:

Apply an operation atomically to an atomic integer or logical variable. After the operation, *old* contains the value just before the operation, which, respectively, adds (GFC_CAF_ATOMIC_ADD) atomically the **value** to the atomic integer variable or does a bitwise AND, OR or exclusive OR between the atomic variable and **value**; the result is then stored in the atomic variable.

Arguments:

<i>op</i>	intent(in) the operation to be performed; possible values GFC_CAF_ATOMIC_ADD (1), GFC_CAF_ATOMIC_AND (2), GFC_CAF_ATOMIC_OR (3), GFC_CAF_ATOMIC_XOR (4).
<i>token</i>	intent(in) An opaque pointer identifying the coarray.
<i>offset</i>	intent(in) The number of bytes the actual data is shifted compared to the base address of the coarray.
<i>image_index</i>	intent(in) The ID of the remote image; must be a positive number; zero indicates the current image when used noncoindexed.

<i>old</i>	intent(out) The value the atomic variable had just before the atomic operation.
<i>val</i>	intent(in) The new value for the atomic variable, assigned to the atomic variable, if <code>compare</code> equals the value of the atomic variable.
<i>stat</i>	intent(out) Stores the status <code>STAT=</code> and may be NULL.
<i>type</i>	intent(in) the data type, i.e. <code>BT_INTEGER</code> (1) or <code>BT_LOGICAL</code> (2)
<i>kind</i>	intent(in) the kind value (only 4; always <code>int</code>)

7.2.33 `_gfortran_caf_co_broadcast` — Sending data to all images

Synopsis: `void _gfortran_caf_co_broadcast (gfc_descriptor_t *a, int source_image, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Distribute a value from a given image to all other images in the team. Has to be called collectively.

Arguments:

<i>a</i>	intent(inout) An array descriptor with the data to be broadcasted (on <i>source_image</i>) or to be received (other images).
<i>source_image</i>	intent(in) The ID of the image from which the data should be broadcasted.
<i>stat</i>	intent(out) Stores the status <code>STAT=</code> and may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>errmsg_len</i>	intent(in) the buffer size of <i>errmsg</i> .

7.2.34 `_gfortran_caf_co_max` — Collective maximum reduction

Synopsis: `void _gfortran_caf_co_max (gfc_descriptor_t *a, int result_image, int *stat, char *errmsg, int a_len, size_t errmsg_len)`

Description:

Calculates for each array element of the variable *a* the maximum value for that element in the current team; if *result_image* has the value 0, the result shall be stored on all images, otherwise, only on the specified image. This function operates on numeric values and character strings.

Arguments:

<i>a</i>	intent(inout) An array descriptor for the data to be processed. On the destination image(s) the result overwrites the old content.
<i>result_image</i>	intent(in) The ID of the image to which the reduced value should be copied to; if zero, it has to be copied to all images.

<i>stat</i>	intent(out) Stores the status STAT= and may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>a_len</i>	intent(in) the string length of argument <i>a</i>
<i>errmsg_len</i>	intent(in) the buffer size of <i>errmsg</i>

Notes: If *result_image* is nonzero, the data in the array descriptor *a* on all images except of the specified one become undefined; hence, the library may make use of this.

7.2.35 `_gfortran_caf_co_min` — Collective minimum reduction

Synopsis: `void _gfortran_caf_co_min (gfc_descriptor_t *a, int result_image, int *stat, char *errmsg, int a_len, size_t errmsg_len)`

Description:

Calculates for each array element of the variable *a* the minimum value for that element in the current team; if *result_image* has the value 0, the result shall be stored on all images, otherwise, only on the specified image. This function operates on numeric values and character strings.

Arguments:

<i>a</i>	intent(inout) An array descriptor for the data to be processed. On the destination image(s) the result overwrites the old content.
<i>result_image</i>	intent(in) The ID of the image to which the reduced value should be copied to; if zero, it has to be copied to all images.
<i>stat</i>	intent(out) Stores the status STAT= and may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>a_len</i>	intent(in) the string length of argument <i>a</i>
<i>errmsg_len</i>	intent(in) the buffer size of <i>errmsg</i>

Notes: If *result_image* is nonzero, the data in the array descriptor *a* on all images except of the specified one become undefined; hence, the library may make use of this.

7.2.36 `_gfortran_caf_co_sum` — Collective summing reduction

Synopsis: `void _gfortran_caf_co_sum (gfc_descriptor_t *a, int result_image, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Calculates for each array element of the variable *a* the sum of all values for that element in the current team; if *result_image* has the value 0, the result shall be stored on all images, otherwise, only on the specified image. This function operates on numeric values only.

Arguments:

<i>a</i>	intent(inout) An array descriptor with the data to be processed. On the destination image(s) the result overwrites the old content.
<i>result_image</i>	intent(in) The ID of the image to which the reduced value should be copied to; if zero, it has to be copied to all images.
<i>stat</i>	intent(out) Stores the status <code>STAT=</code> and may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>errmsg_len</i>	intent(in) the buffer size of <i>errmsg</i>

Notes: If *result_image* is nonzero, the data in the array descriptor *a* on all images except of the specified one become undefined; hence, the library may make use of this.

7.2.37 `_gfortran_caf_co_reduce` — Generic collective reduction

Synopsis: `void _gfortran_caf_co_reduce (gfc_descriptor_t *a, void * (*opr) (void *, void *), int opr_flags, int result_image, int *stat, char *errmsg, int a_len, size_t errmsg_len)`

Description:

Calculates for each array element of the variable *a* the reduction value for that element in the current team; if *result_image* has the value 0, the result shall be stored on all images, otherwise, only on the specified image. The *opr* is a pure function doing a mathematically commutative and associative operation.

The *opr_flags* denote the following; the values are bitwise ored. `GFC_CAF_BYREF` (1) if the result should be returned by reference; `GFC_CAF_HIDDENLEN` (2) whether the result and argument string lengths shall be specified as hidden arguments; `GFC_CAF_ARG_VALUE` (4) whether the arguments shall be passed by value, `GFC_CAF_ARG_DESC` (8) whether the arguments shall be passed by descriptor.

Arguments:

<i>a</i>	intent(inout) An array descriptor with the data to be processed. On the destination image(s) the result overwrites the old content.
<i>opr</i>	intent(in) Function pointer to the reduction function
<i>opr_flags</i>	intent(in) Flags regarding the reduction function
<i>result_image</i>	intent(in) The ID of the image to which the reduced value should be copied to; if zero, it has to be copied to all images.
<i>stat</i>	intent(out) Stores the status <code>STAT=</code> and may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.

a_len intent(in) the string length of argument *a*
errmsg_len intent(in) the buffer size of *errmsg*

Notes: If *result_image* is nonzero, the data in the array descriptor *a* on all images except of the specified one become undefined; hence, the library may make use of this.

For character arguments, the result is passed as first argument, followed by the result string length, next come the two string arguments, followed by the two hidden string length arguments. With C binding, there are no hidden arguments and by-reference passing and either only a single character is passed or an array descriptor.

7.2.38 `_gfortran_caf_form_team` — Team creation function

Synopsis: `void _gfortran_caf_form_team (int team_id, caf_team_t *team, int
 new_index, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Create a team. All images giving the same *team_id* in a call to `FORM TEAM` will form a new team addressable by the opaque handle *team* which is of type `team_type` from the intrinsic module Section 9.1 [ISO_FORTRAN_ENV], page 311. In the team the image gets the image index given by *new_index* if present. If *new_index* is absent, then an implementation specific index is assigned.

Arguments:

team_id intent(in) A unique id for each team to form. Images giving the same *team_id* in a call to `FORM TEAM` belong to the same team.
team intent(out) The opaque pointer to the newly formed team
new_index intent(in) If non-null gives the unique index of this image in the newly formed team. When no *new_index* is given, the caf-library is free to choose a unique index.
stat intent(out) Stores the status `STAT=` and may be `NULL`.
errmsg intent(out) When an error occurs, this is set to an error message; may be `NULL`.
errmsg_len intent(in) the buffer size of *errmsg*

Notes: The id given in *team_id* has to be unique in all subsequent calls to `FORM TEAM` on the same image. That id is the same used in `TEAM_NUMBER=` of coarray indexes, which motivates the uniqueness.

The index given in *new_index* needs to be unique among all members of team to create. Failing uniqueness may lead to misbehaviour, which depends on the caf-library's implementation. The library is free to implement checks for this, which imposes overhead and therefore may be avoided.

7.2.39 `_gfortran_caf_change_team` — Team activation function

Synopsis: `void _gfortran_caf_change_team (caf_team_t team, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Activates the team given by *team*, which must be formed but not active yet. This routine starts a new epoch on the coarray memory pool. All coarrays registered from now on, will be freed once the team is terminated.

Arguments:

<i>team</i>	intent(inout) The opaque pointer to an already formed team
<i>stat</i>	intent(out) Stores the status <code>STAT=</code> and may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>errmsg_len</i>	intent(in) the buffer size of <i>errmsg</i>

Notes: When an error occurs and *stat* is non-null, it will be set. Nevertheless will the Fortran program continue with the first statement in the change team block.

7.2.40 `_gfortran_caf_end_team` — Team termination function

Synopsis: `void _gfortran_caf_end_team (int *stat, char *errmsg, size_t errmsg_len)`

Description:

Terminates the last team changed to. The coarray memory epoch is terminated and all coarrays allocated since the execution of `CHANGE TEAM` are freed.

Arguments:

<i>stat</i>	intent(out) Stores the status <code>STAT=</code> and may be NULL.
<i>errmsg</i>	intent(out) When an error occurs, this is set to an error message; may be NULL.
<i>errmsg_len</i>	intent(in) the buffer size of <i>errmsg</i>

7.2.41 `_gfortran_caf_sync_team` — Synchronize all images of a given team

Synopsis: `void _gfortran_caf_sync_team (caf_team_t team, int *stat, char *errmsg, size_t errmsg_len)`

Description:

Blocks execution of the image calling `SYNC TEAM` until all images of the team given by *team* have joined the synchronisation call.

Arguments:

<i>team</i>	intent(in) The opaque pointer to an active team
<i>stat</i>	intent(out) Stores the status <code>STAT=</code> and may be NULL.

errmsg intent(out) When an error occurs, this is set to an error message; may be NULL.
errmsg_len intent(in) the buffer size of *errmsg*

7.2.42 `_gfortran_caf_get_team` — Get the opaque handle of the specified team

Synopsis: `caf_team_t _gfortran_caf_get_team (int32_t *level)`

Description:

Get the current team, when *level* is null, or the team specified by *level* set to `INITIAL_TEAM`, `PARENT_TEAM` or `CURRENT_TEAM` from the `ISO_FORTRAN_ENV` intrinsic module. When being on the `INITIAL_TEAM` and requesting its `PARENT_TEAM`, then the initial team is returned.

Arguments:

level intent(in) If set to one of the levels specified in the `ISO_FORTRAN_ENV` module, the function returns the handle of the given team. Values different from the allowed ones lead to a runtime error.

7.2.43 `_gfortran_caf_team_number` — Get the unique id of the given team

Synopsis: `int _gfortran_caf_team_number (caf_team_t team)`

Description:

The team id given when forming the team Section 7.2.38 [`_gfortran_caf_form_team`], page 115, of the team specified by *team*, if given, or of the current team, if *team* is absent. It is a runtime error to specify a non-existing team. The team has to be formed, i.e., it is not necessary that it is changed into to get the team number. The initial team has the team number -1.

Arguments:

team intent(in) The team for which the team id is desired.

8 Intrinsic Procedures

8.1 Introduction to intrinsic procedures

The intrinsic procedures provided by GNU Fortran include procedures required by the Fortran 95 and later supported standards, and a set of intrinsic procedures for backwards compatibility with G77. Any conflict between a description here and a description in the Fortran standards is unintentional, and the standard(s) should be considered authoritative.

The enumeration of the `KIND` type parameter is processor defined in the Fortran 95 standard. GNU Fortran defines the default integer type and default real type by `INTEGER(KIND=4)` and `REAL(KIND=4)`, respectively. The standard mandates that both data types shall have another kind that has more precision. On typical target architectures supported by `gfortran`, this kind type parameter is `KIND=8`. Hence, `REAL(KIND=8)` and `DOUBLE PRECISION` are equivalent. In the description of generic intrinsic procedures, the kind type parameter is specified by `KIND=*`, and in the description of specific names for an intrinsic procedure the kind type parameter is explicitly given (e.g., `REAL(KIND=4)` or `REAL(KIND=8)`). Finally, for brevity the optional `KIND=` syntax is omitted.

Many of the intrinsic procedures take one or more optional arguments. This document follows the convention used in the Fortran 95 standard, and denotes such arguments by square brackets.

GNU Fortran offers the `-std=` command-line option, which can be used to restrict the set of intrinsic procedures to a given standard. By default, `gfortran` sets the `-std=gnu` option, and so all intrinsic procedures described here are accepted. There is one caveat. For a select group of intrinsic procedures, `g77` implemented both a function and a subroutine. Both classes have been implemented in `gfortran` for backwards compatibility with `g77`. It is noted here that these functions and subroutines cannot be intermixed in a given subprogram. In the descriptions that follow, the applicable standard for each intrinsic procedure is noted.

8.2 ABORT — Abort the program

Synopsis: `CALL ABORT`

Description:

`ABORT` causes immediate termination of the program. On operating systems that support a core dump, `ABORT` produces a core dump. It also prints a backtrace, unless `-fno-backtrace` is given.

Class: Subroutine

Return value:

Does not return.

Example:

```
program test_abort
  integer :: i = 1, j = 2
  if (i /= j) call abort
end program test_abort
```

Standard: GNU extension

See also: Section 8.106 [EXIT], page 191,
 Section 8.169 [KILL], page 231,
 Section 8.43 [BACKTRACE], page 148,

8.3 ABS — Absolute value

Synopsis: RESULT = ABS(A)

Description:

ABS(A) computes the absolute value of A.

Class: Elemental function

Arguments:

A The type of the argument shall be an INTEGER, REAL,
 or COMPLEX.

Return value:

The return value is of the same type and kind as the argument except the return value is REAL for a COMPLEX argument.

Example:

```
program test_abs
  integer :: i = -1
  real :: x = -1.e0
  complex :: z = (-1.e0,0.e0)
  i = abs(i)
  x = abs(x)
  z = abs(z)
end program test_abs
```

Specific names:

Name	Argument	Return type	Standard
ABS(A)	REAL(4) A	REAL(4)	Fortran 77 and later
CABS(A)	COMPLEX(4) A	REAL(4)	Fortran 77 and later
DABS(A)	REAL(8) A	REAL(8)	Fortran 77 and later
IABS(A)	INTEGER(4) A	INTEGER(4)	Fortran 77 and later
BABS(A)	INTEGER(1) A	INTEGER(1)	GNU extension
IIABS(A)	INTEGER(2) A	INTEGER(2)	GNU extension
JIABS(A)	INTEGER(4) A	INTEGER(4)	GNU extension
KIABS(A)	INTEGER(8) A	INTEGER(8)	GNU extension
ZABS(A)	COMPLEX(8) A	REAL(8)	GNU extension
CDABS(A)	COMPLEX(8) A	REAL(8)	GNU extension

Standard: Fortran 77 and later, has overloads that are GNU extensions

8.4 ACCESS — Checks file access modes

Synopsis: RESULT = ACCESS(NAME, MODE)

Description:

ACCESS(NAME, MODE) checks whether the file NAME exists, is readable, writable or executable. Except for the executable check, ACCESS can be replaced by Fortran 95's INQUIRE.

Class: Inquiry function

Arguments:

<i>NAME</i>	Scalar CHARACTER of default kind with the file name. Trailing blank are ignored unless the character achar(0) is present, then all characters up to and excluding achar(0) are used as file name.
<i>MODE</i>	Scalar CHARACTER of default kind with the file access mode, may be any concatenation of "r" (readable), "w" (writable) and "x" (executable), or " " to check for existence.

Return value:

Returns a scalar **INTEGER**, which is 0 if the file is accessible in the given mode; otherwise or if an invalid argument has been given for **MODE** the value 1 is returned.

Example:

```

program access_test
  implicit none
  character(len=*), parameter :: file = 'test.dat'
  character(len=*), parameter :: file2 = 'test.dat '//achar(0)
  if(access(file,' ') == 0) print *, trim(file),' is exists'
  if(access(file,'r') == 0) print *, trim(file),' is readable'
  if(access(file,'w') == 0) print *, trim(file),' is writable'
  if(access(file,'x') == 0) print *, trim(file),' is executable'
  if(access(file2,'rwx') == 0) &
    print *, trim(file2),' is readable, writable and executable'
end program access_test

```

Standard: GNU extension

8.5 ACHAR — Character in ASCII collating sequence

Synopsis: **RESULT = ACHAR(I [, KIND])**

Description:

ACHAR(I) returns the character located at position **I** in the ASCII collating sequence.

Class: Elemental function

Arguments:

<i>I</i>	The type shall be INTEGER .
<i>KIND</i>	(Optional) A scalar INTEGER constant expression indicating the kind parameter of the result.

Return value:

The return value is of type **CHARACTER** with a length of one. If the *KIND* argument is present, the return value is of the specified kind and of the default kind otherwise.

Example:

```

program test_achar

```

```

character c
c = achar(32)
end program test_achar

```

Notes: See Section 8.149 [ICHAR], page 219, for a discussion of converting between numerical values and formatted string representations.

Standard: Fortran 77 and later, with *KIND* argument Fortran 2003 and later

See also: Section 8.63 [CHAR], page 160,
 Section 8.141 [IACHAR], page 213,
 Section 8.149 [ICHAR], page 219,

8.6 ACOS — Arccosine function

Synopsis: RESULT = ACOS(X)

Description:

ACOS(X) computes the arccosine of X (inverse of COS(X)).

Class: Elemental function

Arguments:

X The type shall either be REAL with a magnitude that is less than or equal to one - or the type shall be COMPLEX.

Return value:

The return value is of the same type and kind as X . The real part of the result is in radians and lies in the range $0 \leq \Re \operatorname{acos}(x) \leq \pi$.

Example:

```

program test_acos
  real(8) :: x = 0.866_8
  x = acos(x)
end program test_acos

```

Specific names:

Name	Argument	Return type	Standard
ACOS(X)	REAL(4) X	REAL(4)	Fortran 77 and later
DACOS(X)	REAL(8) X	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later, for a complex argument Fortran 2008 or later

See also: Inverse function:
 Section 8.77 [COS], page 171,
 Degrees function:
 Section 8.7 [ACOSD], page 122,

8.7 ACOSD — Arccosine function, degrees

Synopsis: RESULT = ACOSD(X)

Description:

ACOSD(X) computes the arccosine of X in degrees (inverse of COSD(X)).

Class: Elemental function

Arguments:

X The type shall either be **REAL** with a magnitude that is less than or equal to one.

Return value:

The return value is of the same type and kind as *X*. The real part of the result is in degrees and lies in the range $0 \leq \Re \operatorname{acos}(x) \leq 180$.

Example:

```
program test_acosd
  real(8) :: x = 0.866_8
  x = acosd(x)
end program test_acosd
```

Specific names:

Name	Argument	Return type	Standard
ACOSD(X)	REAL(4) X	REAL(4)	Fortran 2023
DACOSD(X)	REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2023

See also: Inverse function:
Section 8.78 [COSD], page 171,
Radians function:
Section 8.6 [ACOS], page 122,

8.8 ACOSH — Inverse hyperbolic cosine function

Synopsis: **RESULT = ACOSH(X)**

Description:

ACOSH(X) computes the inverse hyperbolic cosine of X.

Class: Elemental function

Arguments:

X The type shall be **REAL** or **COMPLEX**.

Return value:

The return value has the same type and kind as *X*. If *X* is complex, the imaginary part of the result is in radians and lies between $0 \leq \Im \operatorname{acosh}(x) \leq \pi$.

Example:

```
PROGRAM test_acosh
  REAL(8), DIMENSION(3) :: x = (/ 1.0, 2.0, 3.0 /)
  WRITE (*,*) ACOSH(x)
END PROGRAM
```

Specific names:

Name	Argument	Return type	Standard
DACOSH(X)	REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2008 and later

See also: Inverse function:
Section 8.79 [COSH], page 172,

8.9 ACOSPI — Circular arc cosine function

Description:

ACOSPI(X) computes $\text{acos}(x)/\pi$, which is a measure of an angle in half-revolutions.

Standard: Fortran 2023

Class: Elemental function

Syntax: RESULT = ACOSPI(X)

Arguments:

X The type shall be REAL with $-1 \leq x \leq 1$.

Return value:

The return value has the same type and kind as X. It is expressed in half-revolutions and satisfies $0 \leq \text{acospi}(x) \leq 1$.

Example:

```
program test_acospi
  implicit none
  real, parameter :: x = 0.123, y(3) = [0.123, 0.45, 0.8]
  real, parameter :: a = acospi(x), b(3) = acospi(y)
  call foo(x, y)
contains
  subroutine foo(u, v)
    real, intent(in) :: u, v(:)
    real :: f, g(size(v))
    f = acospi(u)
    g = acospi(v)
    if (abs(a - f) > 8 * epsilon(f)) stop 1
    if (any(abs(g - b) > 8 * epsilon(f))) stop 2
  end subroutine foo
end program test_acospi
```

See also: Section 8.23 [ASINPI], page 133,
Section 8.28 [ATAN2PI], page 137,
Section 8.31 [ATANPI], page 139,

8.10 ADJUSTL — Left adjust a string

Synopsis: RESULT = ADJUSTL(STRING)

Description:

ADJUSTL(STRING) left adjusts a string by removing leading spaces. Spaces are inserted at the end of the string as needed.

Class: Elemental function

Arguments:

STRING The type shall be CHARACTER.

Return value:

The return value is of type **CHARACTER** and of the same kind as *STRING* where leading spaces are removed and the same number of spaces are inserted on the end of *STRING*.

Example:

```

program test_adjustl
  character(len=20) :: str = '  gfortran'
  str = adjustl(str)
  print *, str
end program test_adjustl

```

Standard: Fortran 90 and later

See also: Section 8.11 [ADJUSTR], page 125,
Section 8.288 [TRIM], page 304,

8.11 ADJUSTR — Right adjust a string

Synopsis: **RESULT = ADJUSTR(STRING)**

Description:

ADJUSTR(STRING) right adjusts a string by removing trailing spaces. Spaces are inserted at the start of the string as needed.

Class: Elemental function

Arguments:

STR The type shall be **CHARACTER**.

Return value:

The return value is of type **CHARACTER** and of the same kind as *STRING* where trailing spaces are removed and the same number of spaces are inserted at the start of *STRING*.

Example:

```

program test_adjustr
  character(len=20) :: str = 'gfortran'
  str = adjustr(str)
  print *, str
end program test_adjustr

```

Standard: Fortran 90 and later

See also: Section 8.10 [ADJUSTL], page 124,
Section 8.288 [TRIM], page 304,

8.12 AIMAG — Imaginary part of complex number

Synopsis: **RESULT = AIMAG(Z)**

Description:

AIMAG(Z) yields the imaginary part of complex argument Z. The **IMAG(Z)** and **IMAGPART(Z)** intrinsic functions are provided for compatibility with g77, and their use in new code is strongly discouraged.

Class: Elemental function

Arguments:

Z The type of the argument shall be **COMPLEX**.

Return value:

The return value is of type **REAL** with the kind type parameter of the argument.

Example:

```
program test_aimag
  complex(4) z4
  complex(8) z8
  z4 = cmplx(1.e0_4, 0.e0_4)
  z8 = cmplx(0.e0_8, 1.e0_8)
  print *, aimag(z4), dimag(z8)
end program test_aimag
```

Specific names:

Name	Argument	Return type	Standard
AIMAG(Z)	COMPLEX Z	REAL	Fortran 77 and later
DIMAG(Z)	COMPLEX(8) Z	REAL(8)	GNU extension
IMAG(Z)	COMPLEX Z	REAL	GNU extension
IMAGPART(Z)	COMPLEX Z	REAL	GNU extension

Standard: Fortran 77 and later, has overloads that are GNU extensions

8.13 AINT — Truncate to a whole number

Synopsis: **RESULT = AINT(A [, KIND])**

Description:

AINT(A [, KIND]) truncates its argument to a whole number.

Class: Elemental function

Arguments:

A The type of the argument shall be **REAL**.
KIND (Optional) A scalar **INTEGER** constant expression indicating the kind parameter of the result.

Return value:

The return value is of type **REAL** with the kind type parameter of the argument if the optional *KIND* is absent; otherwise, the kind type parameter is given by *KIND*. If the magnitude of *X* is less than one, **AINT(X)** returns zero. If the magnitude is equal to or greater than one then it returns the largest whole number that does not exceed its magnitude. The sign is the same as the sign of *X*.

Example:

```
program test_aint
  real(4) x4
  real(8) x8
  x4 = 1.234E0_4
  x8 = 4.321_8
  print *, aint(x4), dint(x8)
```

```

      x8 = aint(x4,8)
end program test_aint

```

Specific names:

Name	Argument	Return type	Standard
AINT(A)	REAL(4) A	REAL(4)	Fortran 77 and later
DINT(A)	REAL(8) A	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later

8.14 ALARM — Execute a routine after a given delay

Synopsis: CALL ALARM(SECONDS, HANDLER [, STATUS])

Description:

ALARM(SECONDS, HANDLER [, STATUS]) causes external subroutine *HANDLER* to be executed after a delay of *SECONDS* by using `alarm(2)` to set up a signal and `signal(2)` to catch it. If *STATUS* is supplied, it is returned with the number of seconds remaining until any previously scheduled alarm was due to be delivered, or zero if there was no previously scheduled alarm.

Class: Subroutine

Arguments:

SECONDS The type of the argument shall be a scalar INTEGER. It is INTENT(IN).

HANDLER Signal handler (INTEGER FUNCTION or SUBROUTINE) or dummy/global INTEGER scalar. The scalar values may be either SIG_IGN=1 to ignore the alarm generated or SIG_DFL=0 to set the default action. It is INTENT(IN).

STATUS (Optional) *STATUS* shall be a scalar variable of the default INTEGER kind. It is INTENT(OUT).

Example:

```

program test_alarm
  external handler_print
  integer i
  call alarm (3, handler_print, i)
  print *, i
  call sleep(10)
end program test_alarm

```

This causes the external routine *handler_print* to be called after 3 seconds.

Standard: GNU extension

8.15 ALL — All values in MASK along DIM are true

Synopsis: RESULT = ALL(MASK [, DIM])

Description:

ALL(MASK [, DIM]) determines if all the values are true in *MASK* in the array along dimension *DIM*.

Class: Transformational function

Arguments:

MASK The type of the argument shall be **LOGICAL** and it shall not be scalar.

DIM (Optional) *DIM* shall be a scalar integer with a value that lies between one and the rank of *MASK*.

Return value:

ALL(MASK) returns a scalar value of type **LOGICAL** where the kind type parameter is the same as the kind type parameter of *MASK*. If *DIM* is present, then **ALL(MASK, DIM)** returns an array with the rank of *MASK* minus 1. The shape is determined from the shape of *MASK* where the *DIM* dimension is elided.

- (A) **ALL(MASK)** is true if all elements of *MASK* are true. It also is true if *MASK* has zero size; otherwise, it is false.
- (B) If the rank of *MASK* is one, then **ALL(MASK,DIM)** is equivalent to **ALL(MASK)**. If the rank is greater than one, then **ALL(MASK,DIM)** is determined by applying **ALL** to the array sections.

Example:

```

program test_all
  logical l
  l = all(/.true., .true., .true./)
  print *, l
  call section
contains
  subroutine section
    integer a(2,3), b(2,3)
    a = 1
    b = 1
    b(2,2) = 2
    print *, all(a .eq. b, 1)
    print *, all(a .eq. b, 2)
  end subroutine section
end program test_all

```

Standard: Fortran 90 and later

8.16 ALLOCATED — Status of an allocatable entity

Synopsis:

```

RESULT = ALLOCATED (ARRAY)
RESULT = ALLOCATED (SCALAR)

```

Description:

ALLOCATED (ARRAY) and **ALLOCATED (SCALAR)** check the allocation status of *ARRAY* and *SCALAR*, respectively.

Class: Inquiry function

Arguments:

ARRAY The argument shall be an **ALLOCATABLE** array.

SCALAR The argument shall be an **ALLOCATABLE** scalar.

Return value:

The return value is a scalar **LOGICAL** with the default logical kind type parameter. If the argument is allocated, then the result is **.TRUE.**; otherwise, it returns **.FALSE.**

Example:

```
program test_allocated
  integer :: i = 4
  real(4), allocatable :: x(:)
  if (.not. allocated(x)) allocate(x(i))
end program test_allocated
```

Standard: Fortran 90 and later; for the **SCALAR=** keyword and allocatable scalar entities, Fortran 2003 and later.

8.17 AND — Bitwise logical AND

Synopsis: **RESULT = AND(I, J)**

Description:

Bitwise logical AND.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. For integer arguments, programmers should consider the use of the Section 8.143 [IAND], page 215, intrinsic defined by the Fortran standard.

Class: Function

Arguments:

<i>I</i>	The type shall be either a scalar INTEGER type or a scalar LOGICAL type or a boz-literal-constant.
<i>J</i>	The type shall be the same as the type of <i>I</i> or a boz-literal-constant. <i>I</i> and <i>J</i> shall not both be boz-literal-constants. If either <i>I</i> or <i>J</i> is a boz-literal-constant, then the other argument must be a scalar INTEGER .

Return value:

The return type is either a scalar **INTEGER** or a scalar **LOGICAL**. If the kind type parameters differ, then the smaller kind type is implicitly converted to larger kind, and the return has the larger kind. A boz-literal-constant is converted to an **INTEGER** with the kind type parameter of the other argument as-if a call to Section 8.155 [INT], page 223, occurred.

Example:

```
PROGRAM test_and
  LOGICAL :: T = .TRUE., F = .FALSE.
  INTEGER :: a, b
  DATA a / Z'F' /, b / Z'3' /

  WRITE (*,*) AND(T, T), AND(T, F), AND(F, T), AND(F, F)
  WRITE (*,*) AND(a, b)
END PROGRAM
```

Standard: GNU extension

See also: Fortran 95 elemental function:
Section 8.143 [IAND], page 215,

8.18 ANINT — Nearest whole number

Synopsis: `RESULT = ANINT(A [, KIND])`

Description:

`ANINT(A [, KIND])` rounds its argument to the nearest whole number.

Class: Elemental function

Arguments:

A The type of the argument shall be `REAL`.
KIND (Optional) A scalar `INTEGER` constant expression indicating the kind parameter of the result.

Return value:

The return value is of type real with the kind type parameter of the argument if the optional *KIND* is absent; otherwise, the kind type parameter is given by *KIND*. If *A* is greater than zero, `ANINT(A)` returns `AIN(X+0.5)`. If *A* is less than or equal to zero then it returns `AIN(X-0.5)`.

Example:

```
program test_anint
  real(4) x4
  real(8) x8
  x4 = 1.234E0_4
  x8 = 4.321_8
  print *, anint(x4), dnint(x8)
  x8 = anint(x4,8)
end program test_anint
```

Specific names:

Name	Argument	Return type	Standard
<code>ANINT(A)</code>	<code>REAL(4) A</code>	<code>REAL(4)</code>	Fortran 77 and later
<code>DNINT(A)</code>	<code>REAL(8) A</code>	<code>REAL(8)</code>	Fortran 77 and later

Standard: Fortran 77 and later

8.19 ANY — Any value in *MASK* along *DIM* is true

Synopsis: `RESULT = ANY(MASK [, DIM])`

Description:

`ANY(MASK [, DIM])` determines if any of the values in the logical array *MASK* along dimension *DIM* are `.TRUE.`.

Class: Transformational function

Arguments:

MASK The type of the argument shall be `LOGICAL` and it shall not be scalar.
DIM (Optional) *DIM* shall be a scalar integer with a value that lies between one and the rank of *MASK*.

Return value:

ANY(MASK) returns a scalar value of type **LOGICAL** where the kind type parameter is the same as the kind type parameter of *MASK*. If *DIM* is present, then **ANY(MASK, DIM)** returns an array with the rank of *MASK* minus 1. The shape is determined from the shape of *MASK* where the *DIM* dimension is elided.

- (A) **ANY(MASK)** is true if any element of *MASK* is true; otherwise, it is false. It also is false if *MASK* has zero size.
- (B) If the rank of *MASK* is one, then **ANY(MASK,DIM)** is equivalent to **ANY(MASK)**. If the rank is greater than one, then **ANY(MASK,DIM)** is determined by applying **ANY** to the array sections.

Example:

```

program test_any
  logical l
  l = any(/.true., .true., .true./)
  print *, l
  call section
contains
  subroutine section
    integer a(2,3), b(2,3)
    a = 1
    b = 1
    b(2,2) = 2
    print *, any(a .eq. b, 1)
    print *, any(a .eq. b, 2)
  end subroutine section
end program test_any

```

Standard: Fortran 90 and later

8.20 ASIN — Arcsine function

Synopsis: **RESULT = ASIN(X)**

Description:

ASIN(X) computes the arcsine of its *X* (inverse of **SIN(X)**).

Class: Elemental function

Arguments:

X The type shall be either **REAL** and a magnitude that is less than or equal to one - or be **COMPLEX**.

Return value:

The return value is of the same type and kind as *X*. The real part of the result is in radians and lies in the range $-\pi/2 \leq \Re \operatorname{asin}(x) \leq \pi/2$.

Example:

```

program test_asin
  real(8) :: x = 0.866_8
  x = asin(x)
end program test_asin

```

Specific names:

Name	Argument	Return type	Standard
ASIN(X)	REAL(4) X	REAL(4)	Fortran 77 and later
DASIN(X)	REAL(8) X	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later, for a complex argument Fortran 2008 or later

See also: Inverse function:
 Section 8.258 [SIN], page 285,
 Degrees function:
 Section 8.21 [ASIND], page 132,

8.21 ASIND — Arcsine function, degrees

Synopsis: RESULT = ASIND(X)

Description:

ASIND(X) computes the arcsine of its *X* in degrees (inverse of SIND(X)).

Class: Elemental function

Arguments:

X The type shall be either REAL and a magnitude that
 is less than or equal to one.

Return value:

The return value is of the same type and kind as *X*. The result is in degrees and lies in the range $-90 \leq \Re \operatorname{asin}(x) \leq 90$.

Example:

```
program test_asind
  real(8) :: x = 0.866_8
  x = asind(x)
end program test_asind
```

Specific names:

Name	Argument	Return type	Standard
ASIND(X)	REAL(4) X	REAL(4)	Fortran 2023
DASIND(X)	REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2023

See also: Inverse function:
 Section 8.259 [SIND], page 286,
 Radians function:
 Section 8.20 [ASIN], page 131,

8.22 ASINH — Inverse hyperbolic sine function

Synopsis: RESULT = ASINH(X)

Description:

ASINH(X) computes the inverse hyperbolic sine of *X*.

Class: Elemental function

Arguments:

X The type shall be **REAL** or **COMPLEX**.

Return value:

The return value is of the same type and kind as **X**. If **X** is complex, the imaginary part of the result is in radians and lies between $-\pi/2 \leq \Im \operatorname{asinh}(x) \leq \pi/2$.

Example:

```
PROGRAM test_asinh
  REAL(8), DIMENSION(3) :: x = (/ -1.0, 0.0, 1.0 /)
  WRITE (*,*) ASINH(x)
END PROGRAM
```

Specific names:

Name	Argument	Return type	Standard
DASINH(X)	REAL(8) X	REAL(8)	GNU extension.

Standard: Fortran 2008 and later

See also: Inverse function:
Section 8.260 [SINH], page 286,

8.23 ASINPI — Circular arc sine function

Description:

ASINPI(X) computes $\operatorname{asin}(x)/\pi$, which is a measure of an angle in half-revolutions.

Standard: Fortran 2023

Class: Elemental function

Syntax: RESULT = ASINPI(X)

Arguments:

X The type shall be **REAL** with $-1 \leq x \leq 1$.

Return value:

The return value has the same type and kind as **X**. It is expressed in half-revolutions and satisfies $-0.5 \leq \operatorname{asinpi}(x) \leq 0.5$.

Example:

```
program test_asinpi
  implicit none
  real, parameter :: x = 0.123, y(3) = [0.123, 0.45, 0.8]
  real, parameter :: a = asinpi(x), b(3) = asinpi(y)
  call foo(x, y)
contains
  subroutine foo(u, v)
    real, intent(in) :: u, v(:)
    real :: f, g(size(v))
    f = asinpi(u)
    g = asinpi(v)
    if (abs(a - f) > 8 * epsilon(f)) stop 1
    if (any(abs(g - b) > 8 * epsilon(f))) stop 2
  end subroutine foo
end program test_asinpi
```

See also: Section 8.9 [ACOSPI], page 124,
 Section 8.28 [ATAN2PI], page 137,
 Section 8.31 [ATANPI], page 139,

8.24 ASSOCIATED — Status of a pointer or pointer/target pair

Synopsis: `RESULT = ASSOCIATED(POINTER [, TARGET])`

Description:

`ASSOCIATED(POINTER [, TARGET])` determines the status of the pointer *POINTER* or if *POINTER* is associated with the target *TARGET*.

Class: Inquiry function

Arguments:

POINTER *POINTER* shall have the `POINTER` attribute and it can be of any type.

TARGET (Optional) *TARGET* shall be a pointer or a target. It must have the same type, kind type parameter, and array rank as *POINTER*.

The association status of neither *POINTER* nor *TARGET* shall be undefined.

Return value:

`ASSOCIATED(POINTER)` returns a scalar value of type `LOGICAL(4)`. There are several cases:

- (A) When the optional *TARGET* is not present then
`ASSOCIATED(POINTER)` is true if *POINTER* is associated with a target; otherwise, it returns false.
- (B) If *TARGET* is present and a scalar target, the result is true if
TARGET is not a zero-sized storage sequence and the target associated with *POINTER* occupies the same storage units. If *POINTER* is disassociated, the result is false.
- (C) If *TARGET* is present and an array target, the result is true if
TARGET and *POINTER* have the same shape, are not zero-sized arrays, are arrays whose elements are not zero-sized storage sequences, and *TARGET* and *POINTER* occupy the same storage units in array element order. As in case(B), the result is false, if *POINTER* is disassociated.
- (D) If *TARGET* is present and an scalar pointer, the result is true
 if *TARGET* is associated with *POINTER*, the target associated with *TARGET* are not zero-sized storage sequences and occupy the same storage units. The result is false, if either *TARGET* or *POINTER* is disassociated.
- (E) If *TARGET* is present and an array pointer, the result is true if
 target associated with *POINTER* and the target associated with *TARGET* have the same shape, are not zero-sized arrays, are ar-

rays whose elements are not zero-sized storage sequences, and *TARGET* and *POINTER* occupy the same storage units in array element order. The result is false, if either *TARGET* or *POINTER* is disassociated.

Example:

```

program test_associated
  implicit none
  real, target :: tgt(2) = (/1., 2./)
  real, pointer :: ptr(:)
  ptr => tgt
  if (associated(ptr) .eqv. .false.) call abort
  if (associated(ptr,tgt) .eqv. .false.) call abort
end program test_associated

```

Standard: Fortran 90 and later

See also: Section 8.215 [NULL], page 259,

8.25 ATAN — Arctangent function

Synopsis:

```

RESULT = ATAN(X)
RESULT = ATAN(Y, X)

```

Description:

ATAN(X) computes the arctangent of X.

Class: Elemental function

Arguments:

X	The type shall be REAL or COMPLEX; if Y is present, X shall be REAL.
Y	The type and kind type parameter shall be the same as X.

Return value:

The return value is of the same type and kind as X. If Y is present, the result is identical to ATAN2(Y,X). Otherwise, it is the arctangent of X, where the real part of the result is in radians and lies in the range $-\pi/2 \leq \Re \operatorname{atan}(x) \leq \pi/2$.

Example:

```

program test_atan
  real(8) :: x = 2.866_8
  x = atan(x)
end program test_atan

```

Specific names:

Name	Argument	Return type	Standard
ATAN(X)	REAL(4) X	REAL(4)	Fortran 77 and later
DATAN(X)	REAL(8) X	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later, for a complex argument and for two arguments Fortran 2008 or later

See also: Inverse function:
 Section 8.276 [TAN], page 297,
 Degrees function:
 Section 8.29 [ATAND], page 138,

8.26 ATAN2 — Arctangent function

Synopsis: RESULT = ATAN2(Y, X)

Description:

ATAN2(Y, X) computes the principal value of the argument function of the complex number $X + iY$. This function can be used to transform from Cartesian into polar coordinates and allows to determine the angle in the correct quadrant.

Class: Elemental function

Arguments:

Y	The type shall be REAL.
X	The type and kind type parameter shall be the same as Y. If Y is zero, then X must be nonzero.

Return value:

The return value has the same type and kind type parameter as Y. It is the principal value of the complex number $X + iY$. If X is nonzero, then it lies in the range $-\pi \leq \text{atan}(x) \leq \pi$. The sign is positive if Y is positive. If Y is zero, then the return value is zero if X is strictly positive, π if X is negative and Y is positive zero (or the processor does not handle signed zeros), and $-\pi$ if X is negative and Y is negative zero. Finally, if X is zero, then the magnitude of the result is $\pi/2$.

Example:

```
program test_atan2
  real(4) :: x = 1.e0_4, y = 0.5e0_4
  x = atan2(y,x)
end program test_atan2
```

Specific names:

Name	Argument	Return type	Standard
ATAN2(X, Y)	REAL(4) X, Y	REAL(4)	Fortran 77 and later
DATAN2(X, Y)	REAL(8) X, Y	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later

See also: Alias:
 Section 8.25 [ATAN], page 135,
 Degrees function:
 Section 8.27 [ATAN2D], page 136,

8.27 ATAN2D — Arctangent function, degrees

Synopsis: RESULT = ATAN2D(Y, X)

Description:

ATAN2D(Y, X) computes the principal value of the argument function of the complex number $X + iY$ in degrees. This function can be used to transform from Cartesian into polar coordinates and allows to determine the angle in the correct quadrant.

Class: Elemental function

Arguments:

Y The type shall be **REAL**.
 X The type and kind type parameter shall be the same as Y. If Y is zero, then X must be nonzero.

Return value:

The return value has the same type and kind type parameter as Y. It is the principal value of the complex number $X + iY$. If X is nonzero, then it lies in the range $-180 \leq \text{atan}(x) \leq 180$. The sign is positive if Y is positive. If Y is zero, then the return value is zero if X is strictly positive, 180 if X is negative and Y is positive zero (or the processor does not handle signed zeros), and -180 if X is negative and Y is negative zero. Finally, if X is zero, then the magnitude of the result is 90.

Example:

```
program test_atan2d
  real(4) :: x = 1.e0_4, y = 0.5e0_4
  x = atan2d(y,x)
end program test_atan2d
```

Specific names:

Name	Argument	Return type	Standard
ATAN2D(X, Y)	REAL(4) X, Y	REAL(4)	Fortran 2023
DATAN2D(X, Y)	REAL(8) X, Y	REAL(8)	GNU extension

Standard: Fortran 2023

See also: Alias:

Section 8.29 [ATAND], page 138,
 Radians function:
 Section 8.26 [ATAN2], page 136,

8.28 ATAN2PI — Circular arc tangent function

Description:

ATAN2PI(Y, X) computes $\text{atan2}(y, x)/\pi$, and provides a measure of an angle in half-revolutions within the proper quadrant.

Standard: Fortran 2023

Class: Elemental function

Syntax: RESULT = ATAN2PI(Y, X)

Arguments:

Y The type shall be **REAL**.

X The type and kind type parameter shall be the same as *Y*. If *Y* is zero, then *X* shall be nonzero.

Return value:

The return value has the same type and kind type parameter as *Y* and satisfies $-1 \leq \text{atan2}(y, x)/\pi \leq 1$.

Example:

```
program test_atan2pi
  real(kind=4) :: x = 1.e0_4, y = 0.5e0_4
  x = atan2pi(y, x)
end program test_atan2pi
```

See also: Section 8.9 [ACOSPI], page 124,
 Section 8.23 [ASINPI], page 133,
 Section 8.31 [ATANPI], page 139,

8.29 ATAND — Arctangent function, degrees

Synopsis:

```
RESULT = ATAND(X)
RESULT = ATAND(Y, X)
```

Description:

ATAND(*X*) computes the arctangent of *X* in degrees (inverse of Section 8.277 [TAND], page 298).

Class: Elemental function

Arguments:

X The type shall be REAL.
Y The type and kind type parameter shall be the same as *X*.

Return value:

The return value is of the same type and kind as *X*. If *Y* is present, the result is identical to ATAN2D(*Y*, *X*). Otherwise, the result is in degrees and lies in the range $-90 \leq \text{atand}(x) \leq 90$.

Example:

```
program test_atand
  real(8) :: x = 2.866_8
  real(4) :: x1 = 1.e0_4, y1 = 0.5e0_4
  x = atand(x)
  x1 = atand(y1, x1)
end program test_atand
```

Specific names:

Name	Argument	Return type	Standard
ATAND(<i>X</i>)	REAL(4) <i>X</i>	REAL(4)	Fortran 2023
DATAND(<i>X</i>)	REAL(8) <i>X</i>	REAL(8)	GNU extension

Standard: Fortran 2023

See also: Inverse function:
 Section 8.277 [TAND], page 298,
 Radians function:
 Section 8.25 [ATAN], page 135,

8.30 ATANH — Inverse hyperbolic tangent function

Synopsis: RESULT = ATANH(X)

Description:

ATANH(X) computes the inverse hyperbolic tangent of X.

Class: Elemental function

Arguments:

X The type shall be REAL or COMPLEX.

Return value:

The return value has same type and kind as X. If X is complex, the imaginary part of the result is in radians and lies between $-\pi/2 \leq \Im \operatorname{atanh}(x) \leq \pi/2$.

Example:

```
PROGRAM test_atanh
  REAL, DIMENSION(3) :: x = (/ -1.0, 0.0, 1.0 /)
  WRITE (*,*) ATANH(x)
END PROGRAM
```

Specific names:

Name	Argument	Return type	Standard
DATANH(X)	REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2008 and later

See also: Inverse function:
 Section 8.278 [TANH], page 298,

8.31 ATANPI — Circular arc tangent function

Description:

ATANPI(X) computes $\operatorname{atan}(x)/\pi$. ATANPI(Y, X) computes $\operatorname{atan2}(y, x)/\pi$. These provide a measure of an angle in half-revolutions.

Standard: Fortran 2023

Class: Elemental function

Syntax:

```
RESULT = ATANPI(X)
RESULT = ATANPI(Y, X)
```

Arguments:

Y The type shall be REAL.
 X If Y appears, X shall have the same type and kind as Y. If Y is zero, then X shall not be zero. If Y does not appear in a function reference, then X shall be REAL.

Return value:

The return value has the same type and kind as *X*. It is expressed in half-revolutions and satisfies $-0.5 \leq \text{atanpi}(x) \leq 0.5$.

Example:

```

program test_atanpi
  implicit none
  real, parameter :: x = 0.123, y(3) = [0.123, 0.45, 0.8]
  real, parameter :: a = atanpi(x), b(3) = atanpi(y)
  call foo(x, y)
contains
  subroutine foo(u, v)
    real, intent(in) :: u, v(:)
    real :: f, g(size(v))
    f = atanpi(u)
    g = atanpi(v)
    if (abs(a - f) > 8 * epsilon(f)) stop 1
    if (any(abs(g - b) > 8 * epsilon(f))) stop 2
  end subroutine foo
end program test_atanpi

```

See also: Section 8.9 [ACOSPI], page 124,
 Section 8.23 [ASINPI], page 133,
 Section 8.28 [ATAN2PI], page 137,

8.32 ATOMIC_ADD — Atomic ADD operation

Synopsis: CALL ATOMIC_ADD (ATOM, VALUE [, STAT])

Description:

ATOMIC_ADD(ATOM, VALUE) atomically adds the value of *VALUE* to the variable *ATOM*. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of ISO_FORTRAN_ENV's STAT_STOPPED_IMAGE and if the remote image has failed, the value STAT_FAILED_IMAGE.

Class: Atomic subroutine

Arguments:

<i>ATOM</i>	Scalar coarray or coindexed variable of integer type with ATOMIC_INT_KIND kind.
<i>VALUE</i>	Scalar of the same type as <i>ATOM</i> . If the kind is different, the value is converted to the kind of <i>ATOM</i> .
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  integer(atomic_int_kind) :: atom[*]
  call atomic_add (atom[1], this_image())
end program atomic

```

Standard: TS 18508 or later

See also: Section 8.35 [ATOMIC_DEFINE], page 142,
 Section 8.36 [ATOMIC_FETCH_ADD], page 143,
 Section 9.1 [ISO_FORTRAN_ENV], page 311,
 Section 8.33 [ATOMIC_AND], page 141,
 Section 8.40 [ATOMIC_OR], page 146,
 Section 8.42 [ATOMIC_XOR], page 148,

8.33 ATOMIC_AND — Atomic bitwise AND operation

Synopsis: CALL ATOMIC_AND (ATOM, VALUE [, STAT])

Description:

ATOMIC_AND(ATOM, VALUE) atomically defines *ATOM* with the bitwise AND between the values of *ATOM* and *VALUE*. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of ISO_FORTRAN_ENV's STAT_STOPPED_IMAGE and if the remote image has failed, the value STAT_FAILED_IMAGE.

Class: Atomic subroutine

Arguments:

<i>ATOM</i>	Scalar coarray or coindexed variable of integer type with ATOMIC_INT_KIND kind.
<i>VALUE</i>	Scalar of the same type as <i>ATOM</i> . If the kind is different, the value is converted to the kind of <i>ATOM</i> .
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  integer(atomic_int_kind) :: atom[*]
  call atomic_and (atom[1], int(b'10100011101'))
end program atomic

```

Standard: TS 18508 or later

See also: Section 8.35 [ATOMIC_DEFINE], page 142,
 Section 8.37 [ATOMIC_FETCH_AND], page 144,
 Section 9.1 [ISO_FORTRAN_ENV], page 311,
 Section 8.32 [ATOMIC_ADD], page 140,
 Section 8.40 [ATOMIC_OR], page 146,
 Section 8.42 [ATOMIC_XOR], page 148,

8.34 ATOMIC_CAS — Atomic compare and swap

Synopsis: CALL ATOMIC_CAS (ATOM, OLD, COMPARE, NEW [, STAT])

Description:

ATOMIC_CAS compares the variable *ATOM* with the value of *COMPARE*; if the value is the same, *ATOM* is set to the value of *NEW*. Additionally, *OLD* is set

to the value of *ATOM* that was used for the comparison. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of *ISO_FORTRAN_ENV*'s *STAT_STOPPED_IMAGE* and if the remote image has failed, the value *STAT_FAILED_IMAGE*.

Class: Atomic subroutine

Arguments:

<i>ATOM</i>	Scalar coarray or coindexed variable of either integer type with <i>ATOMIC_INT_KIND</i> kind or logical type with <i>ATOMIC_LOGICAL_KIND</i> kind.
<i>OLD</i>	Scalar of the same type and kind as <i>ATOM</i> .
<i>COMPARE</i>	Scalar variable of the same type and kind as <i>ATOM</i> .
<i>NEW</i>	Scalar variable of the same type as <i>ATOM</i> . If kind is different, the value is converted to the kind of <i>ATOM</i> .
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  logical(atomic_logical_kind) :: atom[*], prev
  call atomic_cas (atom[1], prev, .false., .true.)
end program atomic

```

Standard: TS 18508 or later

See also: Section 8.35 [*ATOMIC_DEFINE*], page 142,
 Section 8.41 [*ATOMIC_REF*], page 147,
 Section 9.1 [*ISO_FORTRAN_ENV*], page 311,

8.35 *ATOMIC_DEFINE* — Setting a variable atomically

Synopsis: CALL *ATOMIC_DEFINE* (*ATOM*, *VALUE* [, *STAT*])

Description:

ATOMIC_DEFINE(*ATOM*, *VALUE*) defines the variable *ATOM* with the value *VALUE* atomically. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of *ISO_FORTRAN_ENV*'s *STAT_STOPPED_IMAGE* and if the remote image has failed, the value *STAT_FAILED_IMAGE*.

Class: Atomic subroutine

Arguments:

<i>ATOM</i>	Scalar coarray or coindexed variable of either integer type with <i>ATOMIC_INT_KIND</i> kind or logical type with <i>ATOMIC_LOGICAL_KIND</i> kind.
-------------	--

VALUE Scalar of the same type as *ATOM*. If the kind is different, the value is converted to the kind of *ATOM*.
STAT (optional) Scalar default-kind integer variable.

Example:

```
program atomic
  use iso_fortran_env
  integer(atomic_int_kind) :: atom[*]
  call atomic_define (atom[1], this_image())
end program atomic
```

Standard: Fortran 2008 and later; with *STAT*, TS 18508 or later

See also: Section 8.41 [ATOMIC_REF], page 147,
 Section 8.34 [ATOMIC_CAS], page 141,
 Section 9.1 [ISO_FORTTRAN_ENV], page 311,
 Section 8.32 [ATOMIC_ADD], page 140,
 Section 8.33 [ATOMIC_AND], page 141,
 Section 8.40 [ATOMIC_OR], page 146,
 Section 8.42 [ATOMIC_XOR], page 148,

8.36 ATOMIC_FETCH_ADD — Atomic ADD operation with prior fetch

Synopsis: CALL ATOMIC_FETCH_ADD (ATOM, VALUE, OLD [, STAT])

Description:

ATOMIC_FETCH_ADD(ATOM, VALUE, OLD) atomically stores the value of *ATOM* in *OLD* and adds the value of *VALUE* to the variable *ATOM*. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of ISO_FORTTRAN_ENV's STAT_STOPPED_IMAGE and if the remote image has failed, the value STAT_FAILED_IMAGE.

Class: Atomic subroutine

Arguments:

ATOM Scalar coarray or coindexed variable of integer type with ATOMIC_INT_KIND kind. ATOMIC_LOGICAL_KIND kind.
VALUE Scalar of the same type as *ATOM*. If the kind is different, the value is converted to the kind of *ATOM*.
OLD Scalar of the same type and kind as *ATOM*.
STAT (optional) Scalar default-kind integer variable.

Example:

```
program atomic
  use iso_fortran_env
  integer(atomic_int_kind) :: atom[*], old
  call atomic_add (atom[1], this_image(), old)
end program atomic
```

Standard: TS 18508 or later

See also: Section 8.35 [ATOMIC_DEFINE], page 142,
 Section 8.32 [ATOMIC_ADD], page 140,
 Section 9.1 [ISO_FORTRAN_ENV], page 311,
 Section 8.37 [ATOMIC_FETCH_AND], page 144,
 Section 8.38 [ATOMIC_FETCH_OR], page 144,
 Section 8.39 [ATOMIC_FETCH_XOR], page 145,

8.37 ATOMIC_FETCH_AND — Atomic bitwise AND operation with prior fetch

Synopsis: CALL ATOMIC_FETCH_AND (ATOM, VALUE, OLD [, STAT])

Description:

ATOMIC_AND(ATOM, VALUE) atomically stores the value of *ATOM* in *OLD* and defines *ATOM* with the bitwise AND between the values of *ATOM* and *VALUE*. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of ISO_FORTRAN_ENV's STAT_STOPPED_IMAGE and if the remote image has failed, the value STAT_FAILED_IMAGE.

Class: Atomic subroutine

Arguments:

<i>ATOM</i>	Scalar coarray or coindexed variable of integer type with ATOMIC_INT_KIND kind.
<i>VALUE</i>	Scalar of the same type as <i>ATOM</i> . If the kind is different, the value is converted to the kind of <i>ATOM</i> .
<i>OLD</i>	Scalar of the same type and kind as <i>ATOM</i> .
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  integer(atomic_int_kind) :: atom[*], old
  call atomic_fetch_and (atom[1], int(b'10100011101'), old)
end program atomic

```

Standard: TS 18508 or later

See also: Section 8.35 [ATOMIC_DEFINE], page 142,
 Section 8.33 [ATOMIC_AND], page 141,
 Section 9.1 [ISO_FORTRAN_ENV], page 311,
 Section 8.36 [ATOMIC_FETCH_ADD], page 143,
 Section 8.38 [ATOMIC_FETCH_OR], page 144,
 Section 8.39 [ATOMIC_FETCH_XOR], page 145,

8.38 ATOMIC_FETCH_OR — Atomic bitwise OR operation with prior fetch

Synopsis: CALL ATOMIC_FETCH_OR (ATOM, VALUE, OLD [, STAT])

Description:

`ATOMIC_OR(ATOM, VALUE)` atomically stores the value of *ATOM* in *OLD* and defines *ATOM* with the bitwise OR between the values of *ATOM* and *VALUE*. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of `ISO_FORTRAN_ENV`'s `STAT_STOPPED_IMAGE` and if the remote image has failed, the value `STAT_FAILED_IMAGE`.

Class: Atomic subroutine

Arguments:

<i>ATOM</i>	Scalar coarray or coindexed variable of integer type with <code>ATOMIC_INT_KIND</code> kind.
<i>VALUE</i>	Scalar of the same type as <i>ATOM</i> . If the kind is different, the value is converted to the kind of <i>ATOM</i> .
<i>OLD</i>	Scalar of the same type and kind as <i>ATOM</i> .
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  integer(atomic_int_kind) :: atom[*], old
  call atomic_fetch_or (atom[1], int(b'10100011101'), old)
end program atomic

```

Standard: TS 18508 or later

See also: Section 8.35 [`ATOMIC_DEFINE`], page 142,
 Section 8.40 [`ATOMIC_OR`], page 146,
 Section 9.1 [`ISO_FORTRAN_ENV`], page 311,
 Section 8.36 [`ATOMIC_FETCH_ADD`], page 143,
 Section 8.37 [`ATOMIC_FETCH_AND`], page 144,
 Section 8.39 [`ATOMIC_FETCH_XOR`], page 145,

8.39 `ATOMIC_FETCH_XOR` — Atomic bitwise XOR operation with prior fetch

Synopsis: `CALL ATOMIC_FETCH_XOR (ATOM, VALUE, OLD [, STAT])`

Description:

`ATOMIC_XOR(ATOM, VALUE)` atomically stores the value of *ATOM* in *OLD* and defines *ATOM* with the bitwise XOR between the values of *ATOM* and *VALUE*. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of `ISO_FORTRAN_ENV`'s `STAT_STOPPED_IMAGE` and if the remote image has failed, the value `STAT_FAILED_IMAGE`.

Class: Atomic subroutine

Arguments:

<i>ATOM</i>	Scalar coarray or coindexed variable of integer type with <code>ATOMIC_INT_KIND</code> kind.
<i>VALUE</i>	Scalar of the same type as <i>ATOM</i> . If the kind is different, the value is converted to the kind of <i>ATOM</i> .
<i>OLD</i>	Scalar of the same type and kind as <i>ATOM</i> .
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  integer(atomic_int_kind) :: atom[*], old
  call atomic_fetch_xor (atom[1], int(b'10100011101'), old)
end program atomic

```

Standard: TS 18508 or later

See also: Section 8.35 [ATOMIC_DEFINE], page 142,
 Section 8.42 [ATOMIC_XOR], page 148,
 Section 9.1 [ISO_FORTTRAN_ENV], page 311,
 Section 8.36 [ATOMIC_FETCH_ADD], page 143,
 Section 8.37 [ATOMIC_FETCH_AND], page 144,
 Section 8.38 [ATOMIC_FETCH_OR], page 144,

8.40 ATOMIC_OR — Atomic bitwise OR operation

Synopsis: CALL ATOMIC_OR (ATOM, VALUE [, STAT])

Description:

ATOMIC_OR(ATOM, VALUE) atomically defines *ATOM* with the bitwise AND between the values of *ATOM* and *VALUE*. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of ISO_FORTTRAN_ENV's `STAT_STOPPED_IMAGE` and if the remote image has failed, the value `STAT_FAILED_IMAGE`.

Class: Atomic subroutine

Arguments:

<i>ATOM</i>	Scalar coarray or coindexed variable of integer type with <code>ATOMIC_INT_KIND</code> kind.
<i>VALUE</i>	Scalar of the same type as <i>ATOM</i> . If the kind is different, the value is converted to the kind of <i>ATOM</i> .
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  integer(atomic_int_kind) :: atom[*]
  call atomic_or (atom[1], int(b'10100011101'))
end program atomic

```

Standard: TS 18508 or later

See also: Section 8.35 [ATOMIC_DEFINE], page 142,
 Section 8.38 [ATOMIC_FETCH_OR], page 144,
 Section 9.1 [ISO_FORTRAN_ENV], page 311,
 Section 8.32 [ATOMIC_ADD], page 140,
 Section 8.40 [ATOMIC_OR], page 146,
 Section 8.42 [ATOMIC_XOR], page 148,

8.41 ATOMIC_REF — Obtaining the value of a variable atomically

Synopsis: CALL ATOMIC_REF(VALUE, ATOM [, STAT])

Description:

ATOMIC_DEFINE(ATOM, VALUE) atomically assigns the value of the variable *ATOM* to *VALUE*. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of ISO_FORTRAN_ENV's STAT_STOPPED_IMAGE and if the remote image has failed, the value STAT_FAILED_IMAGE.

Class: Atomic subroutine

Arguments:

<i>VALUE</i>	Scalar of the same type as <i>ATOM</i> . If the kind is different, the value is converted to the kind of <i>ATOM</i> .
<i>ATOM</i>	Scalar coarray or coindexed variable of either integer type with ATOMIC_INT_KIND kind or logical type with ATOMIC_LOGICAL_KIND kind.
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  logical(atomic_logical_kind) :: atom[*]
  logical :: val
  call atomic_ref (atom, .false.)
  ! ...
  call atomic_ref (atom, val)
  if (val) then
    print *, "Obtained"
  end if
end program atomic

```

Standard: Fortran 2008 and later; with *STAT*, TS 18508 or later

See also: Section 8.35 [ATOMIC_DEFINE], page 142,
 Section 8.34 [ATOMIC_CAS], page 141,
 Section 9.1 [ISO_FORTRAN_ENV], page 311,
 Section 8.36 [ATOMIC_FETCH_ADD], page 143,
 Section 8.37 [ATOMIC_FETCH_AND], page 144,

Section 8.38 [ATOMIC_FETCH_OR], page 144,
 Section 8.39 [ATOMIC_FETCH_XOR], page 145,

8.42 ATOMIC_XOR — Atomic bitwise OR operation

Synopsis: CALL ATOMIC_XOR (ATOM, VALUE [, STAT])

Description:

ATOMIC_AND(ATOM, VALUE) atomically defines *ATOM* with the bitwise XOR between the values of *ATOM* and *VALUE*. When *STAT* is present and the invocation was successful, it is assigned the value 0. If it is present and the invocation has failed, it is assigned a positive value; in particular, for a coindexed *ATOM*, if the remote image has stopped, it is assigned the value of ISO_FORTRAN_ENV's STAT_STOPPED_IMAGE and if the remote image has failed, the value STAT_FAILED_IMAGE.

Class: Atomic subroutine

Arguments:

<i>ATOM</i>	Scalar coarray or coindexed variable of integer type with ATOMIC_INT_KIND kind.
<i>VALUE</i>	Scalar of the same type as <i>ATOM</i> . If the kind is different, the value is converted to the kind of <i>ATOM</i> .
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  integer(atomic_int_kind) :: atom[*]
  call atomic_xor (atom[1], int(b'10100011101'))
end program atomic

```

Standard: TS 18508 or later

See also: Section 8.35 [ATOMIC_DEFINE], page 142,
 Section 8.39 [ATOMIC_FETCH_XOR], page 145,
 Section 9.1 [ISO_FORTRAN_ENV], page 311,
 Section 8.32 [ATOMIC_ADD], page 140,
 Section 8.40 [ATOMIC_OR], page 146,
 Section 8.42 [ATOMIC_XOR], page 148,

8.43 BACKTRACE — Show a backtrace

Synopsis: CALL BACKTRACE

Description:

BACKTRACE shows a backtrace at an arbitrary place in user code. Program execution continues normally afterwards. The backtrace information is printed to the unit corresponding to ERROR_UNIT in ISO_FORTRAN_ENV.

Class: Subroutine

Arguments:

None

Standard: GNU extension

See also: Section 8.2 [ABORT], page 119,

8.44 BESSEL_J0 — Bessel function of the first kind of order 0

Synopsis: RESULT = BESSEL_J0(X)

Description:

BESSEL_J0(X) computes the Bessel function of the first kind of order 0 of X. This function is available under the name BESJ0 as a GNU extension.

Class: Elemental function

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL and lies in the range $-0.4027... \leq Bessel(0, x) \leq 1$. It has the same kind as X.

Example:

```
program test_besj0
  real(8) :: x = 0.0_8
  x = bessej0(x)
end program test_besj0
```

Specific names:

Name	Argument	Return type	Standard
DBESJ0(X)	REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2008 and later

8.45 BESSEL_J1 — Bessel function of the first kind of order 1

Synopsis: RESULT = BESSEL_J1(X)

Description:

BESSEL_J1(X) computes the Bessel function of the first kind of order 1 of X. This function is available under the name BESJ1 as a GNU extension.

Class: Elemental function

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL and lies in the range $-0.5818... \leq Bessel(1, x) \leq 0.5818$. It has the same kind as X.

Example:

```
program test_besj1
  real(8) :: x = 1.0_8
  x = bessej1(x)
end program test_besj1
```

Specific names:

Name	Argument	Return type	Standard
DBESJ1(X)	REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2008

8.46 BESSEL_JN — Bessel function of the first kind

Synopsis:

```
RESULT = BESSEL_JN(N, X)
RESULT = BESSEL_JN(N1, N2, X)
```

Description:

BESSEL_JN(N, X) computes the Bessel function of the first kind of order *N* of *X*. This function is available under the name BESJN as a GNU extension. If *N* and *X* are arrays, their ranks and shapes shall conform.

BESSEL_JN(N1, N2, X) returns an array with the Bessel functions of the first kind of the orders *N1* to *N2*.

Class: Elemental function, except for the transformational function BESSEL_JN(N1, N2, X)

Arguments:

<i>N</i>	Shall be a scalar or an array of type INTEGER.
<i>N1</i>	Shall be a non-negative scalar of type INTEGER.
<i>N2</i>	Shall be a non-negative scalar of type INTEGER.
<i>X</i>	Shall be a scalar or an array of type REAL; for BESSEL_JN(N1, N2, X) it shall be scalar.

Return value:

The return value is a scalar of type REAL. It has the same kind as *X*.

Notes: The transformational function uses a recurrence algorithm which might, for some values of *X*, lead to different results than calls to the elemental function.

Example:

```
program test_besjn
  real(8) :: x = 1.0_8
  x = besse_jn(5,x)
end program test_besjn
```

Specific names:

Name	Argument	Return type	Standard
DBESJN(N, X)	INTEGER N REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2008 and later, negative *N* is allowed as GNU extension

8.47 BESSEL_Y0 — Bessel function of the second kind of order 0

Synopsis: RESULT = BESSEL_Y0(X)

Description:

BESSEL_Y0(X) computes the Bessel function of the second kind of order 0 of X. This function is available under the name BESY0 as a GNU extension.

Class: Elemental function

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL. It has the same kind as X.

Example:

```
program test_besy0
  real(8) :: x = 0.0_8
  x = bessell_y0(x)
end program test_besy0
```

Specific names:

Name	Argument	Return type	Standard
DBESY0(X)	REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2008 and later

8.48 BESSEL_Y1 — Bessel function of the second kind of order 1

Synopsis: RESULT = BESSEL_Y1(X)

Description:

BESSEL_Y1(X) computes the Bessel function of the second kind of order 1 of X. This function is available under the name BESY1 as a GNU extension.

Class: Elemental function

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL. It has the same kind as X.

Example:

```
program test_besy1
  real(8) :: x = 1.0_8
  x = bessell_y1(x)
end program test_besy1
```

Specific names:

Name	Argument	Return type	Standard
DBESY1(X)	REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2008 and later

8.49 BESSEL_YN — Bessel function of the second kind

Synopsis:

```
RESULT = BESSEL_YN(N, X)
RESULT = BESSEL_YN(N1, N2, X)
```

Description:

BESSEL_YN(N, X) computes the Bessel function of the second kind of order *N* of *X*. This function is available under the name **BESYN** as a GNU extension. If *N* and *X* are arrays, their ranks and shapes shall conform.

BESSEL_YN(N1, N2, X) returns an array with the Bessel functions of the first kind of the orders *N1* to *N2*.

Class: Elemental function, except for the transformational function BESSEL_YN(N1, N2, X)

Arguments:

<i>N</i>	Shall be a scalar or an array of type INTEGER .
<i>N1</i>	Shall be a non-negative scalar of type INTEGER .
<i>N2</i>	Shall be a non-negative scalar of type INTEGER .
<i>X</i>	Shall be a scalar or an array of type REAL ; for BESSEL_YN(N1, N2, X) it shall be scalar.

Return value:

The return value is a scalar of type **REAL**. It has the same kind as *X*.

Notes: The transformational function uses a recurrence algorithm which might, for some values of *X*, lead to different results than calls to the elemental function.

Example:

```
program test_besyn
  real(8) :: x = 1.0_8
  x = besSEL_yn(5,x)
end program test_besyn
```

Specific names:

Name	Argument	Return type	Standard
DBESYN(N,X)	INTEGER N	REAL(8)	GNU extension
	REAL(8) X		

Standard: Fortran 2008 and later, negative *N* is allowed as GNU extension

8.50 BGE — Bitwise greater than or equal to

Synopsis: RESULT = BGE(I, J)

Description:

Determines whether an integral is a bitwise greater than or equal to another.

Class: Elemental function

Arguments:

<i>I</i>	Shall be of INTEGER or UNSIGNED type.
<i>J</i>	Shall be of the same type and kind as <i>I</i> .

Return value:

The return value is of type `LOGICAL` and of the default kind.

Notes: For `UNSIGNED` arguments, this function is identical to the `.GE.` and `>=` operators.

Standard: Fortran 2008 and later, extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.51 [BGT], page 153,
Section 8.53 [BLE], page 154,
Section 8.54 [BLT], page 154,

8.51 BGT — Bitwise greater than

Synopsis: `RESULT = BGT(I, J)`

Description:

Determines whether an integral is a bitwise greater than another.

Class: Elemental function

Arguments:

<i>I</i>	Shall be of <code>INTEGER</code> or <code>UNSIGNED</code> type.
<i>J</i>	Shall be of the same type and kind as <i>I</i> .

Return value:

The return value is of type `LOGICAL` and of the default kind.

Notes: For `UNSIGNED` arguments, this function is identical to the `.GT.` and `>` operators.

Standard: Fortran 2008 and later, extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.50 [BGE], page 152,
Section 8.53 [BLE], page 154,
Section 8.54 [BLT], page 154,

8.52 BIT_SIZE — Bit size inquiry function

Synopsis: `RESULT = BIT_SIZE(I)`

Description:

`BIT_SIZE(I)` returns the number of bits (for integers, the precision plus the sign bit) represented by the type of *I*. The result of `BIT_SIZE(I)` is independent of the actual value of *I*.

Class: Inquiry function

Arguments:

<i>I</i>	The type shall be <code>INTEGER</code> or <code>UNSIGNED</code> .
----------	---

Return value:

The return value is of type `INTEGER`

Example:

```

program test_bit_size
  integer :: i = 123
  integer :: size
  size = bit_size(i)
  print *, size
end program test_bit_size

```

Standard: Fortran 90 and later, extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

8.53 BLE — Bitwise less than or equal to

Synopsis: RESULT = BLE(I, J)

Description:

Determines whether an integral is a bitwise less than or equal to another.

Class: Elemental function

Arguments:

<i>I</i>	Shall be of INTEGER or UNSIGNED type.
<i>J</i>	Shall be of the same type and kind as <i>I</i> .

Return value:

The return value is of type LOGICAL and of the default kind.

Notes: For UNSIGNED arguments, this function is identical to the .LE. and <= operators.

Standard: Fortran 2008 and later, extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.51 [BGT], page 153,
 Section 8.50 [BGE], page 152,
 Section 8.54 [BLT], page 154,

8.54 BLT — Bitwise less than

Synopsis: RESULT = BLT(I, J)

Description:

Determines whether an integral is a bitwise less than another.

Class: Elemental function

Arguments:

<i>I</i>	Shall be of INTEGER or UNSIGNED type.
<i>J</i>	Shall be of the same type and kind as <i>I</i> .

Return value:

The return value is of type LOGICAL and of the default kind.

Notes: For UNSIGNED arguments, this function is identical to the .LT. and < operators.

Standard: Fortran 2008 and later, extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.50 [BGE], page 152,
 Section 8.51 [BGT], page 153,
 Section 8.53 [BLE], page 154,

8.55 BTEST — Bit test function

Synopsis: RESULT = BTEST(I, POS)

Description:

BTEST(I, POS) returns logical .TRUE. if the bit at POS in I is set. The counting of the bits starts at 0.

Class: Elemental function

Arguments:

I The type shall be INTEGER or UNSIGNED.
 POS The type shall be INTEGER.

Return value:

The return value is of type LOGICAL

Example:

```
program test_btest
  integer :: i = 32768 + 1024 + 64
  integer :: pos
  logical :: bool
  do pos=0,16
    bool = btest(i, pos)
    print *, pos, bool
  end do
end program test_btest
```

Specific names:

Name	Argument	Return type	Standard
BTEST(I, POS)	INTEGER I, POS	LOGICAL	Fortran 95 and later
BBTEST(I, POS)	INTEGER(1) I, POS	LOGICAL(1)	GNU extension
BITEST(I, POS)	INTEGER(2) I, POS	LOGICAL(2)	GNU extension
BJTEST(I, POS)	INTEGER(4) I, POS	LOGICAL(4)	GNU extension
BKTEST(I, POS)	INTEGER(8) I, POS	LOGICAL(8)	GNU extension

Standard: Fortran 90 and later, has overloads that are GNU extensions; extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

8.56 C_ASSOCIATED — Status of a C pointer

Synopsis: RESULT = C_ASSOCIATED(CPTR1[, CPTR2])

Description:

C_ASSOCIATED(CPTR1[, CPTR2]) determines the status of the C pointer CPTR1 or if CPTR1 is associated with the target CPTR2.

Class: Inquiry function

Arguments:

CPTR1 Scalar of the type `C_PTR` or `C_FUNPTR`.
CPTR2 (Optional) Scalar of the same type as *CPTR1*.

Return value:

The return value is of type `LOGICAL`; it is `.false.` if either *CPTR1* is a C NULL pointer or if *CPTR1* and *CPTR2* point to different addresses.

Example:

```
subroutine association_test(a,b)
  use iso_c_binding, only: c_associated, c_loc, c_ptr
  implicit none
  real, pointer :: a
  type(c_ptr) :: b
  if(c_associated(b, c_loc(a))) &
    stop 'b and a do not point to same target'
end subroutine association_test
```

Standard: Fortran 2003 and later

See also: Section 8.60 [`C_LOC`], page 158,
 Section 8.59 [`C_FUNLOC`], page 158,

8.57 `C_F_POINTER` — Convert C into Fortran pointer

Synopsis: `CALL C_F_POINTER(CPTR, FPTR[, SHAPE, LOWER])`

Description:

`C_F_POINTER(CPTR, FPTR[, SHAPE, LOWER])` assigns the target of the C pointer *CPTR* to the Fortran pointer *FPTR* and specifies its shape. For an array *FPTR*, the lower bounds are specified by *LOWER* if present and otherwise equal to 1.

Class: Subroutine

Arguments:

CPTR scalar of the type `C_PTR`. It is `INTENT(IN)`.
FPTR pointer interoperable with *cptr*. It is `INTENT(OUT)`.
SHAPE (Optional) Rank-one array of type `INTEGER` with `INTENT(IN)`. It shall be present if and only if *FPTR* is an array. The size must be equal to the rank of *FPTR*.
LOWER (Optional) Rank-one array of type `INTEGER` with `INTENT(IN)`. It shall not be present if *SHAPE* is not present. The size must be equal to the rank of *FPTR*.

Example:

```
program main
  use iso_c_binding
  implicit none
  interface
    subroutine my_routine(p) bind(c,name='myC_func')
      import :: c_ptr
    end subroutine my_routine
  end interface
```

```

        type(c_ptr), intent(out) :: p
    end subroutine
end interface
type(c_ptr) :: cptr
real, pointer :: a(:)
call my_routine(cptr)
call c_f_pointer(cptr, a, [12])
end program main

```

Standard: Fortran 2003 and later, with *LOWER* argument Fortran 2023 and later

See also: Section 8.60 [C_LOC], page 158,
Section 8.58 [C_F_PROCPOINTER], page 157,

8.58 C_F_PROCPOINTER — Convert C into Fortran procedure pointer

Synopsis: CALL C_F_PROCPOINTER(CPTR, FPTR)

Description:

C_F_PROCPOINTER(CPTR, FPTR) Assign the target of the C function pointer *CPTR* to the Fortran procedure pointer *FPTR*.

Class: Subroutine

Arguments:

CPTR scalar of the type C_FUNPTR. It is INTENT(IN).
FPTR procedure pointer interoperable with *cptr*. It is INTENT(OUT).

Example:

```

program main
  use iso_c_binding
  implicit none
  abstract interface
    function func(a)
      import :: c_float
      real(c_float), intent(in) :: a
      real(c_float) :: func
    end function
  end interface
  interface
    function getIterFunc() bind(c,name="getIterFunc")
      import :: c_funptr
      type(c_funptr) :: getIterFunc
    end function
  end interface
  type(c_funptr) :: cfunptr
  procedure(func), pointer :: myFunc
  cfunptr = getIterFunc()
  call c_f_procpointer(cfunptr, myFunc)
end program main

```

Standard: Fortran 2003 and later

See also: Section 8.60 [C_LOC], page 158,
Section 8.57 [C_F_POINTER], page 156,

8.59 C_FUNLOC — Obtain the C address of a procedure

Synopsis: `RESULT = C_FUNLOC(X)`

Description:

`C_FUNLOC(X)` determines the C address of the argument.

Class: Inquiry function

Arguments:

`X` Interoperable function or pointer to such function.

Return value:

The return value is of type `C_FUNPTR` and contains the C address of the argument.

Example:

```

module x
  use iso_c_binding
  implicit none
contains
  subroutine sub(a) bind(c)
    real(c_float) :: a
    a = sqrt(a)+5.0
  end subroutine sub
end module x
program main
  use iso_c_binding
  use x
  implicit none
  interface
    subroutine myRoutine(p) bind(c,name='myC_func')
      import :: c_funptr
      type(c_funptr), intent(in) :: p
    end subroutine
  end interface
  call myRoutine(c_funloc(sub))
end program main

```

Standard: Fortran 2003 and later

See also: Section 8.56 [C_ASSOCIATED], page 155,
 Section 8.60 [C_LOC], page 158,
 Section 8.57 [C_F_POINTER], page 156,
 Section 8.58 [C_F_PROCPOINTER], page 157,

8.60 C_LOC — Obtain the C address of an object

Synopsis: `RESULT = C_LOC(X)`

Description:

`C_LOC(X)` determines the C address of the argument.

Class: Inquiry function

Arguments:

X Shall have either the `POINTER` or `TARGET` attribute. It shall not be a coindexed object. It shall either be a variable with interoperable type and kind type parameters, or be a scalar, nonpolymorphic variable with no length type parameters.

Return value:

The return value is of type `C_PTR` and contains the C address of the argument.

Example:

```
subroutine association_test(a,b)
  use iso_c_binding, only: c_associated, c_loc, c_ptr
  implicit none
  real, pointer :: a
  type(c_ptr) :: b
  if(c_associated(b, c_loc(a))) &
    stop 'b and a do not point to same target'
end subroutine association_test
```

Standard: Fortran 2003 and later

See also: Section 8.56 [`C_ASSOCIATED`], page 155,
 Section 8.59 [`C_FUNLOC`], page 158,
 Section 8.57 [`C_F_POINTER`], page 156,
 Section 8.58 [`C_F_PROCPOINTER`], page 157,

8.61 `C_SIZEOF` — Size in bytes of an expression

Synopsis: `N = C_SIZEOF(X)`

Description:

`C_SIZEOF(X)` calculates the number of bytes of storage the expression `X` occupies.

Class: Inquiry function of the module `ISO_C_BINDING`

Arguments:

X The argument shall be an interoperable data entity.

Return value:

The return value is of type integer and of the system-dependent kind `C_SIZE_T` (from the `ISO_C_BINDING` module). Its value is the number of bytes occupied by the argument. If the argument has the `POINTER` attribute, the number of bytes of the storage area pointed to is returned. If the argument is of a derived type with `POINTER` or `ALLOCATABLE` components, the return value does not account for the sizes of the data pointed to by these components.

Example:

```
use iso_c_binding
integer(c_int) :: i
real(c_float) :: r, s(5)
print *, (c_sizeof(s)/c_sizeof(r) == 5)
```

`end`

The example prints `T` unless you are using a platform where default `REAL` variables are unusually padded.

Standard: Fortran 2008

See also: Section 8.263 [SIZEOF], page 288,
Section 8.271 [STORAGE-SIZE], page 294,

8.62 CEILING — Integer ceiling function

Synopsis: `RESULT = CEILING(A [, KIND])`

Description:

`CEILING(A)` returns the least integer greater than or equal to `A`.

Class: Elemental function

Arguments:

<code>A</code>	The type shall be <code>REAL</code> .
<code>KIND</code>	(Optional) A scalar <code>INTEGER</code> constant expression indicating the kind parameter of the result.

Return value:

The return value is of type `INTEGER(KIND)` if `KIND` is present and a default-kind `INTEGER` otherwise.

Example:

```

program test_ceiling
  real :: x = 63.29
  real :: y = -63.59
  print *, ceiling(x) ! returns 64
  print *, ceiling(y) ! returns -63
end program test_ceiling

```

Standard: Fortran 95 and later

See also: Section 8.114 [FLOOR], page 196,
Section 8.212 [NINT], page 258,

8.63 CHAR — Character conversion function

Synopsis: `RESULT = CHAR(I [, KIND])`

Description:

`CHAR(I [, KIND])` returns the character represented by the integer `I`.

Class: Elemental function

Arguments:

<code>I</code>	The type shall be <code>INTEGER</code> .
<code>KIND</code>	(Optional) A scalar <code>INTEGER</code> constant expression indicating the kind parameter of the result.

Return value:

The return value is of type `CHARACTER(1)`

Example:

```

program test_char
  integer :: i = 74
  character(1) :: c
  c = char(i)
  print *, i, c ! returns 'J'
end program test_char

```

Specific names:

Name	Argument	Return type	Standard
CHAR(I)	INTEGER I	CHARACTER(LEN=1)	Fortran 77 and later

Notes: See Section 8.149 [ICHAR], page 219, for a discussion of converting between numerical values and formatted string representations.

Standard: Fortran 77 and later

See also: Section 8.5 [ACHAR], page 121,
 Section 8.141 [IACHAR], page 213,
 Section 8.149 [ICHAR], page 219,

8.64 CHDIR — Change working directory

Synopsis:

```

CALL CHDIR(NAME [, STATUS])
STATUS = CHDIR(NAME)

```

Description:

Change current working directory to a specified path.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

<i>NAME</i>	The type shall be CHARACTER of default kind and shall specify a valid path within the file system.
<i>STATUS</i>	(Optional) INTEGER status flag of the default kind. Returns 0 on success, and a system specific and nonzero error code otherwise.

Example:

```

PROGRAM test_chdir
  CHARACTER(len=255) :: path
  CALL getcwd(path)
  WRITE(*,*) TRIM(path)
  CALL chdir("/tmp")
  CALL getcwd(path)
  WRITE(*,*) TRIM(path)
END PROGRAM

```

Standard: GNU extension

See also: Section 8.129 [GETCWD], page 207,

8.65 CHMOD — Change access permissions of files

Synopsis:

```
CALL CHMOD(NAME, MODE[, STATUS])
STATUS = CHMOD(NAME, MODE)
```

Description:

CHMOD changes the permissions of a file.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

<i>NAME</i>	Scalar CHARACTER of default kind with the file name. Trailing blanks are ignored unless the character <code>achar(0)</code> is present, then all characters up to and excluding <code>achar(0)</code> are used as the file name.
<i>MODE</i>	Scalar CHARACTER of default kind giving the file permission. <i>MODE</i> uses the same syntax as the <code>chmod</code> utility as defined by the POSIX standard. The argument shall either be a string of a nonnegative octal number or a symbolic mode.
<i>STATUS</i>	(optional) scalar INTEGER, which is 0 on success and nonzero otherwise.

Return value:

In either syntax, *STATUS* is set to 0 on success and nonzero otherwise.

Example: CHMOD as subroutine

```
program chmod_test
  implicit none
  integer :: status
  call chmod('test.dat','u+x',status)
  print *, 'Status: ', status
end program chmod_test
```

CHMOD as function:

```
program chmod_test
  implicit none
  integer :: status
  status = chmod('test.dat','u+x')
  print *, 'Status: ', status
end program chmod_test
```

Standard: GNU extension

8.66 CMPLX — Complex conversion function

Synopsis: `RESULT = CMPLX(X [, Y [, KIND]])`

Description:

`CMPLX(X [, Y [, KIND]])` returns a complex number where *X* is converted to the real component. If *Y* is present it is converted to the imaginary component. If *Y* is not present then the imaginary component is set to 0.0. If *X* is complex then *Y* must not be present.

Class: Elemental function

Arguments:

<i>X</i>	The type may be <code>INTEGER</code> , <code>REAL</code> , <code>COMPLEX</code> or <code>UNSIGNED</code> .
<i>Y</i>	(Optional; only allowed if <i>X</i> is not <code>COMPLEX</code> .) May be <code>INTEGER</code> , <code>REAL</code> or <code>UNSIGNED</code> .
<i>KIND</i>	(Optional) A scalar <code>INTEGER</code> constant expression indicating the kind parameter of the result.

Return value:

The return value is of `COMPLEX` type, with a kind equal to *KIND* if it is specified. If *KIND* is not specified, the result is of the default `COMPLEX` kind, regardless of the kinds of *X* and *Y*.

Example:

```

program test_cmplx
  integer :: i = 42
  real :: x = 3.14
  complex :: z
  z = cmplx(i, x)
  print *, z, cmplx(x)
end program test_cmplx

```

Standard: Fortran 77 and later, extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.75 [COMPLEX], page 169,

8.67 CO_BROADCAST — Copy a value to all images the current set of images

Synopsis: `CALL CO_BROADCAST(A, SOURCE_IMAGE [, STAT, ERRMSG])`

Description:

`CO_BROADCAST` copies the value of argument *A* on the image with image index `SOURCE_IMAGE` to all images in the current team. *A* becomes defined as if by intrinsic assignment. If the execution was successful and *STAT* is present, it is assigned the value zero. If the execution failed, *STAT* gets assigned a nonzero value and, if present, *ERRMSG* gets assigned a value describing the occurred error.

Class: Collective subroutine

Arguments:

A INTENT(INOUT) argument; shall have the same dynamic type and type parameters on all images of the current team. If it is an array, it shall have the same shape on all images.

SOURCE_IMAGE a scalar integer expression. It shall have the same value on all images and refer to an image of the current team.

STAT (optional) a scalar integer variable

ERRMSG (optional) a scalar character variable

Example:

```

program test
  integer :: val(3)
  if (this_image() == 1) then
    val = [1, 5, 3]
  end if
  call co_broadcast (val, source_image=1)
  print *, this_image, ":", val
end program test

```

Standard: Technical Specification (TS) 18508 or later

See also: Section 8.68 [CO_MAX], page 164,
 Section 8.69 [CO_MIN], page 165,
 Section 8.71 [CO_SUM], page 167,
 Section 8.70 [CO_REDUCE], page 166,

8.68 CO_MAX — Maximal value on the current set of images

Synopsis: CALL CO_MAX(*A* [, *RESULT_IMAGE*, *STAT*, *ERRMSG*])

Description:

CO_MAX determines element-wise the maximal value of *A* on all images of the current team. If *RESULT_IMAGE* is present, the maximum values are returned in *A* on the specified image only and the value of *A* on the other images become undefined. If *RESULT_IMAGE* is not present, the value is returned on all images. If the execution was successful and *STAT* is present, it is assigned the value zero. If the execution failed, *STAT* gets assigned a nonzero value and, if present, *ERRMSG* gets assigned a value describing the occurred error.

Class: Collective subroutine

Arguments:

A shall be an integer, real or character variable, which has the same type and type parameters on all images of the team.

RESULT_IMAGE (optional) a scalar integer expression; if present, it shall have the same value on all images and refer to an image of the current team.

STAT (optional) a scalar integer variable

ERRMSG (optional) a scalar character variable

Example:

```

program test
  integer :: val
  val = this_image ()
  call co_max (val, result_image=1)
  if (this_image() == 1) then
    write(*,*) "Maximal value", val  ! prints num_images()
  end if
end program test

```

Standard: Technical Specification (TS) 18508 or later

See also: Section 8.69 [CO_MIN], page 165,
 Section 8.71 [CO_SUM], page 167,
 Section 8.70 [CO_REDUCE], page 166,
 Section 8.67 [CO_BROADCAST], page 163,

8.69 CO_MIN — Minimal value on the current set of images

Synopsis: CALL CO_MIN(A [, RESULT_IMAGE, STAT, ERRMSG])

Description:

CO_MIN determines element-wise the minimal value of *A* on all images of the current team. If *RESULT_IMAGE* is present, the minimal values are returned in *A* on the specified image only and the value of *A* on the other images become undefined. If *RESULT_IMAGE* is not present, the value is returned on all images. If the execution was successful and *STAT* is present, it is assigned the value zero. If the execution failed, *STAT* gets assigned a nonzero value and, if present, *ERRMSG* gets assigned a value describing the occurred error.

Class: Collective subroutine

Arguments:

<i>A</i>	shall be an integer, real or character variable, which has the same type and type parameters on all images of the team.
<i>RESULT_IMAGE</i> (optional)	a scalar integer expression; if present, it shall have the same value on all images and refer to an image of the current team.
<i>STAT</i>	(optional) a scalar integer variable
<i>ERRMSG</i>	(optional) a scalar character variable

Example:

```

program test
  integer :: val
  val = this_image ()
  call co_min (val, result_image=1)
  if (this_image() == 1) then
    write(*,*) "Minimal value", val  ! prints 1
  end if
end program test

```

Standard: Technical Specification (TS) 18508 or later

See also: Section 8.68 [CO_MAX], page 164,
 Section 8.71 [CO_SUM], page 167,
 Section 8.70 [CO_REDUCE], page 166,
 Section 8.67 [CO_BROADCAST], page 163,

8.70 CO_REDUCE — Reduction of values on the current set of images

Synopsis: CALL CO_REDUCE(A, OPERATION, [, RESULT_IMAGE, STAT, ERRMSG])

Description:

CO_REDUCE determines element-wise the reduction of the value of *A* on all images of the current team. The pure function passed as *OPERATION* is used to pairwise reduce the values of *A* by passing either the value of *A* of different images or the result values of such a reduction as argument. If *A* is an array, the deduction is done element wise. If *RESULT_IMAGE* is present, the result values are returned in *A* on the specified image only and the value of *A* on the other images become undefined. If *RESULT_IMAGE* is not present, the value is returned on all images. If the execution was successful and *STAT* is present, it is assigned the value zero. If the execution failed, *STAT* gets assigned a nonzero value and, if present, *ERRMSG* gets assigned a value describing the occurred error.

Class: Collective subroutine

Arguments:

<i>A</i>	is an <code>INTENT(INOUT)</code> argument and shall be non-polymorphic. If it is allocatable, it shall be allocated; if it is a pointer, it shall be associated. <i>A</i> shall have the same type and type parameters on all images of the team; if it is an array, it shall have the same shape on all images.
<i>OPERATION</i>	pure function with two scalar nonallocatable arguments, which shall be nonpolymorphic and have the same type and type parameters as <i>A</i> . The function shall return a nonallocatable scalar of the same type and type parameters as <i>A</i> . The function shall be the same on all images and with regards to the arguments mathematically commutative and associative. Note that <i>OPERATION</i> may not be an elemental function, unless it is an intrinsic function.
<i>RESULT_IMAGE</i> (optional)	a scalar integer expression; if present, it shall have the same value on all images and refer to an image of the current team.
<i>STAT</i>	(optional) a scalar integer variable
<i>ERRMSG</i>	(optional) a scalar character variable

Example:

```

program test
  integer :: val
  val = this_image ()
  call co_reduce (val, result_image=1, operation=myprod)
  if (this_image() == 1) then
    write(*,*) "Product value", val ! prints num_images() factorial
  end if
contains
  pure function myprod(a, b)
    integer, value :: a, b
    integer :: myprod
    myprod = a * b
  end function myprod
end program test

```

Notes: While the rules permit in principle an intrinsic function, none of the intrinsics in the standard fulfill the criteria of having a specific function, which takes two arguments of the same type and returning that type as result.

Standard: Technical Specification (TS) 18508 or later

See also: Section 8.69 [CO_MIN], page 165,
 Section 8.68 [CO_MAX], page 164,
 Section 8.71 [CO_SUM], page 167,
 Section 8.67 [CO_BROADCAST], page 163,

8.71 CO_SUM — Sum of values on the current set of images

Synopsis: CALL CO_SUM(A [, RESULT_IMAGE, STAT, ERRMSG])

Description:

CO_SUM sums up the values of each element of *A* on all images of the current team. If *RESULT_IMAGE* is present, the summed-up values are returned in *A* on the specified image only and the value of *A* on the other images become undefined. If *RESULT_IMAGE* is not present, the value is returned on all images. If the execution was successful and *STAT* is present, it is assigned the value zero. If the execution failed, *STAT* gets assigned a nonzero value and, if present, *ERRMSG* gets assigned a value describing the occurred error.

Class: Collective subroutine

Arguments:

<i>A</i>	shall be an integer, real or complex variable, which has the same type and type parameters on all images of the team.
<i>RESULT_IMAGE</i> (optional)	a scalar integer expression; if present, it shall have the same value on all images and refer to an image of the current team.
<i>STAT</i>	(optional) a scalar integer variable
<i>ERRMSG</i>	(optional) a scalar character variable

Example:

```

program test
  integer :: val

```

```

      val = this_image ()
      call co_sum (val, result_image=1)
      if (this_image() == 1) then
        write(*,*) "The sum is ", val ! prints (n**2 + n)/2,
                                   ! with n = num_images()
      end if
end program test

```

Standard: Technical Specification (TS) 18508 or later

See also: Section 8.68 [CO_MAX], page 164,
 Section 8.69 [CO_MIN], page 165,
 Section 8.70 [CO_REDUCE], page 166,
 Section 8.67 [CO_BROADCAST], page 163,

8.72 COMMAND_ARGUMENT_COUNT — Get number of command line arguments

Synopsis: RESULT = COMMAND_ARGUMENT_COUNT()

Description:

COMMAND_ARGUMENT_COUNT returns the number of arguments passed on the command line when the containing program was invoked.

Class: Inquiry function

Arguments:
 None

Return value:

The return value is an INTEGER of default kind.

Example:

```

program test_command_argument_count
  integer :: count
  count = command_argument_count()
  print *, count
end program test_command_argument_count

```

Standard: Fortran 2003 and later

See also: Section 8.127 [GET_COMMAND], page 205,
 Section 8.128 [GET_COMMAND_ARGUMENT], page 206,

8.73 COMPILER_OPTIONS — Options passed to the compiler

Synopsis: STR = COMPILER_OPTIONS()

Description:

COMPILER_OPTIONS returns a string with the options used for compiling.

Class: Inquiry function of the module ISO_FORTRAN_ENV

Arguments:
 None

Return value:

The return value is a default-kind string with system-dependent length. It contains the compiler flags used to compile the file that called the `COMPILER_OPTIONS` intrinsic.

Example:

```

use iso_fortran_env
print '(4a)', 'This file was compiled by ', &
    compiler_version(), ' using the options ', &
    compiler_options()

end

```

Standard: Fortran 2008

See also: Section 8.74 [`COMPILER_VERSION`], page 169,
Section 9.1 [`ISO_FORTRAN_ENV`], page 311,

8.74 `COMPILER_VERSION` — Compiler version string

Synopsis: `STR = COMPILER_VERSION()`

Description:

`COMPILER_VERSION` returns a string with the name and the version of the compiler.

Class: Inquiry function of the module `ISO_FORTRAN_ENV`

Arguments:

None

Return value:

The return value is a default-kind string with system-dependent length. It contains the name of the compiler and its version number.

Example:

```

use iso_fortran_env
print '(4a)', 'This file was compiled by ', &
    compiler_version(), ' using the options ', &
    compiler_options()

end

```

Standard: Fortran 2008

See also: Section 8.73 [`COMPILER_OPTIONS`], page 168,
Section 9.1 [`ISO_FORTRAN_ENV`], page 311,

8.75 `COMPLEX` — Complex conversion function

Synopsis: `RESULT = COMPLEX(X, Y)`

Description:

`COMPLEX(X, Y)` returns a complex number where *X* is converted to the real component and *Y* is converted to the imaginary component.

Class: Elemental function

Arguments:

X The type may be `INTEGER` or `REAL`.
Y The type may be `INTEGER` or `REAL`.

Return value:

If *X* and *Y* are both of `INTEGER` type, then the return value is of default `COMPLEX` type.

If *X* and *Y* are of `REAL` type, or one is of `REAL` type and one is of `INTEGER` type, then the return value is of `COMPLEX` type with a kind equal to that of the `REAL` argument with the highest precision.

Example:

```
program test_complex
  integer :: i = 42
  real :: x = 3.14
  print *, complex(i, x)
end program test_complex
```

Standard: GNU extension

See also: Section 8.66 [CMPLX], page 162,

8.76 CONJG — Complex conjugate function

Synopsis: `Z = CONJG(Z)`

Description:

`CONJG(Z)` returns the conjugate of *Z*. If *Z* is (*x*, *y*) then the result is (*x*, -*y*)

Class: Elemental function

Arguments:

Z The type shall be `COMPLEX`.

Return value:

The return value is of type `COMPLEX`.

Example:

```
program test_conjg
  complex :: z = (2.0, 3.0)
  complex(8) :: dz = (2.71_8, -3.14_8)
  z = conjg(z)
  print *, z
  dz = dconjg(dz)
  print *, dz
end program test_conjg
```

Specific names:

Name	Argument	Return type	Standard
<code>DCONJG(Z)</code>	<code>COMPLEX(8) Z</code>	<code>COMPLEX(8)</code>	GNU extension

Standard: Fortran 77 and later, has an overload that is a GNU extension

8.77 COS — Cosine function

Synopsis: `RESULT = COS(X)`

Description:

`COS(X)` computes the cosine of X .

Class: Elemental function

Arguments:

X The type shall be `REAL` or `COMPLEX`.

Return value:

The return value is of the same type and kind as X . The real part of the result is in radians. If X is of the type `REAL`, the return value lies in the range $-1 \leq \cos(x) \leq 1$.

Example:

```
program test_cos
  real :: x = 0.0
  x = cos(x)
end program test_cos
```

Specific names:

Name	Argument	Return type	Standard
<code>COS(X)</code>	<code>REAL(4) X</code>	<code>REAL(4)</code>	Fortran 77 and later
<code>DCOS(X)</code>	<code>REAL(8) X</code>	<code>REAL(8)</code>	Fortran 77 and later
<code>CCOS(X)</code>	<code>COMPLEX(4) X</code>	<code>COMPLEX(4)</code>	Fortran 77 and later
<code>ZCOS(X)</code>	<code>COMPLEX(8) X</code>	<code>COMPLEX(8)</code>	GNU extension
<code>CDCOS(X)</code>	<code>COMPLEX(8) X</code>	<code>COMPLEX(8)</code>	GNU extension

Standard: Fortran 77 and later, has overloads that are GNU extensions

See also: Inverse function:

Section 8.6 [`ACOS`], page 122,

Degrees function:

Section 8.78 [`COSD`], page 171,

8.78 COSD — Cosine function, degrees

Synopsis: `RESULT = COSD(X)`

Description:

`COSD(X)` computes the cosine of X in degrees.

Class: Elemental function

Arguments:

X The type shall be `REAL`.

Return value:

The return value is of the same type and kind as X and lies in the range $-1 \leq \cosd(x) \leq 1$.

Example:

```
program test_cosd
  real :: x = 0.0
  x = cosd(x)
end program test_cosd
```

Specific names:

Name	Argument	Return type	Standard
COSD(X)	REAL(4) X	REAL(4)	Fortran 2023
DCOSD(X)	REAL(8) X	REAL(8)	GNU extension
CCOSD(X)	COMPLEX(4) X	COMPLEX(4)	GNU extension
ZCOSD(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension
CDCOSD(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension

Standard: Fortran 2023

See also: Inverse function:
Section 8.7 [ACOSD], page 122,
Radians function:
Section 8.77 [COS], page 171,

8.79 COSH — Hyperbolic cosine function

Synopsis: X = COSH(X)

Description:

COSH(X) computes the hyperbolic cosine of X.

Class: Elemental function

Arguments:

X The type shall be REAL or COMPLEX.

Return value:

The return value has same type and kind as X. If X is complex, the imaginary part of the result is in radians. If X is REAL, the return value has a lower bound of one, $\cosh(x) \geq 1$.

Example:

```
program test_cosh
  real(8) :: x = 1.0_8
  x = cosh(x)
end program test_cosh
```

Specific names:

Name	Argument	Return type	Standard
COSH(X)	REAL(4) X	REAL(4)	Fortran 77 and later
DCOSH(X)	REAL(8) X	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later, for a complex argument Fortran 2008 or later

See also: Inverse function:
Section 8.8 [ACOSH], page 123,

8.80 COSPI — Circular cosine function

Description:

COSPI(*X*) computes $\cos(\pi x)$ without performing an explicit multiplication by π . This is achieved through argument reduction where $x = n + r$ with n an integer and $0 \leq r \leq 1$. Due to the properties of floating-point arithmetic, the useful range for *X* is defined by `ABS(X) <= REAL(2,KIND(X))**DIGITS(X)`.

Standard: Fortran 2023

Class: Elemental function

Syntax: `RESULT = COSPI(X)`

Arguments:

X The type shall be `REAL`.

Return value:

The return value is of the same type and kind as *X*. The result is in half-revolutions and satisfies $-1 \leq \text{cospi}(x) \leq 1$.

Example:

```
program test_cospi
  real :: x = 0.0
  x = cospi(x)
end program test_cospi
```

See also: Section 8.9 [ACOSPI], page 124,
Section 8.77 [COS], page 171,

8.81 COTAN — Cotangent function

Synopsis: `RESULT = COTAN(X)`

Description:

COTAN(*X*) computes the cotangent of *X*. Equivalent to `COS(x)` divided by `SIN(x)`, or `1 / TAN(x)`.

This function is for compatibility only and should be avoided in favor of standard constructs wherever possible.

Class: Elemental function

Arguments:

X The type shall be `REAL` or `COMPLEX`.

Return value:

The return value has same type and kind as *X*, and its value is in radians.

Example:

```
program test_cotan
  real(8) :: x = 0.165_8
  x = cotan(x)
end program test_cotan
```

Specific names:

Name	Argument	Return type	Standard
COTAN(X)	REAL(4) X	REAL(4)	GNU extension
DCOTAN(X)	REAL(8) X	REAL(8)	GNU extension

Standard: GNU extension, enabled with `-fdec-math`.

See also: Converse function:
Section 8.276 [TAN], page 297,
Degrees function:
Section 8.82 [COTAND], page 174,

8.82 COTAND — Cotangent function, degrees

Synopsis: RESULT = COTAND(X)

Description:

COTAND(X) computes the cotangent of X in degrees. Equivalent to COSD(x) divided by SIND(x), or 1 / TAND(x).

Class: Elemental function

Arguments:

X The type shall be REAL.

Return value:

The return value has same type and kind as X, and its value is in degrees.

Example:

```
program test_cotand
  real(8) :: x = 0.165_8
  x = cotand(x)
end program test_cotand
```

Specific names:

Name	Argument	Return type	Standard
COTAND(X)	REAL(4) X	REAL(4)	GNU extension
DCOTAND(X)	REAL(8) X	REAL(8)	GNU extension

Standard: GNU extension.

This function is for compatibility only and should be avoided in favor of standard constructs wherever possible.

See also: Converse function:
Section 8.277 [TAND], page 298,
Radians function:
Section 8.81 [COTAN], page 173,

8.83 COUNT — Count function

Synopsis: RESULT = COUNT(MASK [, DIM, KIND])

Description:

Counts the number of `.TRUE.` elements in a logical *MASK*, or, if the *DIM* argument is supplied, counts the number of elements along each row of the

array in the *DIM* direction. If the array has zero size, or all of the elements of *MASK* are *.FALSE.*, then the result is 0.

Class: Transformational function

Arguments:

<i>MASK</i>	The type shall be <i>LOGICAL</i> .
<i>DIM</i>	(Optional) The type shall be <i>INTEGER</i> .
<i>KIND</i>	(Optional) A scalar <i>INTEGER</i> constant expression indicating the kind parameter of the result.

Return value:

The return value is of type *INTEGER* and of kind *KIND*. If *KIND* is absent, the return value is of default integer kind. If *DIM* is present, the result is an array with a rank one less than the rank of *ARRAY*, and a size corresponding to the shape of *ARRAY* with the *DIM* dimension removed.

Example:

```

program test_count
  integer, dimension(2,3) :: a, b
  logical, dimension(2,3) :: mask
  a = reshape( (/ 1, 2, 3, 4, 5, 6 /), (/ 2, 3 /))
  b = reshape( (/ 0, 7, 3, 4, 5, 8 /), (/ 2, 3 /))
  print '(3i3)', a(1,:)
  print '(3i3)', a(2,:)
  print *
  print '(3i3)', b(1,:)
  print '(3i3)', b(2,:)
  print *
  mask = a.ne.b
  print '(3l3)', mask(1,:)
  print '(3l3)', mask(2,:)
  print *
  print '(3i3)', count(mask)
  print *
  print '(3i3)', count(mask, 1)
  print *
  print '(3i3)', count(mask, 2)
end program test_count

```

Standard: Fortran 90 and later, with *KIND* argument Fortran 2003 and later

8.84 CPU_TIME — CPU elapsed time in seconds

Synopsis: CALL CPU_TIME(*TIME*)

Description:

Returns a *REAL* value representing the elapsed CPU time in seconds. This is useful for testing segments of code to determine execution time.

If a time source is available, time is reported with microsecond resolution. If no time source is available, *TIME* is set to *-1.0*.

Note that *TIME* may contain a system-dependent arbitrary offset and may not start with 0.0. For *CPU_TIME*, the absolute value is meaningless; only differences between subsequent calls to this subroutine, as shown in the example below, should be used.

Class: Subroutine

Arguments:

TIME The type shall be REAL with INTENT(OUT).

Return value:

None

Example:

```
program test_cpu_time
  real :: start, finish
  call cpu_time(start)
  ! put code to test here
  call cpu_time(finish)
  print '("Time = ",f6.3," seconds.")',finish-start
end program test_cpu_time
```

Standard: Fortran 95 and later

See also: Section 8.275 [SYSTEM_CLOCK], page 296,
Section 8.87 [DATE_AND_TIME], page 178,

8.85 CSHIFT — Circular shift elements of an array

Synopsis: RESULT = CSHIFT(ARRAY, SHIFT [, DIM])

Description:

CSHIFT(ARRAY, SHIFT [, DIM]) performs a circular shift on elements of *ARRAY* along the dimension of *DIM*. If *DIM* is omitted it is taken to be 1. *DIM* is a scalar of type INTEGER in the range of $1 \leq DIM \leq n$) where *n* is the rank of *ARRAY*. If the rank of *ARRAY* is one, then all elements of *ARRAY* are shifted by *SHIFT* places. If rank is greater than one, then all complete rank one sections of *ARRAY* along the given dimension are shifted. Elements shifted out one end of each rank one section are shifted back in the other end.

Class: Transformational function

Arguments:

ARRAY Shall be an array of any type.

SHIFT The type shall be INTEGER.

DIM The type shall be INTEGER.

Notes: *ARRAY* can also be UNSIGNED.

Return value:

Returns an array of same type and rank as the *ARRAY* argument.

Example:

```
program test_cshift
  integer, dimension(3,3) :: a
  a = reshape( (/ 1, 2, 3, 4, 5, 6, 7, 8, 9 /), (/ 3, 3 /))
  print '(3i3)', a(1,:)
  print '(3i3)', a(2,:)
  print '(3i3)', a(3,:)
  a = cshift(a, SHIFT=(/1, 2, -1/), DIM=2)
  print *
```

```

      print '(3i3)', a(1,:)
      print '(3i3)', a(2,:)
      print '(3i3)', a(3,:)
end program test_cshift

```

Standard: Fortran 90 and later

8.86 CTIME — Convert a time into a string

Synopsis:

```

CALL CTIME(TIME, RESULT).
RESULT = CTIME(TIME).

```

Description:

CTIME converts a system time value, such as returned by Section 8.283 [TIME8], page 301, to a string. The output is of the form ‘Sat Aug 19 18:13:14 1995’.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

<i>TIME</i>	The type shall be of type INTEGER .
<i>RESULT</i>	The type shall be of type CHARACTER and of default kind. It is an INTENT(OUT) argument. If the length of this variable is too short for the time and date string to fit completely, it is blank on procedure return.

Return value:

The converted date and time as a string.

Example:

```

program test_ctime
  integer(8) :: i
  character(len=30) :: date
  i = time8()

  ! Do something, main part of the program

  call ctime(i,date)
  print *, 'Program was started on ', date
end program test_ctime

```

Standard: GNU extension

See also: Section 8.87 [DATE_AND_TIME], page 178,
 Section 8.137 [GMTIME], page 211,
 Section 8.189 [LTIME], page 243,
 Section 8.282 [TIME], page 301,
 Section 8.283 [TIME8], page 301,

8.87 DATE_AND_TIME — Date and time subroutine

Synopsis: CALL DATE_AND_TIME([DATE, TIME, ZONE, VALUES])

Description:

DATE_AND_TIME(DATE, TIME, ZONE, VALUES) gets the corresponding date and time information from the real-time system clock. *DATE* is INTENT(OUT) and of the form ccyymmdd. *TIME* is INTENT(OUT) and of the form hhmmss.sss. *ZONE* is INTENT(OUT) and of the form (+-)hhmm, representing the difference with respect to Coordinated Universal Time (UTC). Unavailable time and date parameters return blanks.

VALUES is INTENT(OUT) and provides the following:

VALUES(1): The year, including the century
 VALUES(2): The month of the year
 VALUES(3): The day of the month
 VALUES(4): The time difference from UTC in minutes
 VALUES(5): The hour of the day
 VALUES(6): The minutes of the hour
 VALUES(7): The seconds of the minute
 VALUES(8): The milliseconds of the second

Class: Subroutine

Arguments:

DATE (Optional) Scalar of type default CHARACTER. Recommended length is 8 or larger.
TIME (Optional) Scalar of type default CHARACTER. Recommended length is 10 or larger.
ZONE (Optional) Scalar of type default CHARACTER. Recommended length is 5 or larger.
VALUES (Optional) Rank-1 array of type INTEGER with a decimal exponent range of at least four and array size at least 8.

Return value:

None

Example:

```
program test_time_and_date
  character(8) :: date
  character(10) :: time
  character(5) :: zone
  integer,dimension(8) :: values
  ! using keyword arguments
  call date_and_time(date,time,zone,values)
  call date_and_time(DATE=date,ZONE=zone)
  call date_and_time(TIME=time)
  call date_and_time(VALUES=values)
  print '(a,2x,a,2x,a)', date, time, zone
  print '(8i5)', values
end program test_time_and_date
```

Standard: Fortran 90 and later

See also: Section 8.84 [CPU_TIME], page 175,
Section 8.275 [SYSTEM_CLOCK], page 296,

8.88 DBLE — Double conversion function

Synopsis: RESULT = DBLE(A)

Description:

DBLE(A) Converts A to double precision real type.

Class: Elemental function

Arguments:

A The type shall be INTEGER, REAL, or COMPLEX.

Return value:

The return value is of type double precision real.

Example:

```
program test_dble
  real    :: x = 2.18
  integer :: i = 5
  complex :: z = (2.3,1.14)
  print *, dble(x), dble(i), dble(z)
end program test_dble
```

Standard: Fortran 77 and later

See also: Section 8.235 [REAL], page 272,

8.89 DCMLPX — Double complex conversion function

Synopsis: RESULT = DCMLPX(X [, Y])

Description:

DCMLPX(X [,Y]) returns a double complex number where X is converted to the real component. If Y is present it is converted to the imaginary component. If Y is not present then the imaginary component is set to 0.0. If X is complex then Y must not be present.

Class: Elemental function

Arguments:

X The type may be INTEGER, REAL, or COMPLEX.
Y (Optional if X is not COMPLEX.) May be INTEGER or
REAL.

Return value:

The return value is of type COMPLEX(8)

Example:

```
program test_dcmlpx
  integer :: i = 42
  real    :: x = 3.14
  complex :: z
  z = cmlpx(i, x)
```

```

      print *, dcmplx(i)
      print *, dcmplx(x)
      print *, dcmplx(z)
      print *, dcmplx(x,i)
    end program test_dcmplx

```

Standard: GNU extension

8.90 DIGITS — Significant binary digits function

Synopsis: RESULT = DIGITS(X)

Description:

DIGITS(X) returns the number of significant binary digits of the internal model representation of X. For example, on a system using a 32-bit floating point representation, a default real number would likely return 24.

Class: Inquiry function

Arguments:

X The type may be INTEGER, REAL or UNSIGNED.

Return value:

The return value is of type INTEGER.

Example:

```

    program test_digits
      integer :: i = 12345
      real :: x = 3.143
      real(8) :: y = 2.33
      print *, digits(i)
      print *, digits(x)
      print *, digits(y)
    end program test_digits

```

Standard: Fortran 90 and later, extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

8.91 DIM — Positive difference

Synopsis: RESULT = DIM(X, Y)

Description:

DIM(X,Y) returns the difference X-Y if the result is positive; otherwise returns zero.

Class: Elemental function

Arguments:

X The type shall be INTEGER or REAL
 Y The type shall be the same type and kind as X. (As a GNU extension, arguments of different kinds are permitted.)

Return value:

The return value is of type INTEGER or REAL. (As a GNU extension, kind is the largest kind of the actual arguments.)

Example:

```

program test_dim
  integer :: i
  real(8) :: x
  i = dim(4, 15)
  x = dim(4.345_8, 2.111_8)
  print *, i
  print *, x
end program test_dim

```

Specific names:

Name	Argument	Return type	Standard
DIM(X,Y)	REAL(4) X, Y	REAL(4)	Fortran 77 and later
IDIM(X,Y)	INTEGER(4) X, Y	INTEGER(4)	Fortran 77 and later
DDIM(X,Y)	REAL(8) X, Y	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later

8.92 DOT_PRODUCT — Dot product function

Synopsis: RESULT = DOT_PRODUCT(VECTOR_A, VECTOR_B)

Description:

DOT_PRODUCT(VECTOR_A, VECTOR_B) computes the dot product multiplication of two vectors *VECTOR_A* and *VECTOR_B*. The two vectors may be either numeric or logical and must be arrays of rank one and of equal size. If the vectors are INTEGER, REAL or UNSIGNED, the result is SUM(VECTOR_A*VECTOR_B). If the vectors are COMPLEX, the result is SUM(CONJG(VECTOR_A)*VECTOR_B). If the vectors are LOGICAL, the result is ANY(VECTOR_A .AND. VECTOR_B). If one of *VECTOR_A* or *VECTOR_B* is UNSIGNED, the other one shall also be UNSIGNED.

Class: Transformational function

Arguments:

VECTOR_A The type shall be numeric or LOGICAL, rank 1. If *VECTOR_B* is UNSIGNED, *VECTOR_A* shall also be unsigned.

VECTOR_B The type shall if *VECTOR_A* is of numeric type or LOGICAL if *VECTOR_A* is of type LOGICAL. *VECTOR_B* shall be a rank-one array. If *VECTOR_A* is UNSIGNED, *VECTOR_B* shall also be unsigned.

Return value:

If the arguments are numeric, the return value is a scalar of numeric type, INTEGER, REAL, COMPLEX or UNSIGNED. If the arguments are LOGICAL, the return value is .TRUE. or .FALSE..

Example:

```

program test_dot_prod

```

```

integer, dimension(3) :: a, b
a = (/ 1, 2, 3 /)
b = (/ 4, 5, 6 /)
print '(3i3)', a
print *
print '(3i3)', b
print *
print *, dot_product(a,b)
end program test_dot_prod

```

Standard: Fortran 90 and later, extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

8.93 DPROD — Double product function

Synopsis: RESULT = DPROD(X, Y)

Description:

DPROD(X,Y) returns the product X*Y.

Class: Elemental function

Arguments:

X The type shall be REAL.
Y The type shall be REAL.

Return value:

The return value is of type REAL(8).

Example:

```

program test_dprod
  real :: x = 5.2
  real :: y = 2.3
  real(8) :: d
  d = dprod(x,y)
  print *, d
end program test_dprod

```

Specific names:

Name	Argument	Return type	Standard
DPROD(X,Y)	REAL(4) X, Y	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later

8.94 DREAL — Double real part function

Synopsis: RESULT = DREAL(A)

Description:

DREAL(Z) returns the real part of complex variable Z.

Class: Elemental function

Arguments:

A The type shall be COMPLEX(8).

Return value:

The return value is of type `REAL(8)`.

Example:

```
program test_dreal
  complex(8) :: z = (1.3_8,7.2_8)
  print *, dreal(z)
end program test_dreal
```

Standard: GNU extension

See also: Section 8.12 [AIMAG], page 125,

8.95 DSHIFTL — Combined left shift

Synopsis: `RESULT = DSHIFTL(I, J, SHIFT)`

Description:

`DSHIFTL(I, J, SHIFT)` combines bits of *I* and *J*. The rightmost *SHIFT* bits of the result are the leftmost *SHIFT* bits of *J*, and the remaining bits are the rightmost bits of *I*.

Class: Elemental function

Arguments:

<i>I</i>	Shall be of type <code>INTEGER</code> , <code>UNSIGNED</code> or a <code>BOZ</code> constant.
<i>J</i>	Shall be of type <code>INTEGER</code> , <code>UNSIGNED</code> or a <code>BOZ</code> constant. If both <i>I</i> and <i>J</i> have <code>INTEGER</code> or <code>UNSIGNED</code> type, then they shall have the same type and kind type parameter. <i>I</i> and <i>J</i> shall not both be <code>BOZ</code> constants.
<i>SHIFT</i>	Shall be of type <code>INTEGER</code> . It shall be nonnegative. If <i>I</i> is not a <code>BOZ</code> constant, then <i>SHIFT</i> shall be less than or equal to <code>BIT_SIZE(I)</code> ; otherwise, <i>SHIFT</i> shall be less than or equal to <code>BIT_SIZE(J)</code> .

Return value:

The return value is the same type and type kind parameter as *I* or, if *I* is a `BOZ` constant, *J*.

Standard: Fortran 2008 and later, extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.96 [DSHIFTR], page 183,

8.96 DSHIFTR — Combined right shift

Synopsis: `RESULT = DSHIFTR(I, J, SHIFT)`

Description:

`DSHIFTR(I, J, SHIFT)` combines bits of *I* and *J*. The leftmost *SHIFT* bits of the result are the rightmost *SHIFT* bits of *I*, and the remaining bits are the leftmost bits of *J*.

Class: Elemental function

Arguments:

<i>I</i>	Shall be of type <code>INTEGER</code> , <code>UNSIGNED</code> or a <code>BOZ</code> constant.
<i>J</i>	Shall be of type <code>INTEGER</code> , <code>UNSIGNED</code> or a <code>BOZ</code> constant. If both <i>I</i> and <i>J</i> have <code>INTEGER</code> or <code>UNSIGNED</code> type, then they shall have the same type and kind type parameter. <i>I</i> and <i>J</i> shall not both be <code>BOZ</code> constants.
<i>SHIFT</i>	Shall be of type <code>INTEGER</code> . It shall be nonnegative. If <i>I</i> is not a <code>BOZ</code> constant, then <i>SHIFT</i> shall be less than or equal to <code>BIT_SIZE(I)</code> ; otherwise, <i>SHIFT</i> shall be less than or equal to <code>BIT_SIZE(J)</code> .

Return value:

The return value is the same type and type kind parameter as *I* or, if *I* is a `BOZ` constant, *J*.

Standard: Fortran 2008 and later, extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.95 [DSHIFTL], page 183,

8.97 DTIME — Execution time subroutine (or function)

Synopsis:

```
CALL DTIME(VALUES, TIME).
TIME = DTIME(VALUES), (not recommended).
```

Description:

`DTIME(VALUES, TIME)` initially returns the number of seconds of runtime since the start of the process's execution in *TIME*. *VALUES* returns the user and system components of this time in `VALUES(1)` and `VALUES(2)` respectively. *TIME* is equal to `VALUES(1) + VALUES(2)`.

Subsequent invocations of `DTIME` return values accumulated since the previous invocation.

On some systems, the underlying timings are represented using types with sufficiently small limits that overflows (wrap around) are possible, such as 32-bit types. Therefore, the values returned by this intrinsic might be, or become, negative, or numerically less than previous values, during a single run of the compiled program.

Please note that this implementation is thread safe if used within OpenMP directives, i.e., its state is consistent while called from multiple threads. However, if `DTIME` is called from multiple threads, the result is still the time since the last invocation. This may not give the intended results. If possible, use `CPU_TIME` instead.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

VALUES and *TIME* are *INTENT(OUT)* and provide the following:

VALUES(1): User time in seconds.
VALUES(2): System time in seconds.
TIME: Run time since start in seconds.

Class: Subroutine, function

Arguments:

VALUES The type shall be *REAL*(4), *DIMENSION*(2).
TIME The type shall be *REAL*(4).

Return value:

Elapsed time in seconds since the last invocation or since the start of program execution if not called before.

Example:

```
program test_dtime
  integer(8) :: i, j
  real, dimension(2) :: tarray
  real :: result
  call dtime(tarray, result)
  print *, result
  print *, tarray(1)
  print *, tarray(2)
  do i=1,100000000 ! Just a delay
    j = i * i - i
  end do
  call dtime(tarray, result)
  print *, result
  print *, tarray(1)
  print *, tarray(2)
end program test_dtime
```

Standard: GNU extension

See also: Section 8.84 [CPU_TIME], page 175,

8.98 EOSHIFT — End-off shift elements of an array

Synopsis: *RESULT* = *EOSHIFT*(*ARRAY*, *SHIFT* [, *BOUNDARY*, *DIM*])

Description:

EOSHIFT(*ARRAY*, *SHIFT* [, *BOUNDARY*, *DIM*]) performs an end-off shift on elements of *ARRAY* along the dimension of *DIM*. If *DIM* is omitted it is taken to be 1. *DIM* is a scalar of type *INTEGER* in the range of $1 \leq DIM \leq n$ where *n* is the rank of *ARRAY*. If the rank of *ARRAY* is one, then all elements of *ARRAY* are shifted by *SHIFT* places. If rank is greater than one, then all complete rank one sections of *ARRAY* along the given dimension are shifted. Elements shifted out one end of each rank one section are dropped. If *BOUNDARY* is present then the corresponding value of from *BOUNDARY* is copied back in the other end. If *BOUNDARY* is not present then the following are copied in depending on the type of *ARRAY*.

<i>Array Type</i>	<i>Boundary Value</i>
Numeric	0 of the type and kind of <i>ARRAY</i> .

Logical .FALSE..
 Character(*len*)*len* blanks.

Class: Transformational function

Arguments:

ARRAY May be any type, not scalar.
SHIFT The type shall be INTEGER.
BOUNDARY Same type as *ARRAY*.
DIM The type shall be INTEGER.

Notes: *ARRAY* can also be UNSIGNED.

Return value:

Returns an array of same type and rank as the *ARRAY* argument.

Example:

```
program test_eoshift
  integer, dimension(3,3) :: a
  a = reshape( (/ 1, 2, 3, 4, 5, 6, 7, 8, 9 /), (/ 3, 3 /))
  print '(3i3)', a(1,:)
  print '(3i3)', a(2,:)
  print '(3i3)', a(3,:)
  a = EOSHIFT(a, SHIFT=(/1, 2, 1/), BOUNDARY=-5, DIM=2)
  print *
  print '(3i3)', a(1,:)
  print '(3i3)', a(2,:)
  print '(3i3)', a(3,:)
end program test_eoshift
```

Standard: Fortran 90 and later, extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

8.99 EPSILON — Epsilon function

Synopsis: RESULT = EPSILON(X)

Description:

EPSILON(X) returns the smallest number *E* of the same kind as *X* such that $1 + E > 1$.

Class: Inquiry function

Arguments:

X The type shall be REAL.

Return value:

The return value is of same type as the argument.

Example:

```
program test_epsilon
  real :: x = 3.143
  real(8) :: y = 2.33
  print *, EPSILON(x)
  print *, EPSILON(y)
end program test_epsilon
```

Standard: Fortran 90 and later

8.100 ERF — Error function

Synopsis: `RESULT = ERF(X)`

Description:

`ERF(X)` computes the error function of X .

Class: Elemental function

Arguments:

X The type shall be `REAL`.

Return value:

The return value is of type `REAL`, of the same kind as X and lies in the range $-1 \leq \operatorname{erf}(x) \leq 1$.

Example:

```
program test_erf
  real(8) :: x = 0.17_8
  x = erf(x)
end program test_erf
```

Specific names:

Name	Argument	Return type	Standard
<code>DERF(X)</code>	<code>REAL(8) X</code>	<code>REAL(8)</code>	GNU extension

Standard: Fortran 2008 and later

8.101 ERFC — Error function

Synopsis: `RESULT = ERFC(X)`

Description:

`ERFC(X)` computes the complementary error function of X .

Class: Elemental function

Arguments:

X The type shall be `REAL`.

Return value:

The return value is of type `REAL` and of the same kind as X . It lies in the range $0 \leq \operatorname{erfc}(x) \leq 2$.

Example:

```
program test_erfc
  real(8) :: x = 0.17_8
  x = erfc(x)
end program test_erfc
```

Specific names:

Name	Argument	Return type	Standard
<code>DERFC(X)</code>	<code>REAL(8) X</code>	<code>REAL(8)</code>	GNU extension

Standard: Fortran 2008 and later

8.102 ERFC_SCALED — Error function

Synopsis: `RESULT = ERFC_SCALED(X)`

Description:

`ERFC_SCALED(X)` computes the exponentially-scaled complementary error function of X .

Class: Elemental function

Arguments:

`X` The type shall be `REAL`.

Return value:

The return value is of type `REAL` and of the same kind as X .

Example:

```
program test_erfc_scaled
  real(8) :: x = 0.17_8
  x = erfc_scaled(x)
end program test_erfc_scaled
```

Standard: Fortran 2008 and later

8.103 ETIME — Execution time subroutine (or function)

Synopsis:

`CALL ETIME(VALUES, TIME).`
`TIME = ETIME(VALUES),` (not recommended).

Description:

`ETIME(VALUES, TIME)` returns the number of seconds of runtime since the start of the process's execution in `TIME`. `VALUES` returns the user and system components of this time in `VALUES(1)` and `VALUES(2)` respectively. `TIME` is equal to `VALUES(1) + VALUES(2)`.

On some systems, the underlying timings are represented using types with sufficiently small limits that overflows (wrap around) are possible, such as 32-bit types. Therefore, the values returned by this intrinsic might be, or become, negative, or numerically less than previous values, during a single run of the compiled program.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

`VALUES` and `TIME` are `INTENT(OUT)` and provide the following:

`VALUES(1):` User time in seconds.
`VALUES(2):` System time in seconds.
`TIME:` Run time since start in seconds.

Class: Subroutine, function

Arguments:

`VALUES` The type shall be `REAL(4)`, `DIMENSION(2)`.
`TIME` The type shall be `REAL(4)`.

Return value:

Elapsed time in seconds since the start of program execution.

Example:

```

program test_etime
  integer(8) :: i, j
  real, dimension(2) :: tarray
  real :: result
  call ETIME(tarray, result)
  print *, result
  print *, tarray(1)
  print *, tarray(2)
  do i=1,1000000000    ! Just a delay
    j = i * i - i
  end do
  call ETIME(tarray, result)
  print *, result
  print *, tarray(1)
  print *, tarray(2)
end program test_etime

```

Standard: GNU extension

See also: Section 8.84 [CPU_TIME], page 175,

8.104 EVENT_QUERY — Query whether a coarray event has occurred

Synopsis: CALL EVENT_QUERY (EVENT, COUNT [, STAT])

Description:

EVENT_QUERY assigns the number of events to *COUNT* that have been posted to the *EVENT* variable and not yet been removed by calling EVENT_WAIT. When *STAT* is present and the invocation is successful, it is assigned the value 0. If it is present and the invocation fails, it is assigned a positive value and *COUNT* is assigned the value -1 .

Class: subroutine

Arguments:

<i>EVENT</i>	(intent(IN)) Scalar of type EVENT_TYPE, defined in ISO_FORTRAN_ENV; shall not be coindexed.
<i>COUNT</i>	(intent(out)) Scalar integer with at least the precision of default integer.
<i>STAT</i>	(optional) Scalar default-kind integer variable.

Example:

```

program atomic
  use iso_fortran_env
  implicit none
  type(event_type) :: event_value_has_been_set[*]
  integer :: cnt
  if (this_image() == 1) then
    call event_query (event_value_has_been_set, cnt)
    if (cnt > 0) write(*,*) "Value has been set"
  end if
end program atomic

```

```

elseif (this_image() == 2) then
  event post (event_value_has_been_set[1])
end if
end program atomic

```

Standard: TS 18508 or later

8.105 EXECUTE_COMMAND_LINE — Execute a shell command

Synopsis: CALL EXECUTE_COMMAND_LINE(COMMAND [, WAIT, EXITSTAT, CMDSTAT, CMDMSG])

Description:

EXECUTE_COMMAND_LINE runs a shell command, synchronously or asynchronously.

The **COMMAND** argument is passed to the shell and executed (The shell is **sh** on Unix systems, and **cmd.exe** on Windows.). If **WAIT** is present and has the value false, the execution of the command is asynchronous if the system supports it; otherwise, the command is executed synchronously using the C library's **system** call.

The three last arguments allow the user to get status information. After synchronous execution, **EXITSTAT** contains the integer exit code of the command, as returned by **system**. **CMDSTAT** is set to zero if the command line was executed (whatever its exit status was). **CMDMSG** is assigned an error message if an error has occurred.

Note that the **system** function need not be thread-safe. It is the responsibility of the user to ensure that **system** is not called concurrently.

For asynchronous execution on supported targets, the POSIX **posix_spawn** or **fork** functions are used. Also, a signal handler for the **SIGCHLD** signal is installed.

Class: Subroutine

Arguments:

COMMAND Shall be a default CHARACTER scalar.
WAIT (Optional) Shall be a default LOGICAL scalar.
EXITSTAT (Optional) Shall be an INTEGER of the default kind.
CMDSTAT (Optional) Shall be an INTEGER of the default kind.
CMDMSG (Optional) Shall be an CHARACTER scalar of the default kind.

Example:

```

program test_exec
  integer :: i

  call execute_command_line ("external_prog.exe", exitstat=i)
  print *, "Exit status of external_prog.exe was ", i

  call execute_command_line ("reindex_files.exe", wait=.false.)
  print *, "Now reindexing files in the background"

end program test_exec

```

Notes:

Because this intrinsic is implemented in terms of the `system` function call, its behavior with respect to signaling is processor dependent. In particular, on POSIX-compliant systems, the `SIGINT` and `SIGQUIT` signals are ignored, and `SIGCHLD` is blocked. As such, if the parent process is terminated, the child process might not be terminated alongside.

Standard: Fortran 2008 and later

See also: Section 8.274 [SYSTEM], page 295,

8.106 EXIT — Exit the program with status.

Synopsis: `CALL EXIT([STATUS])`

Description:

EXIT causes immediate termination of the program with status. If status is omitted it returns the canonical *success* for the system. All Fortran I/O units are closed.

Class: Subroutine

Arguments:

STATUS Shall be an INTEGER of the default kind.

Return value:

STATUS is passed to the parent process on exit.

Example:

```
program test_exit
  integer :: STATUS = 0
  print *, 'This program is going to exit.'
  call EXIT(STATUS)
end program test_exit
```

Standard: GNU extension

See also: Section 8.2 [ABORT], page 119,
Section 8.169 [KILL], page 231,

8.107 EXP — Exponential function

Synopsis: `RESULT = EXP(X)`

Description:

EXP(X) computes the base *e* exponential of X.

Class: Elemental function

Arguments:

X The type shall be REAL or COMPLEX.

Return value:

The return value has same type and kind as X.

Example:

```

program test_exp
  real :: x = 1.0
  x = exp(x)
end program test_exp

```

Specific names:

Name	Argument	Return type	Standard
EXP(X)	REAL(4) X	REAL(4)	Fortran 77 and later
DEXP(X)	REAL(8) X	REAL(8)	Fortran 77 and later
CEXP(X)	COMPLEX(4) X	COMPLEX(4)	Fortran 77 and later
ZEXP(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension
CDEXP(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension

Standard: Fortran 77 and later, has overloads that are GNU extensions

8.108 EXPONENT — Exponent function

Synopsis: RESULT = EXPONENT(X)

Description:

EXPONENT(X) returns the value of the exponent part of X. If X is zero the value returned is zero.

Class: Elemental function

Arguments:

X The type shall be REAL.

Return value:

The return value is of type default INTEGER.

Example:

```

program test_exponent
  real :: x = 1.0
  integer :: i
  i = exponent(x)
  print *, i
  print *, exponent(0.0)
end program test_exponent

```

Standard: Fortran 90 and later

8.109 EXTENDS_TYPE_OF — Query dynamic type for extension

Synopsis: RESULT = EXTENDS_TYPE_OF(A, MOLD)

Description:

Query dynamic type for extension.

Class: Inquiry function

Arguments:

A Shall be an object of extensible declared type or unlimited polymorphic.

MOLD Shall be an object of extensible declared type or unlimited polymorphic.

Return value:

The return value is a scalar of type default logical. It is true if and only if the dynamic type of A is an extension type of the dynamic type of MOLD.

Standard: Fortran 2003 and later

See also: Section 8.241 [SAME_TYPE_AS], page 275,

8.110 FDATE — Get the current time as a string

Synopsis:

```
CALL FDATE( DATE ).
DATE = FDATE( ).
```

Description:

FDATE(DATE) returns the current date (using the same format as Section 8.86 [CTIME], page 177) in *DATE*. It is equivalent to CALL CTIME(DATE, TIME()).

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

DATE The type shall be of type CHARACTER of the default kind. It is an INTENT(OUT) argument. If the length of this variable is too short for the date and time string to fit completely, it is blank on procedure return.

Return value:

The current date and time as a string.

Example:

```
program test_fdate
  integer(8) :: i, j
  character(len=30) :: date
  call fdate(date)
  print *, 'Program started on ', date
  do i = 1, 100000000 ! Just a delay
    j = i * i - i
  end do
  call fdate(date)
  print *, 'Program ended on ', date
end program test_fdate
```

Standard: GNU extension

See also: Section 8.87 [DATE_AND_TIME], page 178,
Section 8.86 [CTIME], page 177,

8.111 FGET — Read a single character in stream mode from stdin

Synopsis:

```
CALL FGET(C [, STATUS])
STATUS = FGET(C)
```

Description:

Read a single character in stream mode from stdin by bypassing normal formatted output. Stream I/O should not be mixed with normal record-oriented (formatted or unformatted) I/O on the same unit; the results are unpredictable.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Note that the `FGET` intrinsic is provided for backwards compatibility with g77. GNU Fortran provides the Fortran 2003 Stream facility. Programmers should consider the use of new stream IO feature in new code for future portability. See also Section 1.3.2 [Fortran 2003 status], page 3.

Class: Subroutine, function

Arguments:

<i>C</i>	The type shall be <code>CHARACTER</code> and of default kind.
<i>STATUS</i>	(Optional) status flag of type <code>INTEGER</code> . Returns 0 on success, -1 on end-of-file, and a system specific positive error code otherwise.

Example:

```
PROGRAM test_fget
  INTEGER, PARAMETER :: strlen = 100
  INTEGER :: status, i = 1
  CHARACTER(len=strlen) :: str = ""

  WRITE (*,*) 'Enter text:'
  DO
    CALL fget(str(i:i), status)
    if (status /= 0 .OR. i > strlen) exit
    i = i + 1
  END DO
  WRITE (*,*) TRIM(str)
END PROGRAM
```

Standard: GNU extension

See also: Section 8.112 [FGETC], page 194,
 Section 8.117 [FPUT], page 198,
 Section 8.118 [FPUTC], page 199,

8.112 FGETC — Read a single character in stream mode

Synopsis:

```
CALL FGETC(UNIT, C [, STATUS])
STATUS = FGETC(UNIT, C)
```

Description:

Read a single character in stream mode by bypassing normal formatted output. Stream I/O should not be mixed with normal record-oriented (formatted or unformatted) I/O on the same unit; the results are unpredictable.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Note that the `FGET` intrinsic is provided for backwards compatibility with `g77`. GNU Fortran provides the Fortran 2003 Stream facility. Programmers should consider the use of new stream IO feature in new code for future portability. See also Section 1.3.2 [Fortran 2003 status], page 3.

Class: Subroutine, function

Arguments:

<i>UNIT</i>	The type shall be <code>INTEGER</code> .
<i>C</i>	The type shall be <code>CHARACTER</code> and of default kind.
<i>STATUS</i>	(Optional) status flag of type <code>INTEGER</code> . Returns 0 on success, -1 on end-of-file and a system specific positive error code otherwise.

Example:

```
PROGRAM test_fgetc
  INTEGER :: fd = 42, status
  CHARACTER :: c

  OPEN(UNIT=fd, FILE="/etc/passwd", ACTION="READ", STATUS = "OLD")
  DO
    CALL fgetc(fd, c, status)
    IF (status /= 0) EXIT
    call fput(c)
  END DO
  CLOSE(UNIT=fd)
END PROGRAM
```

Standard: GNU extension

See also: Section 8.111 [FGET], page 194,
 Section 8.117 [FPUT], page 198,
 Section 8.118 [FPUTC], page 199,

8.113 FINDLOC — Search an array for a value

Synopsis:

```
RESULT = FINDLOC(ARRAY, VALUE, DIM [, MASK] [,KIND]
[,BACK])
RESULT = FINDLOC(ARRAY, VALUE, [, MASK] [,KIND]
[,BACK])
```

Description:

Determines the location of the element in the array with the value given in the *VALUE* argument, or, if the *DIM* argument is supplied, determines the locations of the elements equal to the *VALUE* argument element along each

row of the array in the *DIM* direction. If *MASK* is present, only the elements for which *MASK* is *.TRUE.* are considered. If more than one element in the array has the value *VALUE*, the location returned is that of the first such element in array element order if the *BACK* is not present or if it is *.FALSE.*. If *BACK* is true, the location returned is that of the last such element. If the array has zero size, or all of the elements of *MASK* are *.FALSE.*, then the result is an array of zeroes. Similarly, if *DIM* is supplied and all of the elements of *MASK* along a given row are zero, the result value for that row is zero.

Class: Transformational function

Arguments:

<i>ARRAY</i>	Shall be an array of intrinsic type.
<i>VALUE</i>	A scalar of intrinsic type that is in type conformance with <i>ARRAY</i> .
<i>DIM</i>	(Optional) Shall be a scalar of type <i>INTEGER</i> , with a value between one and the rank of <i>ARRAY</i> , inclusive. It may not be an optional dummy argument.
<i>MASK</i>	(Optional) Shall be of type <i>LOGICAL</i> , and conformable with <i>ARRAY</i> .
<i>KIND</i>	(Optional) A scalar <i>INTEGER</i> constant expression indicating the kind parameter of the result.
<i>BACK</i>	(Optional) A scalar of type <i>LOGICAL</i> .

Notes: *ARRAY* can also be *UNSIGNED*.

Return value:

If *DIM* is absent, the result is a rank-one array with a length equal to the rank of *ARRAY*. If *DIM* is present, the result is an array with a rank one less than the rank of *ARRAY*, and a size corresponding to the size of *ARRAY* with the *DIM* dimension removed. If *DIM* is present and *ARRAY* has a rank of one, the result is a scalar. If the optional argument *KIND* is present, the result is an integer of kind *KIND*, otherwise it is of default kind.

Standard: Fortran 2008 and later

See also: Section 8.196 [MAXLOC], page 247,
Section 8.204 [MINLOC], page 252,

8.114 FLOOR — Integer floor function

Synopsis: `RESULT = FLOOR(A [, KIND])`

Description:

`FLOOR(A)` returns the greatest integer less than or equal to *A*.

Class: Elemental function

Arguments:

<i>A</i>	The type shall be <i>REAL</i> .
<i>KIND</i>	(Optional) A scalar <i>INTEGER</i> constant expression indicating the kind parameter of the result.

Return value:

The return value is of type `INTEGER(KIND)` if *KIND* is present and of default-kind `INTEGER` otherwise.

Example:

```

program test_floor
  real :: x = 63.29
  real :: y = -63.59
  print *, floor(x) ! returns 63
  print *, floor(y) ! returns -64
end program test_floor

```

Standard: Fortran 95 and later

See also: Section 8.62 [CEILING], page 160,
Section 8.212 [NINT], page 258,

8.115 FLUSH — Flush I/O unit(s)

Synopsis: `CALL FLUSH(UNIT)`

Description:

Flushes Fortran unit(s) currently open for output. Without the optional argument, all units are flushed, otherwise just the unit specified.

Class: Subroutine

Arguments:

UNIT (Optional) The type shall be `INTEGER`.

Notes: Beginning with the Fortran 2003 standard, there is a `FLUSH` statement that should be preferred over the `FLUSH` intrinsic.

The `FLUSH` intrinsic and the Fortran 2003 `FLUSH` statement have identical effect: they flush the runtime library's I/O buffer so that the data becomes visible to other processes. This does not guarantee that the data is committed to disk.

On POSIX systems, you can request that all data is transferred to the storage device by calling the `fsync` function, with the POSIX file descriptor of the I/O unit as argument (retrieved with GNU intrinsic `FNUM`). The following example shows how:

```

! Declare the interface for POSIX fsync function
interface
  function fsync (fd) bind(c,name="fsync")
    use iso_c_binding, only: c_int
    integer(c_int), value :: fd
    integer(c_int) :: fsync
  end function fsync
end interface

! Variable declaration
integer :: ret

! Opening unit 10
open (10,file="foo")

```

```

! ...
! Perform I/O on unit 10
! ...

! Flush and sync
flush(10)
ret = fsync(fnum(10))

! Handle possible error
if (ret /= 0) stop "Error calling FSYNC"

```

Standard: GNU extension

8.116 FNUM — File number function

Synopsis: RESULT = FNUM(UNIT)

Description:

FNUM(UNIT) returns the POSIX file descriptor number corresponding to the open Fortran I/O unit UNIT.

Class: Function

Arguments:

UNIT The type shall be INTEGER.

Return value:

The return value is of type INTEGER

Example:

```

program test_fnum
  integer :: i
  open (unit=10, status = "scratch")
  i = fnum(10)
  print *, i
  close (10)
end program test_fnum

```

Standard: GNU extension

8.117 FPUT — Write a single character in stream mode to stdout

Synopsis:

```

CALL FPUT(C [, STATUS])
STATUS = FPUT(C)

```

Description:

Write a single character in stream mode to stdout by bypassing normal formatted output. Stream I/O should not be mixed with normal record-oriented (formatted or unformatted) I/O on the same unit; the results are unpredictable. This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Note that the FGET intrinsic is provided for backwards compatibility with g77. GNU Fortran provides the Fortran 2003 Stream facility. Programmers should

consider the use of new stream IO feature in new code for future portability. See also Section 1.3.2 [Fortran 2003 status], page 3.

Class: Subroutine, function

Arguments:

C The type shall be **CHARACTER** and of default kind.
STATUS (Optional) status flag of type **INTEGER**. Returns 0 on success, -1 on end-of-file and a system specific positive error code otherwise.

Example:

```
PROGRAM test_fput
  CHARACTER(len=10) :: str = "gfortran"
  INTEGER :: i
  DO i = 1, len_trim(str)
    CALL fput(str(i:i))
  END DO
END PROGRAM
```

Standard: GNU extension

See also: Section 8.118 [FPUTC], page 199,
 Section 8.111 [FGET], page 194,
 Section 8.112 [FGETC], page 194,

8.118 FPUTC — Write a single character in stream mode

Synopsis:

```
CALL FPUTC(UNIT, C [, STATUS])
STATUS = FPUTC(UNIT, C)
```

Description:

Write a single character in stream mode by bypassing normal formatted output. Stream I/O should not be mixed with normal record-oriented (formatted or unformatted) I/O on the same unit; the results are unpredictable.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Note that the **FGET** intrinsic is provided for backwards compatibility with **g77**. GNU Fortran provides the Fortran 2003 Stream facility. Programmers should consider the use of new stream IO feature in new code for future portability. See also Section 1.3.2 [Fortran 2003 status], page 3.

Class: Subroutine, function

Arguments:

UNIT The type shall be **INTEGER**.
C The type shall be **CHARACTER** and of default kind.
STATUS (Optional) status flag of type **INTEGER**. Returns 0 on success, -1 on end-of-file and a system specific positive error code otherwise.

Example:

```
PROGRAM test_fputc
  CHARACTER(len=10) :: str = "gfortran"
  INTEGER :: fd = 42, i

  OPEN(UNIT = fd, FILE = "out", ACTION = "WRITE", STATUS="NEW")
  DO i = 1, len_trim(str)
    CALL fputc(fd, str(i:i))
  END DO
  CLOSE(fd)
END PROGRAM
```

Standard: GNU extension

See also: Section 8.117 [FPUT], page 198,
Section 8.111 [FGET], page 194,
Section 8.112 [FGETC], page 194,

8.119 FRACTION — Fractional part of the model representation

Synopsis: `Y = FRACTION(X)`

Description:

`FRACTION(X)` returns the fractional part of the model representation of `X`.

Class: Elemental function

Arguments:

`X` The type of the argument shall be a `REAL`.

Return value:

The return value is of the same type and kind as the argument. The fractional part of the model representation of `X` is returned; it is `X * REAL(RADIX(X))**(-EXPONENT(X))`.

Example:

```
program test_fraction
  implicit none
  real :: x
  x = 178.1387e-4
  print *, fraction(x), x * real(radix(x))**(-exponent(x))
end program test_fraction
```

Standard: Fortran 90 and later

8.120 FREE — Frees memory

Synopsis: `CALL FREE(PTR)`

Description:

Frees memory previously allocated by `MALLOC`. The `FREE` intrinsic is an extension intended to be used with Cray pointers, and is provided in GNU Fortran to allow user to compile legacy code. For new code using Fortran 95 pointers, the memory de-allocation intrinsic is `DEALLOCATE`.

Class: Subroutine

Arguments:

PTR The type shall be `INTEGER`. It represents the location of the memory that should be de-allocated.

Return value:

None

Example: See `MALLOC` for an example.

Standard: GNU extension

See also: Section 8.190 [`MALLOC`], page 244,

8.121 FSEEK — Low level file positioning subroutine

Synopsis: `CALL FSEEK(UNIT, OFFSET, WHENCE[, STATUS])`

Description:

Moves *UNIT* to the specified *OFFSET*. If *WHENCE* is set to 0, the *OFFSET* is taken as an absolute value `SEEK_SET`, if set to 1, *OFFSET* is taken to be relative to the current position `SEEK_CUR`, and if set to 2 relative to the end of the file `SEEK_END`. On error, *STATUS* is set to a nonzero value. If *STATUS* the seek fails silently.

This intrinsic routine is not fully backwards compatible with `g77`. In `g77`, the `FSEEK` takes a statement label instead of a *STATUS* variable. If `FSEEK` is used in old code, change

```
CALL FSEEK(UNIT, OFFSET, WHENCE, *label)
```

to

```
INTEGER :: status
CALL FSEEK(UNIT, OFFSET, WHENCE, status)
IF (status /= 0) GOTO label
```

Please note that GNU Fortran provides the Fortran 2003 Stream facility. Programmers should consider the use of new stream IO feature in new code for future portability. See also Section 1.3.2 [Fortran 2003 status], page 3.

Class: Subroutine

Arguments:

UNIT Shall be a scalar of type `INTEGER`.
OFFSET Shall be a scalar of type `INTEGER`.
WHENCE Shall be a scalar of type `INTEGER`. Its value shall be either 0, 1 or 2.
STATUS (Optional) shall be a scalar of type `INTEGER(4)`.

Example:

```
PROGRAM test_fseek
  INTEGER, PARAMETER :: SEEK_SET = 0, SEEK_CUR = 1, SEEK_END = 2
  INTEGER :: fd, offset, ierr

  ierr = 0
  offset = 5
```

```

      fd      = 10

      OPEN(UNIT=fd, FILE="fseek.test")
      CALL FSEEK(fd, offset, SEEK_SET, ierr) ! move to OFFSET
      print *, FTELL(fd), ierr

      CALL FSEEK(fd, 0, SEEK_END, ierr)      ! move to end
      print *, FTELL(fd), ierr

      CALL FSEEK(fd, 0, SEEK_SET, ierr)      ! move to beginning
      print *, FTELL(fd), ierr

      CLOSE(UNIT=fd)
END PROGRAM

```

Standard: GNU extension

See also: Section 8.123 [FTELL], page 203,

8.122 FSTAT — Get file status

Synopsis:

```

CALL FSTAT(UNIT, VALUES [, STATUS])
STATUS = FSTAT(UNIT, VALUES)

```

Description:

FSTAT is identical to Section 8.270 [STAT], page 292, except that information about an already opened file is obtained.

The elements in **VALUES** are the same as described by Section 8.270 [STAT], page 292.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

UNIT	An open I/O unit number of type INTEGER .
VALUES	The type shall be INTEGER , DIMENSION(13) of either kind 4 or kind 8.
STATUS	(Optional) status flag of type INTEGER of kind 2 or larger. Returns 0 on success and a system specific error code otherwise.

Example: See Section 8.270 [STAT], page 292, for an example.

Standard: GNU extension

See also: To stat a link:
 Section 8.188 [LSTAT], page 242,
 To stat a file:
 Section 8.270 [STAT], page 292,

8.123 FTELL — Current stream position

Synopsis:

```
CALL FTELL(UNIT, OFFSET)
OFFSET = FTELL(UNIT)
```

Description:

Retrieves the current position within an open file.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

OFFSET Shall of type INTEGER.
UNIT Shall of type INTEGER.

Return value:

In either syntax, *OFFSET* is set to the current offset of unit number *UNIT*, or to -1 if the unit is not currently open.

Example:

```
PROGRAM test_ftell
  INTEGER :: i
  OPEN(10, FILE="temp.dat")
  CALL ftell(10,i)
  WRITE(*,*) i
END PROGRAM
```

Standard: GNU extension

See also: Section 8.121 [FSEEK], page 201,

8.124 GAMMA — Gamma function

Synopsis: $X = \text{GAMMA}(X)$

Description:

$\text{GAMMA}(X)$ computes Gamma (Γ) of X . For positive, integer values of X the Gamma function simplifies to the factorial function $\Gamma(x) = (x - 1)!$.

$$\Gamma(x) = \int_0^{\infty} t^{x-1} e^{-t} dt$$

Class: Elemental function

Arguments:

X Shall be of type REAL and neither zero nor a negative integer.

Return value:

The return value is of type REAL of the same kind as X .

Example:

```

program test_gamma
  real :: x = 1.0
  x = gamma(x) ! returns 1.0
end program test_gamma

```

Specific names:

Name	Argument	Return type	Standard
DGAMMA(X)	REAL(8) X	REAL(8)	GNU extension

Standard: Fortran 2008 and later

See also: Logarithm of the Gamma function:
Section 8.185 [LOG_GAMMA], page 241,

8.125 GERROR — Get last system error message

Synopsis: CALL GERROR(RESULT)

Description:

Returns the system error message corresponding to the last system error. This resembles the functionality of `strerror(3)` in C.

Class: Subroutine

Arguments:

RESULT Shall be of type CHARACTER and of default kind.

Example:

```

PROGRAM test_gerror
  CHARACTER(len=100) :: msg
  CALL gerror(msg)
  WRITE(*,*) msg
END PROGRAM

```

Standard: GNU extension

See also: Section 8.152 [IERRNO], page 222,
Section 8.221 [PERROR], page 264,

8.126 GETARG — Get command line arguments

Synopsis: CALL GETARG(POS, VALUE)

Description:

Retrieve the *POS*-th argument that was passed on the command line when the containing program was invoked.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 8.128 [GET_COMMAND_ARGUMENT], page 206, intrinsic defined by the Fortran 2003 standard.

Class: Subroutine

Arguments:

POS Shall be of type `INTEGER` and not wider than the default integer kind; $POS \geq 0$

VALUE Shall be of type `CHARACTER` and of default kind.

Return value:

After `GETARG` returns, the *VALUE* argument holds the *POS*th command line argument. If *VALUE* cannot hold the argument, it is truncated to fit the length of *VALUE*. If there are less than *POS* arguments specified at the command line, *VALUE* is filled with blanks. If $POS = 0$, *VALUE* is set to the name of the program (on systems that support this feature).

Example:

```
PROGRAM test_getarg
  INTEGER :: i
  CHARACTER(len=32) :: arg

  DO i = 1, iargc()
    CALL getarg(i, arg)
    WRITE (*,*) arg
  END DO
END PROGRAM
```

Standard: GNU extension

See also: GNU Fortran 77 compatibility function:
 Section 8.145 [IARGC], page 217,
 Fortran 2003 functions and subroutines:
 Section 8.127 [GET_COMMAND], page 205,
 Section 8.128 [GET_COMMAND_ARGUMENT], page 206,
 Section 8.72 [COMMAND_ARGUMENT_COUNT], page 168,

8.127 GET_COMMAND — Get the entire command line

Synopsis: `CALL GET_COMMAND([COMMAND, LENGTH, STATUS])`

Description:

Retrieve the entire command line that was used to invoke the program.

Class: Subroutine

Arguments:

COMMAND (Optional) shall be of type `CHARACTER` and of default kind.

LENGTH (Optional) Shall be of type `INTEGER` and of default kind.

STATUS (Optional) Shall be of type `INTEGER` and of default kind.

Return value:

If *COMMAND* is present, stores the entire command line that was used to invoke the program in *COMMAND*. If *LENGTH* is present, it is assigned the length of the command line. If *STATUS* is present, it is assigned 0 upon success

of the command, -1 if *COMMAND* is too short to store the command line, or a positive value in case of an error.

Example:

```
PROGRAM test_get_command
  CHARACTER(len=255) :: cmd
  CALL get_command(cmd)
  WRITE (*,*) TRIM(cmd)
END PROGRAM
```

Standard: Fortran 2003 and later

See also: Section 8.128 [GET_COMMAND_ARGUMENT], page 206,
Section 8.72 [COMMAND_ARGUMENT_COUNT], page 168,

8.128 GET_COMMAND_ARGUMENT — Get command line arguments

Synopsis: CALL GET_COMMAND_ARGUMENT(NUMBER [, VALUE, LENGTH, STATUS])

Description:

Retrieve the *NUMBER*-th argument that was passed on the command line when the containing program was invoked.

Class: Subroutine

Arguments:

<i>NUMBER</i>	Shall be a scalar of type INTEGER and of default kind, $NUMBER \geq 0$
<i>VALUE</i>	(Optional) Shall be a scalar of type CHARACTER and of default kind.
<i>LENGTH</i>	(Optional) Shall be a scalar of type INTEGER and of default kind.
<i>STATUS</i>	(Optional) Shall be a scalar of type INTEGER and of default kind.

Return value:

After GET_COMMAND_ARGUMENT returns, the *VALUE* argument holds the *NUMBER*-th command line argument. If *VALUE* cannot hold the argument, it is truncated to fit the length of *VALUE*. If there are less than *NUMBER* arguments specified at the command line, *VALUE* is filled with blanks. If *NUMBER* = 0, *VALUE* is set to the name of the program (on systems that support this feature). The *LENGTH* argument contains the length of the *NUMBER*-th command line argument. If the argument retrieval fails, *STATUS* is a positive number; if *VALUE* contains a truncated command line argument, *STATUS* is -1; and otherwise the *STATUS* is zero.

Example:

```
PROGRAM test_get_command_argument
  INTEGER :: i
  CHARACTER(len=32) :: arg

  i = 0
  DO
```

```

      CALL get_command_argument(i, arg)
      IF (LEN_TRIM(arg) == 0) EXIT

      WRITE (*,*) TRIM(arg)
      i = i+1
    END DO
  END PROGRAM

```

Standard: Fortran 2003 and later

See also: Section 8.127 [GET_COMMAND], page 205,
Section 8.72 [COMMAND_ARGUMENT_COUNT], page 168,

8.129 GETCWD — Get current working directory

Synopsis:

```

CALL GETCWD(C [, STATUS])
STATUS = GETCWD(C)

```

Description:

Get current working directory.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

<i>C</i>	The type shall be <code>CHARACTER</code> and of default kind.
<i>STATUS</i>	(Optional) status flag. Returns 0 on success, a system specific and nonzero error code otherwise.

Example:

```

PROGRAM test_getcwd
  CHARACTER(len=255) :: cwd
  CALL getcwd(cwd)
  WRITE(*,*) TRIM(cwd)
END PROGRAM

```

Standard: GNU extension

See also: Section 8.64 [CHDIR], page 161,

8.130 GETENV — Get an environmental variable

Synopsis: CALL GETENV(NAME, VALUE)

Description:

Get the *VALUE* of the environmental variable *NAME*.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 8.131 [GET_ENVIRONMENT_VARIABLE], page 208, intrinsic defined by the Fortran 2003 standard.

Note that `GETENV` need not be thread-safe. It is the responsibility of the user to ensure that the environment is not being updated concurrently with a call to the `GETENV` intrinsic.

Class: Subroutine

Arguments:

NAME Shall be of type `CHARACTER` and of default kind.
VALUE Shall be of type `CHARACTER` and of default kind.

Return value:

Stores the value of *NAME* in *VALUE*. If *VALUE* is not large enough to hold the data, it is truncated. If *NAME* is not set, *VALUE* is filled with blanks.

Example:

```
PROGRAM test_getenv
  CHARACTER(len=255) :: homedir
  CALL getenv("HOME", homedir)
  WRITE (*,*) TRIM(homedir)
END PROGRAM
```

Standard: GNU extension

See also: Section 8.131 [GET_ENVIRONMENT_VARIABLE], page 208,

8.131 GET_ENVIRONMENT_VARIABLE — Get an environmental variable

Synopsis: CALL GET_ENVIRONMENT_VARIABLE(*NAME*[, *VALUE*, *LENGTH*, *STATUS*, *TRIM_NAME*])

Description:

Get the *VALUE* of the environmental variable *NAME*.

Note that `GET_ENVIRONMENT_VARIABLE` need not be thread-safe. It is the responsibility of the user to ensure that the environment is not being updated concurrently with a call to the `GET_ENVIRONMENT_VARIABLE` intrinsic.

Class: Subroutine

Arguments:

NAME Shall be a scalar of type `CHARACTER` and of default kind.
VALUE (Optional) Shall be a scalar of type `CHARACTER` and of default kind.
LENGTH (Optional) Shall be a scalar of type `INTEGER` and of default kind.
STATUS (Optional) Shall be a scalar of type `INTEGER` and of default kind.
TRIM_NAME(Optional) Shall be a scalar of type `LOGICAL` and of default kind.

Return value:

Stores the value of *NAME* in *VALUE*. If *VALUE* is not large enough to hold the data, it is truncated. If *NAME* is not set, *VALUE* is filled with blanks. Argument *LENGTH* contains the length needed for storing the environment variable *NAME* or zero if it is not present. *STATUS* is -1 if *VALUE* is present

but too short for the environment variable; it is 1 if the environment variable does not exist and 2 if the processor does not support environment variables; in all other cases *STATUS* is zero. If *TRIM_NAME* is present with the value *.FALSE.*, the trailing blanks in *NAME* are significant; otherwise they are not part of the environment variable name.

Example:

```
PROGRAM test_getenv
  CHARACTER(len=255) :: homedir
  CALL get_environment_variable("HOME", homedir)
  WRITE (*,*) TRIM(homedir)
END PROGRAM
```

Standard: Fortran 2003 and later

8.132 GETGID — Group ID function

Synopsis: RESULT = GETGID()

Description:

Returns the numerical group ID of the current process.

Class: Function

Return value:

The return value of GETGID is an INTEGER of the default kind.

Example: See GETPID for an example.

Standard: GNU extension

See also: Section 8.134 [GETPID], page 210,
Section 8.136 [GETUID], page 211,

8.133 GETLOG — Get login name

Synopsis: CALL GETLOG(C)

Description:

Gets the username under which the program is running.

Class: Subroutine

Arguments:

C Shall be of type CHARACTER and of default kind.

Return value:

Stores the current user name in *C*. (On systems where POSIX functions *geteuid* and *getpwuid* are not available, and the *getlogin* function is not implemented either, this returns a blank string.)

Example:

```
PROGRAM TEST_GETLOG
  CHARACTER(32) :: login
  CALL GETLOG(login)
  WRITE(*,*) login
END PROGRAM
```

Standard: GNU extension

See also: Section 8.136 [GETUID], page 211,

8.134 GETPID — Process ID function

Synopsis: `RESULT = GETPID()`

Description:

Returns the numerical process identifier of the current process.

Class: Function

Return value:

The return value of `GETPID` is an `INTEGER` of the default kind.

Example:

```
program info
  print *, "The current process ID is ", getpid()
  print *, "Your numerical user ID is ", getuid()
  print *, "Your numerical group ID is ", getgid()
end program info
```

Standard: GNU extension

See also: Section 8.132 [GETGID], page 209,
Section 8.136 [GETUID], page 211,

8.135 GET_TEAM — Get the handle of a team

Synopsis: `RESULT = GET_TEAM([LEVEL])`

Description:

Returns the handle of the current team, if *LEVEL* is not given. Or the team specified by *LEVEL*, where *LEVEL* is one of the constants `INITIAL_TEAM`, `PARENT_TEAM` or `CURRENT_TEAM` from the intrinsic module `ISO_FORTRAN_ENV`. Calling the function with `PARENT_TEAM` while being on the initial team, returns a handle to the initial team. This ensures that always a valid team is returned, given that team handles can neither be checked for validity nor compared with each other or null.

Class: Transformational function

Return value:

An opaque handle of `TEAM_TYPE` from the intrinsic module `ISO_FORTRAN_ENV`.

Example:

```
program info
  use, intrinsic :: iso_fortran_env
  type(team_type) :: init, curr, par, nt

  init = get_team()
  curr = get_team(current_team) ! init equals curr here
  form team(1, nt)
  change team(nt)
  curr = get_team() ! or get_team(current_team)
```

```

        par = get_team(parent_team) ! par equals init here
    end team
end program info

```

Standard: Fortran 2018 or later

See also: Section 8.281 [THIS_IMAGE], page 300,
Section 9.1 [ISO_FORTRAN_ENV], page 311,

8.136 GETUID — User ID function

Synopsis: RESULT = GETUID()

Description:

Returns the numerical user ID of the current process.

Class: Function

Return value:

The return value of GETUID is an INTEGER of the default kind.

Example: See GETPID for an example.

Standard: GNU extension

See also: Section 8.134 [GETPID], page 210,
Section 8.133 [GETLOG], page 209,

8.137 GMTIME — Convert time to GMT info

Synopsis: CALL GMTIME(TIME, VALUES)

Description:

Given a system time value *TIME* (as provided by the Section 8.282 [TIME], page 301, intrinsic), fills *VALUES* with values extracted from it appropriate to the UTC time zone (Universal Coordinated Time, also known in some countries as GMT, Greenwich Mean Time), using `gmtime(3)`.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 8.87 [DATE_AND_TIME], page 178, intrinsic defined by the Fortran 95 standard.

Class: Subroutine

Arguments:

<i>TIME</i>	An INTEGER scalar expression corresponding to a system time, with INTENT(IN).
<i>VALUES</i>	A default INTEGER array with 9 elements, with INTENT(OUT).

Return value:

The elements of *VALUES* are assigned as follows:

1. Seconds after the minute, range 0–59 or 0–61 to allow for leap seconds
2. Minutes after the hour, range 0–59

3. Hours past midnight, range 0–23
4. Day of month, range 1–31
5. Number of months since January, range 0–11
6. Years since 1900
7. Number of days since Sunday, range 0–6
8. Days since January 1, range 0–365
9. Daylight savings indicator: positive if daylight savings is in effect, zero if not, and negative if the information is not available.

Standard: GNU extension

See also: Section 8.87 [DATE_AND_TIME], page 178,
 Section 8.86 [CTIME], page 177,
 Section 8.189 [LTIME], page 243,
 Section 8.282 [TIME], page 301,
 Section 8.283 [TIME8], page 301,

8.138 HOSTNM — Get system host name

Synopsis:

```
CALL HOSTNM(C [, STATUS])
STATUS = HOSTNM(NAME)
```

Description:

Retrieves the host name of the system on which the program is running. This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

<i>C</i>	Shall of type CHARACTER and of default kind.
<i>STATUS</i>	(Optional) status flag of type INTEGER . Returns 0 on success, or a system specific error code otherwise.

Return value:

In either syntax, *NAME* is set to the current hostname if it can be obtained, or to a blank string otherwise.

Standard: GNU extension

8.139 HUGE — Largest number of a kind

Synopsis: `RESULT = HUGE(X)`

Description:

HUGE(X) returns the largest number that is not an infinity in the model of the type of **X**.

Class: Inquiry function

Arguments:

X Shall be of type **REAL**, **INTEGER** or **UNSIGNED**.

Return value:

The return value is of the same type and kind as *X*

Example:

```
program test_huge_tiny
  print *, huge(0), huge(0.0), huge(0.0d0)
  print *, tiny(0.0), tiny(0.0d0)
end program test_huge_tiny
```

Standard: Fortran 90 and later, extension for **UNSIGNED** (see Section 5.1.34 [Unsigned integers], page 67)

8.140 HYPOT — Euclidean distance function

Synopsis: **RESULT = HYPOT(X, Y)**

Description:

HYPOT(X,Y) is the Euclidean distance function. It is equal to $\sqrt{X^2 + Y^2}$, without undue underflow or overflow.

Class: Elemental function

Arguments:

X The type shall be **REAL**.
Y The type and kind type parameter shall be the same as *X*.

Return value:

The return value has the same type and kind type parameter as *X*.

Example:

```
program test_hypot
  real(4) :: x = 1.e0_4, y = 0.5e0_4
  x = hypot(x,y)
end program test_hypot
```

Standard: Fortran 2008 and later

8.141 IACHAR — Code in ASCII collating sequence

Synopsis: **RESULT = IACHAR(C [, KIND])**

Description:

IACHAR(C) returns the code for the ASCII character in the first character position of *C*.

Class: Elemental function

Arguments:

C Shall be a scalar **CHARACTER**, with **INTENT(IN)**
KIND (Optional) A scalar **INTEGER** constant expression indicating the kind parameter of the result.

Return value:

The return value is of type `INTEGER` and of kind *KIND*. If *KIND* is absent, the return value is of default integer kind.

Example:

```
program test_iachar
  integer i
  i = iachar(' ')
end program test_iachar
```

Notes: See Section 8.149 [ICHAR], page 219, for a discussion of converting between numerical values and formatted string representations.

Standard: Fortran 95 and later, with *KIND* argument Fortran 2003 and later

See also: Section 8.5 [ACHAR], page 121,
 Section 8.63 [CHAR], page 160,
 Section 8.149 [ICHAR], page 219,

8.142 IALL — Bitwise AND of array elements

Synopsis:

```
RESULT = IALL(ARRAY[, MASK])
RESULT = IALL(ARRAY, DIM[, MASK])
```

Description:

Reduces with bitwise AND the elements of *ARRAY* along dimension *DIM* if the corresponding element in *MASK* is `TRUE`.

Class: Transformational function

Arguments:

<i>ARRAY</i>	Shall be an array of type <code>INTEGER</code> or <code>UNSIGNED</code>
<i>DIM</i>	(Optional) shall be a scalar of type <code>INTEGER</code> with a value in the range from 1 to n, where n equals the rank of <i>ARRAY</i> .
<i>MASK</i>	(Optional) shall be of type <code>LOGICAL</code> and either be a scalar or an array of the same shape as <i>ARRAY</i> .

Return value:

The result is of the same type as *ARRAY*.

If *DIM* is absent, a scalar with the bitwise AND of all elements in *ARRAY* is returned. Otherwise, an array of rank n-1, where n equals the rank of *ARRAY*, and a shape similar to that of *ARRAY* with dimension *DIM* dropped is returned.

Example:

```
PROGRAM test_iall
  INTEGER(1) :: a(2)

  a(1) = b'00100100'
  a(2) = b'01101010'
```

```

      ! prints 00100000
      PRINT '(b8.8)', IALL(a)
END PROGRAM

```

Standard: Fortran 2008 and later, extension for **UNSIGNED** (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.144 [IANY], page 216,
 Section 8.159 [IPARITY], page 225,
 Section 8.143 [IAND], page 215,

8.143 IAND — Bitwise logical and

Synopsis: `RESULT = IAND(I, J)`

Description:

Bitwise logical AND.

Class: Elemental function

Arguments:

I The type shall be **INTEGER**, **UNSIGNED** or a boz-literal-constant.

J The type shall be the same type as *I* with the same kind type parameter or a boz-literal-constant. *I* and *J* shall not both be boz-literal-constants.

Return value:

The return type is with the kind type parameter of the arguments. A boz-literal-constant is converted to an **INTEGER** or **UNSIGNED** with the kind type parameter of the other argument as-if a call to Section 8.155 [INT], page 223, or Section 8.292 [UINT], page 306, respectively, occurred.

Example:

```

PROGRAM test_iand
  INTEGER :: a, b
  DATA a / Z'F' /, b / Z'3' /
  WRITE (*,*) IAND(a, b)
END PROGRAM

```

Specific names:

Name	Argument	Return type	Standard
IAND(A)	INTEGER A	INTEGER	Fortran 90 and later
BIAND(A)	INTEGER(1) A	INTEGER(1)	GNU extension
IIAND(A)	INTEGER(2) A	INTEGER(2)	GNU extension
JIAND(A)	INTEGER(4) A	INTEGER(4)	GNU extension
KIAND(A)	INTEGER(8) A	INTEGER(8)	GNU extension

Standard: Fortran 90 and later, with boz-literal-constant Fortran 2008 and later, has overloads that are GNU extensions. Extension for **UNSIGNED** (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.158 [IOR], page 225,
 Section 8.151 [IEOR], page 221,

Section 8.147 [IBITS], page 218,
 Section 8.148 [IBSET], page 218,
 Section 8.146 [IBCLR], page 217,
 Section 8.214 [NOT], page 259,

8.144 IANY — Bitwise OR of array elements

Synopsis:

```
RESULT = IANY(ARRAY[, MASK])
RESULT = IANY(ARRAY, DIM[, MASK])
```

Description:

Reduces with bitwise OR (inclusive or) the elements of *ARRAY* along dimension *DIM* if the corresponding element in *MASK* is **TRUE**.

Class: Transformational function

Arguments:

ARRAY Shall be an array of type **INTEGER** or **UNSIGNED**
DIM (Optional) shall be a scalar of type **INTEGER** with a value in the range from 1 to n, where n equals the rank of *ARRAY*.
MASK (Optional) shall be of type **LOGICAL** and either be a scalar or an array of the same shape as *ARRAY*.

Return value:

The result is of the same type as *ARRAY*.

If *DIM* is absent, a scalar with the bitwise OR of all elements in *ARRAY* is returned. Otherwise, an array of rank n-1, where n equals the rank of *ARRAY*, and a shape similar to that of *ARRAY* with dimension *DIM* dropped is returned.

Example:

```
PROGRAM test_iany
  INTEGER(1) :: a(2)

  a(1) = b'00100100'
  a(2) = b'01101010'

  ! prints 01101110
  PRINT '(b8.8)', IANY(a)
END PROGRAM
```

Standard: Fortran 2008 and later, extension for **UNSIGNED** (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.159 [IPARITY], page 225,
 Section 8.142 [IALL], page 214,
 Section 8.158 [IOR], page 225,

8.145 IARGC — Get the number of command line arguments

Synopsis: `RESULT = IARGC()`

Description:

IARGC returns the number of arguments passed on the command line when the containing program was invoked.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 8.72 [COMMAND_ARGUMENT_COUNT], page 168, intrinsic defined by the Fortran 2003 standard.

Class: Function

Arguments:

None

Return value:

The number of command line arguments, type `INTEGER(4)`.

Example: See Section 8.126 [GETARG], page 204,

Standard: GNU extension

See also: GNU Fortran 77 compatibility subroutine:

Section 8.126 [GETARG], page 204,

Fortran 2003 functions and subroutines:

Section 8.127 [GET_COMMAND], page 205,

Section 8.128 [GET_COMMAND_ARGUMENT], page 206,

Section 8.72 [COMMAND_ARGUMENT_COUNT], page 168,

8.146 IBCLR — Clear bit

Synopsis: `RESULT = IBCLR(I, POS)`

Description:

IBCLR returns the value of *I* with the bit at position *POS* set to zero.

Class: Elemental function

Arguments:

I The type shall be `INTEGER` or `UNSIGNED`.

POS The type shall be `INTEGER`.

Return value:

The return value is of the same type as *I*.

Specific names:

Name	Argument	Return type	Standard
IBCLR(A)	INTEGER A	INTEGER	Fortran 90 and later
BBCLR(A)	INTEGER(1) A	INTEGER(1)	GNU extension
IIBCLR(A)	INTEGER(2) A	INTEGER(2)	GNU extension
JIBCLR(A)	INTEGER(4) A	INTEGER(4)	GNU extension
KIBCLR(A)	INTEGER(8) A	INTEGER(8)	GNU extension

Standard: Fortran 90 and later, has overloads that are GNU extensions. Extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.147 [IBITS], page 218,
 Section 8.148 [IBSET], page 218,
 Section 8.143 [IAND], page 215,
 Section 8.158 [IOR], page 225,
 Section 8.151 [IEOR], page 221,
 Section 8.209 [MVBITS], page 256,

8.147 IBITS — Bit extraction

Synopsis: RESULT = IBITS(I, POS, LEN)

Description:

IBITS extracts a field of length *LEN* from *I*, starting from bit position *POS* and extending left for *LEN* bits. The result is right-justified and the remaining bits are zeroed. The value of *POS*+*LEN* must be less than or equal to the value BIT_SIZE(*I*).

Class: Elemental function

Arguments:

<i>I</i>	The type shall be INTEGER or UNSIGNED.
<i>POS</i>	The type shall be INTEGER.
<i>LEN</i>	The type shall be INTEGER.

Return value:

The return value is of type as *I*.

Specific names:

Name	Argument	Return type	Standard
IBITS(A)	INTEGER A	INTEGER	Fortran 90 and later
BBITS(A)	INTEGER(1) A	INTEGER(1)	GNU extension
IIBITS(A)	INTEGER(2) A	INTEGER(2)	GNU extension
JIBITS(A)	INTEGER(4) A	INTEGER(4)	GNU extension
KIBITS(A)	INTEGER(8) A	INTEGER(8)	GNU extension

Standard: Fortran 90 and later, has overloads that are GNU extensions. Extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.52 [BIT_SIZE], page 153,
 Section 8.146 [IBCLR], page 217,
 Section 8.148 [IBSET], page 218,
 Section 8.143 [IAND], page 215,
 Section 8.158 [IOR], page 225,
 Section 8.151 [IEOR], page 221,

8.148 IBSET — Set bit

Synopsis: RESULT = IBSET(I, POS)

Description:

IBSET returns the value of *I* with the bit at position *POS* set to one.

Class: Elemental function

Arguments:

I The type shall be `INTEGER` or `UNSIGNED`.
POS The type shall be `INTEGER`.

Return value:

The return value is of the same type as *I*.

Specific names:

Name	Argument	Return type	Standard
IBSET(A)	INTEGER A	INTEGER	Fortran 90 and later
BBSET(A)	INTEGER(1) A	INTEGER(1)	GNU extension
IIBSET(A)	INTEGER(2) A	INTEGER(2)	GNU extension
JIBSET(A)	INTEGER(4) A	INTEGER(4)	GNU extension
KIBSET(A)	INTEGER(8) A	INTEGER(8)	GNU extension

Standard: Fortran 90 and later, has overloads that are GNU extensions. Extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.146 [IBCLR], page 217,
 Section 8.147 [IBITS], page 218,
 Section 8.143 [IAND], page 215,
 Section 8.158 [IOR], page 225,
 Section 8.151 [IEOR], page 221,
 Section 8.209 [MVBITS], page 256,

8.149 ICHAR — Character-to-integer conversion function

Synopsis: `RESULT = ICHAR(C [, KIND])`

Description:

ICHAR(*C*) returns the code for the character in the first character position of *C* in the system's native character set. The correspondence between characters and their codes is not necessarily the same across different GNU Fortran implementations.

Class: Elemental function

Arguments:

C Shall be a scalar `CHARACTER`, with `INTENT(IN)`
KIND (Optional) A scalar `INTEGER` constant expression indicating the kind parameter of the result.

Return value:

The return value is of type `INTEGER` and of kind *KIND*. If *KIND* is absent, the return value is of default integer kind.

Example:

```
program test_ichar
```

```

      integer i
      i = ichar(' ')
end program test_ichar

```

Specific names:

Name	Argument	Return type	Standard
ICHAR(C)	CHARACTER C	INTEGER(4)	Fortran 77 and later

Notes: No intrinsic exists to convert between a numeric value and a formatted character string representation – for instance, given the **CHARACTER** value '154', obtaining an **INTEGER** or **REAL** value with the value 154, or vice versa. Instead, this functionality is provided by internal-file I/O, as in the following example:

```

program read_val
  integer value
  character(len=10) string, string2
  string = '154'

  ! Convert a string to a numeric value
  read (string,'(I10)') value
  print *, value

  ! Convert a value to a formatted string
  write (string2,'(I10)') value
  print *, string2
end program read_val

```

Standard: Fortran 77 and later, with *KIND* argument Fortran 2003 and later

See also: Section 8.5 [ACHAR], page 121,
 Section 8.63 [CHAR], page 160,
 Section 8.141 [IACHAR], page 213,

8.150 IDATE — Get current local time subroutine (day/month/year)

Synopsis: CALL IDATE(VALUE)

Description:

IDATE(VALUE) Fills *VALUES* with the numerical values at the current local time. The day (in the range 1-31), month (in the range 1-12), and year appear in elements 1, 2, and 3 of *VALUES*, respectively. The year has four significant digits.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 8.87 [DATE-AND-TIME], page 178, intrinsic defined by the Fortran 95 standard.

Class: Subroutine

Arguments:

<i>VALUES</i>	The type shall be INTEGER , DIMENSION(3) and the kind shall be the default integer kind.
---------------	--

Return value:

Does not return anything.

Example:

```

program test_idate
  integer, dimension(3) :: tarray
  call idate(tarray)
  print *, tarray(1)
  print *, tarray(2)
  print *, tarray(3)
end program test_idate

```

Standard: GNU extension

See also: Section 8.87 [DATE_AND_TIME], page 178,

8.151 IEOR — Bitwise logical exclusive or

Synopsis: RESULT = IEOR(I, J)

Description:

IEOR returns the bitwise Boolean exclusive-OR of *I* and *J*.

Class: Elemental function

Arguments:

I The type shall be INTEGER, UNSIGNED or a boz-literal-constant.

J The type shall be the same type as *I* with the same kind type parameter or a boz-literal-constant. *I* and *J* shall not both be boz-literal-constants.

Return value:

The return type is with the kind type parameter of the arguments. A boz-literal-constant is converted to an INTEGER or UNSIGNED with the kind type parameter of the other argument as-if a call to Section 8.155 [INT], page 223, or Section 8.292 [UINT], page 306, respectively, occurred.

Specific names:

Name	Argument	Return type	Standard
IEOR(A)	INTEGER A	INTEGER	Fortran 90 and later
BIEOR(A)	INTEGER(1) A	INTEGER(1)	GNU extension
IIIEOR(A)	INTEGER(2) A	INTEGER(2)	GNU extension
JIEOR(A)	INTEGER(4) A	INTEGER(4)	GNU extension
KIEOR(A)	INTEGER(8) A	INTEGER(8)	GNU extension

Standard: Fortran 90 and later, with boz-literal-constant Fortran 2008 and later, has overloads that are GNU extensions. Extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.158 [IOR], page 225,
 Section 8.143 [IAND], page 215,
 Section 8.147 [IBITS], page 218,
 Section 8.148 [IBSET], page 218,
 Section 8.146 [IBCLR], page 217,
 Section 8.214 [NOT], page 259,

8.152 IERRNO — Get the last system error number

Synopsis: `RESULT = IERRNO()`

Description:

Returns the last system error number, as given by the C `errno` variable.

Class: Function

Arguments:

None

Return value:

The return value is of type `INTEGER` and of the default integer kind.

Standard: GNU extension

See also: Section 8.221 [`PERERROR`], page 264,

8.153 IMAGE_INDEX — Function that converts a cosubscript to an image index

Synopsis: `RESULT = IMAGE_INDEX(COARRAY, SUB)`

Description:

Returns the image index belonging to a cosubscript.

Class: Inquiry function.

Arguments:

`COARRAY` Coarray of any type.

`SUB` default integer rank-1 array of a size equal to the corank of `COARRAY`.

Return value:

Scalar default integer with the value of the image index that corresponds to the cosubscripts. For invalid cosubscripts the result is zero.

Example:

```
INTEGER :: array[2,-1:4,8,*]
! Writes 28 (or 0 if there are fewer than 28 images)
WRITE (*,*) IMAGE_INDEX (array, [2,0,3,1])
```

Standard: Fortran 2008 and later

See also: Section 8.281 [`THIS_IMAGE`], page 300,
Section 8.216 [`NUM_IMAGES`], page 260,

8.154 INDEX — Position of a substring within a string

Synopsis: `RESULT = INDEX(STRING, SUBSTRING [, BACK [, KIND]])`

Description:

Returns the position of the start of the first occurrence of string `SUBSTRING` as a substring in `STRING`, counting from one. If `SUBSTRING` is not present in `STRING`, zero is returned. If the `BACK` argument is present and true, the return value is the start of the last occurrence rather than the first.

Class: Elemental function

Arguments:

STRING Shall be a scalar **CHARACTER**, with **INTENT(IN)**
SUBSTRING Shall be a scalar **CHARACTER**, with **INTENT(IN)**
BACK (Optional) Shall be a scalar **LOGICAL**, with **INTENT(IN)**
KIND (Optional) A scalar **INTEGER** constant expression indicating the kind parameter of the result.

Return value:

The return value is of type **INTEGER** and of kind *KIND*. If *KIND* is absent, the return value is of default integer kind.

Specific names:

Name	Argument	Return type	Standard
INDEX(<i>STRING</i> , <i>SUBSTRING</i>)	CHARACTER	INTEGER(4)	Fortran 77 and later

Standard: Fortran 77 and later, with *KIND* argument Fortran 2003 and later

See also: Section 8.243 [SCAN], page 276,
 Section 8.298 [VERIFY], page 309,

8.155 INT — Convert to integer type

Synopsis: **RESULT = INT(A [, KIND])**

Description:

Convert to integer type

Class: Elemental function, extension for **UNSIGNED** (see Section 5.1.34 [Unsigned integers], page 67).

Arguments:

A Shall be of type **INTEGER**, **REAL**, **COMPLEX** or **UNSIGNED** or a *boz*-literal-constant.
KIND (Optional) A scalar **INTEGER** constant expression indicating the kind parameter of the result.

Return value:

These functions return a **INTEGER** variable or array under the following rules:

- (A) If *A* is of type **INTEGER**, **INT(A)** = *A*
- (B) If *A* is of type **REAL** and $|A| < 1$, **INT(A)** equals 0. If $|A| \geq 1$, then **INT(A)** is the integer whose magnitude is the largest integer that does not exceed the magnitude of *A* and whose sign is the same as the sign of *A*.
- (C) If *A* is of type **COMPLEX**, rule B is applied to the real part of *A*.
- (D) If *A* is of type **UNSIGNED** and $0 \leq A \leq \text{HUGE}(A)$, **INT(A)** = *A*. Outside that range, the result is interpreted using two's complement.

Example:

```

program test_int
  integer :: i = 42
  complex :: z = (-3.7, 1.0)
  print *, int(i)
  print *, int(z), int(z,8)
end program

```

Specific names:

Name	Argument	Return type	Standard
INT(A)	REAL(4) A	INTEGER	Fortran 77 and later
IFIX(A)	REAL(4) A	INTEGER	Fortran 77 and later
IDINT(A)	REAL(8) A	INTEGER	Fortran 77 and later

Standard: Fortran 77 and later, with `boz-literal-constant` Fortran 2008 and later.

8.156 INT2 — Convert to 16-bit integer type

Synopsis: `RESULT = INT2(A)`

Description:

Convert to a `KIND=2` integer type. This is equivalent to the standard `INT` intrinsic with an optional argument of `KIND=2`, and is only included for backwards compatibility.

Class: Elemental function

Arguments:

A Shall be of type `INTEGER`, `REAL`, or `COMPLEX`.

Return value:

The return value is a `INTEGER(2)` variable.

Standard: GNU extension

See also: Section 8.155 [INT], page 223,
Section 8.157 [INT8], page 224,

8.157 INT8 — Convert to 64-bit integer type

Synopsis: `RESULT = INT8(A)`

Description:

Convert to a `KIND=8` integer type. This is equivalent to the standard `INT` intrinsic with an optional argument of `KIND=8`, and is only included for backwards compatibility.

Class: Elemental function

Arguments:

A Shall be of type `INTEGER`, `REAL`, or `COMPLEX`.

Return value:

The return value is a `INTEGER(8)` variable.

Standard: GNU extension

See also: Section 8.155 [INT], page 223,
Section 8.156 [INT2], page 224,

8.158 IOR — Bitwise logical or

Synopsis: `RESULT = IOR(I, J)`

Description:

IOR returns the bitwise Boolean inclusive-OR of *I* and *J*.

Class: Elemental function

Arguments:

I The type shall be `INTEGER`, `UNSIGNED` or a boz-literal-constant.
J The type shall be the same type as *I* with the same kind type parameter or a boz-literal-constant. *I* and *J* shall not both be boz-literal-constants.

Return value:

The return type is `INTEGER` with the kind type parameter of the arguments. A boz-literal-constant is converted to an `INTEGER` or `UNSIGNED` with the kind type parameter of the other argument as-if a call to Section 8.155 [INT], page 223, or Section 8.292 [UINT], page 306, respectively, occurred.

Specific names:

Name	Argument	Return type	Standard
<code>IOR(A)</code>	<code>INTEGER A</code>	<code>INTEGER</code>	Fortran 90 and later
<code>BIOR(A)</code>	<code>INTEGER(1) A</code>	<code>INTEGER(1)</code>	GNU extension
<code>IIOR(A)</code>	<code>INTEGER(2) A</code>	<code>INTEGER(2)</code>	GNU extension
<code>JIOR(A)</code>	<code>INTEGER(4) A</code>	<code>INTEGER(4)</code>	GNU extension
<code>KIOR(A)</code>	<code>INTEGER(8) A</code>	<code>INTEGER(8)</code>	GNU extension

Standard: Fortran 90 and later, with boz-literal-constant Fortran 2008 and later, has overloads that are GNU extensions. Extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.151 [IEOR], page 221,
Section 8.143 [IAND], page 215,
Section 8.147 [IBITS], page 218,
Section 8.148 [IBSET], page 218,
Section 8.146 [IBCLR], page 217,
Section 8.214 [NOT], page 259,

8.159 IPARITY — Bitwise XOR of array elements

Synopsis:

`RESULT = IPARITY(ARRAY[, MASK])`
`RESULT = IPARITY(ARRAY, DIM[, MASK])`

Description:

Reduces with bitwise XOR (exclusive or) the elements of *ARRAY* along dimension *DIM* if the corresponding element in *MASK* is `TRUE`.

Class: Transformational function

Arguments:

ARRAY Shall be an array of type `INTEGER` or `UNSIGNED`.
DIM (Optional) shall be a scalar of type `INTEGER` with a value in the range from 1 to *n*, where *n* equals the rank of *ARRAY*.
MASK (Optional) shall be of type `LOGICAL` and either be a scalar or an array of the same shape as *ARRAY*.

Return value:

The result is of the same type as *ARRAY*.

If *DIM* is absent, a scalar with the bitwise XOR of all elements in *ARRAY* is returned. Otherwise, an array of rank *n*-1, where *n* equals the rank of *ARRAY*, and a shape similar to that of *ARRAY* with dimension *DIM* dropped is returned.

Example:

```
PROGRAM test_iparity
  INTEGER(1) :: a(2)

  a(1) = int(b'00100100', 1)
  a(2) = int(b'01101010', 1)

  ! prints 01001110
  PRINT '(b8.8)', IPARITY(a)
END PROGRAM
```

Standard: Fortran 2008 and later. Extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.144 [IANY], page 216,
 Section 8.142 [IALL], page 214,
 Section 8.151 [IEOR], page 221,
 Section 8.220 [PARITY], page 263,

8.160 IRAND — Integer pseudo-random number

Synopsis: `RESULT = IRAND(I)`

Description:

`IRAND(FLAG)` returns a pseudo-random number from a uniform distribution between 0 and a system-dependent limit (which is in most cases 2147483647). If *FLAG* is 0, the next number in the current sequence is returned; if *FLAG* is 1, the generator is restarted by `CALL SRAND(0)`; if *FLAG* has any other value, it is used as a new seed with `SRAND`.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. It implements a simple modulo generator as provided by g77. For new code, one should consider the use of Section 8.231 [RANDOM_NUMBER], page 269, as it implements a superior algorithm.

Class: Function

Arguments:

I Shall be a scalar INTEGER of kind 4.

Return value:

The return value is of INTEGER(kind=4) type.

Example:

```

program test_irand
  integer,parameter :: seed = 86456

  call srand(seed)
  print *, irand(), irand(), irand(), irand()
  print *, irand(seed), irand(), irand(), irand()
end program test_irand

```

Standard: GNU extension

8.161 IS_CONTIGUOUS — Test whether an array is contiguous

Synopsis: RESULT = IS_CONTIGUOUS (ARRAY)

Description:

IS_CONTIGUOUS tests whether an array is contiguous.

Class: Inquiry function

Arguments:

ARRAY Shall be an array of any type.

Return value:

Returns a LOGICAL of the default kind, which is .TRUE. if *ARRAY* is contiguous and false otherwise.

Example:

```

program test
  integer :: a(10)
  a = [1,2,3,4,5,6,7,8,9,10]
  call sub (a)        ! every element, is contiguous
  call sub (a(::2)) ! every other element, is noncontiguous
contains
  subroutine sub (x)
    integer :: x(:)
    if (is_contiguous (x)) then
      write (*,*) 'X is contiguous'
    else
      write (*,*) 'X is not contiguous'
    end if
  end subroutine sub
end program test

```

Standard: Fortran 2008 and later

8.162 IS_IOSTAT_END — Test for end-of-file value

Synopsis: RESULT = IS_IOSTAT_END(I)

Description:

IS_IOSTAT_END tests whether an variable has the value of the I/O status “end of file”. The function is equivalent to comparing the variable with the IOSTAT_END parameter of the intrinsic module ISO_FORTRAN_ENV.

Class: Elemental function

Arguments:

I Shall be of the type INTEGER.

Return value:

Returns a LOGICAL of the default kind, which is .TRUE. if *I* has the value that indicates an end of file condition for IOSTAT= specifiers, and is .FALSE. otherwise.

Example:

```
PROGRAM iostat
  IMPLICIT NONE
  INTEGER :: stat, i
  OPEN(88, FILE='test.dat')
  READ(88, *, IOSTAT=stat) i
  IF(IS_IOSTAT_END(stat)) STOP 'END OF FILE'
END PROGRAM
```

Standard: Fortran 2003 and later

8.163 IS_IOSTAT_EOR — Test for end-of-record value

Synopsis: RESULT = IS_IOSTAT_EOR(I)

Description:

IS_IOSTAT_EOR tests whether an variable has the value of the I/O status “end of record”. The function is equivalent to comparing the variable with the IOSTAT_EOR parameter of the intrinsic module ISO_FORTRAN_ENV.

Class: Elemental function

Arguments:

I Shall be of the type INTEGER.

Return value:

Returns a LOGICAL of the default kind, which is .TRUE. if *I* has the value that indicates an end of file condition for IOSTAT= specifiers, and is .FALSE. otherwise.

Example:

```
PROGRAM iostat
  IMPLICIT NONE
  INTEGER :: stat, i(50)
  OPEN(88, FILE='test.dat', FORM='UNFORMATTED')
  READ(88, IOSTAT=stat) i
  IF(IS_IOSTAT_EOR(stat)) STOP 'END OF RECORD'
END PROGRAM
```

Standard: Fortran 2003 and later

8.164 ISATTY — Whether a unit is a terminal device

Synopsis: `RESULT = ISATTY(UNIT)`

Description:

Determine whether a unit is connected to a terminal device.

Class: Function

Arguments:

UNIT Shall be a scalar `INTEGER`.

Return value:

Returns `.TRUE.` if the *UNIT* is connected to a terminal device, `.FALSE.` otherwise.

Example:

```
PROGRAM test_isatty
  INTEGER(kind=1) :: unit
  DO unit = 1, 10
    write(*,*) isatty(unit=unit)
  END DO
END PROGRAM
```

Standard: GNU extension

See also: Section 8.289 [TTYNAM], page 305,

8.165 ISHFT — Shift bits

Synopsis: `RESULT = ISHFT(I, SHIFT)`

Description:

`ISHFT` returns a value corresponding to *I* with all of the bits shifted *SHIFT* places. A value of *SHIFT* greater than zero corresponds to a left shift, a value of zero corresponds to no shift, and a value less than zero corresponds to a right shift. If the absolute value of *SHIFT* is greater than `BIT_SIZE(I)`, the value is undefined. Bits shifted out from the left end or right end are lost; zeros are shifted in from the opposite end.

Class: Elemental function

Arguments:

I The type shall be `INTEGER` or `UNSIGNED`.

SHIFT The type shall be `INTEGER`.

Return value:

The return value is of type of *I*.

Specific names:

Name	Argument	Return type	Standard
<code>ISHFT(A)</code>	<code>INTEGER A</code>	<code>INTEGER</code>	Fortran 90 and later
<code>BSHFT(A)</code>	<code>INTEGER(1) A</code>	<code>INTEGER(1)</code>	GNU extension
<code>IISHFT(A)</code>	<code>INTEGER(2) A</code>	<code>INTEGER(2)</code>	GNU extension
<code>JISHFT(A)</code>	<code>INTEGER(4) A</code>	<code>INTEGER(4)</code>	GNU extension
<code>KISHFT(A)</code>	<code>INTEGER(8) A</code>	<code>INTEGER(8)</code>	GNU extension

Standard: Fortran 90 and later, has overloads that are GNU extensions. Extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.166 [ISHFTC], page 230,

8.166 ISHFTC — Shift bits circularly

Synopsis: RESULT = ISHFTC(I, SHIFT [, SIZE])

Description:

ISHFTC returns a value corresponding to *I* with the rightmost *SIZE* bits shifted circularly *SHIFT* places; that is, bits shifted out one end are shifted into the opposite end. A value of *SHIFT* greater than zero corresponds to a left shift, a value of zero corresponds to no shift, and a value less than zero corresponds to a right shift. The absolute value of *SHIFT* must be less than *SIZE*. If the *SIZE* argument is omitted, it is taken to be equivalent to BIT_SIZE(I).

Class: Elemental function

Arguments:

<i>I</i>	The type shall be INTEGER or UNSIGNED.
<i>SHIFT</i>	The type shall be INTEGER.
<i>SIZE</i>	(Optional) The type shall be INTEGER; the value must be greater than zero and less than or equal to BIT_SIZE(I).

Return value:

The return value is of the same type as *I*.

Specific names:

Name	Argument	Return type	Standard
ISHFTC(A)	INTEGER A	INTEGER	Fortran 90 and later
BSHFTC(A)	INTEGER(1) A	INTEGER(1)	GNU extension
IISHFTC(A)	INTEGER(2) A	INTEGER(2)	GNU extension
JISHFTC(A)	INTEGER(4) A	INTEGER(4)	GNU extension
KISHFTC(A)	INTEGER(8) A	INTEGER(8)	GNU extension

Standard: Fortran 90 and later, has overloads that are GNU extensions. Extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.165 [ISHFT], page 229,

8.167 ISNAN — Test for a NaN

Synopsis: ISNAN(X)

Description:

ISNAN tests whether a floating-point value is an IEEE Not-a-Number (NaN).

Class: Elemental function

Arguments:

<i>X</i>	Variable of the type REAL.
----------	----------------------------

Return value:

Returns a default-kind LOGICAL. The returned value is TRUE if *X* is a NaN and FALSE otherwise.

Example:

```

program test_nan
  implicit none
  real :: x
  x = -1.0
  x = sqrt(x)
  if (isnan(x)) stop '"x" is a NaN'
end program test_nan

```

Standard: GNU extension

8.168 ITIME — Get current local time subroutine (hour/minutes/seconds)

Synopsis: CALL ITIME(VALUES)

Description:

ITIME(VALUES) Fills *VALUES* with the numerical values at the current local time. The hour (in the range 1-24), minute (in the range 1-60), and seconds (in the range 1-60) appear in elements 1, 2, and 3 of *VALUES*, respectively.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 8.87 [DATE_AND_TIME], page 178, intrinsic defined by the Fortran 95 standard.

Class: Subroutine

Arguments:

VALUES The type shall be INTEGER, DIMENSION(3) and the kind shall be the default integer kind.

Return value:

Does not return anything.

Example:

```

program test_itime
  integer, dimension(3) :: tarray
  call itime(tarray)
  print *, tarray(1)
  print *, tarray(2)
  print *, tarray(3)
end program test_itime

```

Standard: GNU extension

See also: Section 8.87 [DATE_AND_TIME], page 178,

8.169 KILL — Send a signal to a process

Synopsis:

```

CALL KILL(PID, SIG [, STATUS])
STATUS = KILL(PID, SIG)

```

Description:

Sends the signal specified by *SIG* to the process *PID*. See `kill(2)`.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

<i>PID</i>	Shall be a scalar <code>INTEGER</code> with <code>INTENT(IN)</code> .
<i>SIG</i>	Shall be a scalar <code>INTEGER</code> with <code>INTENT(IN)</code> .
<i>STATUS</i>	[Subroutine](Optional) Shall be a scalar <code>INTEGER</code> . Returns 0 on success; otherwise a system-specific error code is returned.
<i>STATUS</i>	[Function] The kind type parameter is that of <code>pid</code> . Returns 0 on success; otherwise a system-specific error code is returned.

Standard: GNU extension

See also: Section 8.2 [ABORT], page 119,
Section 8.106 [EXIT], page 191,

8.170 KIND — Kind of an entity

Synopsis: `K = KIND(X)`

Description:

`KIND(X)` returns the kind value of the entity *X*.

Class: Inquiry function

Arguments:

<i>X</i>	Shall be of type <code>LOGICAL</code> , <code>INTEGER</code> , <code>REAL</code> , <code>COMPLEX</code> or <code>CHARACTER</code> . It may be scalar or array valued.
----------	---

Return value:

The return value is a scalar of type `INTEGER` and of the default integer kind.

Example:

```
program test_kind
  integer,parameter :: kc = kind(' ')
  integer,parameter :: kl = kind(.true.)

  print *, "The default character kind is ", kc
  print *, "The default logical kind is ", kl
end program test_kind
```

Standard: Fortran 95 and later

8.171 LBOUND — Lower dimension bounds of an array

Synopsis: `RESULT = LBOUND(ARRAY [, DIM [, KIND]])`

Description:

Returns the lower bounds of an array, or a single lower bound along the *DIM* dimension.

Class: Inquiry function

Arguments:

ARRAY Shall be an array, of any type.
DIM (Optional) Shall be a scalar **INTEGER**.
KIND (Optional) A scalar **INTEGER** constant expression indicating the kind parameter of the result.

Return value:

The return value is of type **INTEGER** and of kind *KIND*. If *KIND* is absent, the return value is of default integer kind. If *DIM* is absent, the result is an array of the lower bounds of *ARRAY*. If *DIM* is present, the result is a scalar corresponding to the lower bound of the array along that dimension. If *ARRAY* is an expression rather than a whole array or array structure component, or if it has a zero extent along the relevant dimension, the lower bound is taken to be 1.

Standard: Fortran 90 and later, with *KIND* argument Fortran 2003 and later

See also: Section 8.290 [UBOUND], page 305,
 Section 8.172 [LCOBOUND], page 233,

8.172 LCOBOUND — Lower codimension bounds of an array

Synopsis: **RESULT = LCOBOUND(COARRAY [, DIM [, KIND]])**

Description:

Returns the lower bounds of a coarray, or a single lower cobound along the *DIM* codimension.

Class: Inquiry function

Arguments:

ARRAY Shall be an coarray, of any type.
DIM (Optional) Shall be a scalar **INTEGER**.
KIND (Optional) A scalar **INTEGER** constant expression indicating the kind parameter of the result.

Return value:

The return value is of type **INTEGER** and of kind *KIND*. If *KIND* is absent, the return value is of default integer kind. If *DIM* is absent, the result is an array of the lower cobounds of *COARRAY*. If *DIM* is present, the result is a scalar corresponding to the lower cobound of the array along that codimension.

Standard: Fortran 2008 and later

See also: Section 8.291 [UCOBOUND], page 306,
 Section 8.171 [LBOUND], page 232,

8.173 LEADZ — Number of leading zero bits of an integer

Synopsis: `RESULT = LEADZ(I)`

Description:

LEADZ returns the number of leading zero bits of an integer.

Class: Elemental function

Arguments:

I Shall be of type `INTEGER`.

Return value:

The type of the return value is the default `INTEGER`. If all the bits of *I* are zero, the result value is `BIT_SIZE(I)`.

Example:

```
PROGRAM test_leadz
  WRITE (*,*) BIT_SIZE(1)  ! prints 32
  WRITE (*,*) LEADZ(1)     ! prints 31
END PROGRAM
```

Standard: Fortran 2008 and later

See also: Section 8.52 [`BIT_SIZE`], page 153,
 Section 8.285 [`TRAILZ`], page 302,
 Section 8.222 [`POPCNT`], page 264,
 Section 8.223 [`POPPAR`], page 265,

8.174 LEN — Length of a character entity

Synopsis: `L = LEN(STRING [, KIND])`

Description:

Returns the length of a character string. If *STRING* is an array, the length of an element of *STRING* is returned. Note that *STRING* need not be defined when this intrinsic is invoked, since only the length, not the content, of *STRING* is needed.

Class: Inquiry function

Arguments:

STRING Shall be a scalar or array of type `CHARACTER`, with
 `INTENT(IN)`
KIND (Optional) A scalar `INTEGER` constant expression in-
 dicating the kind parameter of the result.

Return value:

The return value is of type `INTEGER` and of kind *KIND*. If *KIND* is absent, the return value is of default integer kind.

Specific names:

Name	Argument	Return type	Standard
<code>LEN(STRING)</code>	<code>CHARACTER</code>	<code>INTEGER</code>	Fortran 77 and later

Standard: Fortran 77 and later, with *KIND* argument Fortran 2003 and later

See also: Section 8.175 [LEN_TRIM], page 235,
 Section 8.10 [ADJUSTL], page 124,
 Section 8.11 [ADJUSTR], page 125,

8.175 LEN_TRIM — Length of a character entity without trailing blank characters

Synopsis: RESULT = LEN_TRIM(STRING [, KIND])

Description:

Returns the length of a character string, ignoring any trailing blanks.

Class: Elemental function

Arguments:

<i>STRING</i>	Shall be a scalar of type CHARACTER, with INTENT(IN)
<i>KIND</i>	(Optional) A scalar INTEGER constant expression indicating the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind *KIND*. If *KIND* is absent, the return value is of default integer kind.

Standard: Fortran 90 and later, with *KIND* argument Fortran 2003 and later

See also: Section 8.174 [LEN], page 234,
 Section 8.10 [ADJUSTL], page 124,
 Section 8.11 [ADJUSTR], page 125,

8.176 LGE — Lexical greater than or equal

Synopsis: RESULT = LGE(STRING_A, STRING_B)

Description:

Determines whether one string is lexically greater than or equal to another string, where the two strings are interpreted as containing ASCII character codes. If the String A and String B are not the same length, the shorter is compared as if spaces were appended to it to form a value that has the same length as the longer.

In general, the lexical comparison intrinsics LGE, LGT, LLE, and LLT differ from the corresponding intrinsic operators .GE., .GT., .LE., and .LT., in that the latter use the processor's character ordering (which is not ASCII on some targets), whereas the former always use the ASCII ordering.

Class: Elemental function

Arguments:

<i>STRING_A</i>	Shall be of default CHARACTER type.
<i>STRING_B</i>	Shall be of default CHARACTER type.

Return value:

Returns `.TRUE.` if `STRING_A >= STRING_B`, and `.FALSE.` otherwise, based on the ASCII ordering.

Specific names:

Name	Argument	Return type	Standard
<code>LGE(STRING_A,STRING_B)</code>	CHARACTER	LOGICAL	Fortran 77 and later

Standard: Fortran 77 and later

See also: Section 8.177 [LGT], page 236,
 Section 8.179 [LLE], page 237,
 Section 8.180 [LLT], page 238,

8.177 LGT — Lexical greater than

Synopsis: `RESULT = LGT(STRING_A, STRING_B)`

Description:

Determines whether one string is lexically greater than another string, where the two strings are interpreted as containing ASCII character codes. If the String A and String B are not the same length, the shorter is compared as if spaces were appended to it to form a value that has the same length as the longer.

In general, the lexical comparison intrinsics `LGE`, `LGT`, `LLE`, and `LLT` differ from the corresponding intrinsic operators `.GE.`, `.GT.`, `.LE.`, and `.LT.`, in that the latter use the processor's character ordering (which is not ASCII on some targets), whereas the former always use the ASCII ordering.

Class: Elemental function

Arguments:

`STRING_A` Shall be of default CHARACTER type.
`STRING_B` Shall be of default CHARACTER type.

Return value:

Returns `.TRUE.` if `STRING_A > STRING_B`, and `.FALSE.` otherwise, based on the ASCII ordering.

Specific names:

Name	Argument	Return type	Standard
<code>LGT(STRING_A,STRING_B)</code>	CHARACTER	LOGICAL	Fortran 77 and later

Standard: Fortran 77 and later

See also: Section 8.176 [LGE], page 235,
 Section 8.179 [LLE], page 237,
 Section 8.180 [LLT], page 238,

8.178 LINK — Create a hard link

Synopsis:

```
CALL LINK(PATH1, PATH2 [, STATUS])
STATUS = LINK(PATH1, PATH2)
```

Description:

Makes a (hard) link from file *PATH1* to *PATH2*. A null character (`CHAR(0)`) can be used to mark the end of the names in *PATH1* and *PATH2*; otherwise, trailing blanks in the file names are ignored. If the *STATUS* argument is supplied, it contains 0 on success or a nonzero error code upon return; see `link(2)`.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

PATH1 Shall be of default `CHARACTER` type.
PATH2 Shall be of default `CHARACTER` type.
STATUS (Optional) Shall be of default `INTEGER` type.

Standard: GNU extension

See also: Section 8.273 [SYMLNK], page 295,
 Section 8.296 [UNLINK], page 308,

8.179 LLE — Lexical less than or equal

Synopsis: `RESULT = LLE(STRING_A, STRING_B)`

Description:

Determines whether one string is lexically less than or equal to another string, where the two strings are interpreted as containing ASCII character codes. If the String A and String B are not the same length, the shorter is compared as if spaces were appended to it to form a value that has the same length as the longer.

In general, the lexical comparison intrinsics `LGE`, `LGT`, `LLE`, and `LLT` differ from the corresponding intrinsic operators `.GE.`, `.GT.`, `.LE.`, and `.LT.`, in that the latter use the processor's character ordering (which is not ASCII on some targets), whereas the former always use the ASCII ordering.

Class: Elemental function

Arguments:

STRING_A Shall be of default `CHARACTER` type.
STRING_B Shall be of default `CHARACTER` type.

Return value:

Returns `.TRUE.` if `STRING_A <= STRING_B`, and `.FALSE.` otherwise, based on the ASCII ordering.

Specific names:

Name	Argument	Return type	Standard
LLE(String_A,String_B)	CHARACTER	LOGICAL	Fortran 77 and later

Standard: Fortran 77 and later

See also: Section 8.176 [LGE], page 235,
Section 8.177 [LGT], page 236,
Section 8.180 [LLT], page 238,

8.180 LLT — Lexical less than

Synopsis: RESULT = LLT(String_A, String_B)

Description:

Determines whether one string is lexically less than another string, where the two strings are interpreted as containing ASCII character codes. If the String A and String B are not the same length, the shorter is compared as if spaces were appended to it to form a value that has the same length as the longer.

In general, the lexical comparison intrinsics LGE, LGT, LLE, and LLT differ from the corresponding intrinsic operators .GE., .GT., .LE., and .LT., in that the latter use the processor's character ordering (which is not ASCII on some targets), whereas the former always use the ASCII ordering.

Class: Elemental function

Arguments:

String_A Shall be of default CHARACTER type.
String_B Shall be of default CHARACTER type.

Return value:

Returns .TRUE. if String_A < String_B, and .FALSE. otherwise, based on the ASCII ordering.

Specific names:

Name	Argument	Return type	Standard
LLT(String_A,String_B)	CHARACTER	LOGICAL	Fortran 77 and later

Standard: Fortran 77 and later

See also: Section 8.176 [LGE], page 235,
Section 8.177 [LGT], page 236,
Section 8.179 [LLE], page 237,

8.181 LNBLNK — Index of the last non-blank character in a string

Synopsis: RESULT = LNBLNK(String)

Description:

Returns the length of a character string, ignoring any trailing blanks. This is identical to the standard `LEN_TRIM` intrinsic, and is only included for backwards compatibility.

Class: Elemental function

Arguments:

STRING Shall be a scalar of type `CHARACTER`, with `INTENT(IN)`

Return value:

The return value is of `INTEGER(kind=4)` type.

Standard: GNU extension

See also: Section 8.154 [`INDEX` intrinsic], page 222,
Section 8.175 [`LEN_TRIM`], page 235,

8.182 LOC — Returns the address of a variable

Synopsis: `RESULT = LOC(X)`

Description:

`LOC(X)` returns the address of `X` as an integer.

Class: Inquiry function

Arguments:

X Variable of any type.

Return value:

The return value is of type `INTEGER`, with a `KIND` corresponding to the size (in bytes) of a memory address on the target machine.

Example:

```
program test_loc
  integer :: i
  real :: r
  i = loc(r)
  print *, i
end program test_loc
```

Standard: GNU extension

8.183 LOG — Natural logarithm function

Synopsis: `RESULT = LOG(X)`

Description:

`LOG(X)` computes the natural logarithm of `X`, i.e. the logarithm to the base e .

Class: Elemental function

Arguments:

X The type shall be `REAL` or `COMPLEX`.

Return value:

The return value is of type **REAL** or **COMPLEX**. The kind type parameter is the same as *X*. If *X* is **COMPLEX**, the imaginary part ω is in the range $-\pi < \omega \leq \pi$.

Example:

```

program test_log
  real(8) :: x = 2.7182818284590451_8
  complex :: z = (1.0, 2.0)
  x = log(x)      ! yields (approximately) 1
  z = log(z)
end program test_log

```

Specific names:

Name	Argument	Return type	Standard
ALOG(<i>X</i>)	REAL(4) <i>X</i>	REAL(4)	Fortran 77 or later
DLOG(<i>X</i>)	REAL(8) <i>X</i>	REAL(8)	Fortran 77 or later
CLOG(<i>X</i>)	COMPLEX(4) <i>X</i>	COMPLEX(4)	Fortran 77 or later
ZLOG(<i>X</i>)	COMPLEX(8) <i>X</i>	COMPLEX(8)	GNU extension
CDLOG(<i>X</i>)	COMPLEX(8) <i>X</i>	COMPLEX(8)	GNU extension

Standard: Fortran 77 and later, has GNU extensions

8.184 LOG10 — Base 10 logarithm function

Synopsis: **RESULT** = LOG10(*X*)

Description:

LOG10(*X*) computes the base 10 logarithm of *X*.

Class: Elemental function

Arguments:

X The type shall be **REAL**.

Return value:

The return value is of type **REAL** or **COMPLEX**. The kind type parameter is the same as *X*.

Example:

```

program test_log10
  real(8) :: x = 10.0_8
  x = log10(x)
end program test_log10

```

Specific names:

Name	Argument	Return type	Standard
ALOG10(<i>X</i>)	REAL(4) <i>X</i>	REAL(4)	Fortran 77 and later
DLOG10(<i>X</i>)	REAL(8) <i>X</i>	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later

8.185 LOG_GAMMA — Logarithm of the Gamma function

Synopsis: `X = LOG_GAMMA(X)`

Description:

`LOG_GAMMA(X)` computes the natural logarithm of the absolute value of the Gamma (Γ) function.

Class: Elemental function

Arguments:

`X` Shall be of type `REAL` and neither zero nor a negative integer.

Return value:

The return value is of type `REAL` of the same kind as `X`.

Example:

```
program test_log_gamma
  real :: x = 1.0
  x = lgamma(x) ! returns 0.0
end program test_log_gamma
```

Specific names:

Name	Argument	Return type	Standard
<code>LGAMMA(X)</code>	<code>REAL(4) X</code>	<code>REAL(4)</code>	GNU extension
<code>ALGAMA(X)</code>	<code>REAL(4) X</code>	<code>REAL(4)</code>	GNU extension
<code>DLGAMA(X)</code>	<code>REAL(8) X</code>	<code>REAL(8)</code>	GNU extension

Standard: Fortran 2008 and later

See also: Gamma function:
Section 8.124 [GAMMA], page 203,

8.186 LOGICAL — Convert to logical type

Synopsis: `RESULT = LOGICAL(L [, KIND])`

Description:

Converts one kind of `LOGICAL` variable to another.

Class: Elemental function

Arguments:

`L` The type shall be `LOGICAL`.
`KIND` (Optional) A scalar `INTEGER` constant expression indicating the kind parameter of the result.

Return value:

The return value is a `LOGICAL` value equal to `L`, with a kind corresponding to `KIND`, or of the default logical kind if `KIND` is not given.

Standard: Fortran 90 and later

See also: Section 8.155 [INT], page 223,
 Section 8.235 [REAL], page 272,
 Section 8.66 [CMPLX], page 162,

8.187 LSHIFT — Left shift bits

Synopsis: `RESULT = LSHIFT(I, SHIFT)`

Description:

LSHIFT returns a value corresponding to *I* with all of the bits shifted left by *SHIFT* places. *SHIFT* shall be nonnegative and less than or equal to `BIT_SIZE(I)`, otherwise the result value is undefined. Bits shifted out from the left end are lost; zeros are shifted in from the opposite end.

This function has been superseded by the `ISHFT` intrinsic, which is standard in Fortran 95 and later, and the `SHIFTL` intrinsic, which is standard in Fortran 2008 and later.

Class: Elemental function

Arguments:

<i>I</i>	The type shall be <code>INTEGER</code> .
<i>SHIFT</i>	The type shall be <code>INTEGER</code> .

Return value:

The return value is of type `INTEGER` and of the same kind as *I*.

Standard: GNU extension

See also: Section 8.165 [`ISHFT`], page 229,
 Section 8.166 [`ISHFTC`], page 230,
 Section 8.240 [`RSHIFT`], page 275,
 Section 8.253 [`SHIFTA`], page 282,
 Section 8.254 [`SHIFTL`], page 283,
 Section 8.255 [`SHIFTR`], page 283,

8.188 LSTAT — Get file status

Synopsis:

```
CALL LSTAT(NAME, VALUES [, STATUS])
STATUS = LSTAT(NAME, VALUES)
```

Description:

LSTAT is identical to Section 8.270 [`STAT`], page 292, except that if path is a symbolic link, then the operation is performed on the link itself, not the file that it refers to.

The elements in `VALUES` are the same as described by Section 8.270 [`STAT`], page 292.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Class: Subroutine, function

Arguments:

<i>NAME</i>	The type shall be <code>CHARACTER</code> of the default kind, a valid path within the file system.
-------------	--

VALUES The type shall be `INTEGER, DIMENSION(13)` of either kind 4 or kind 8.

STATUS (Optional) status flag of type `INTEGER` of kind 2 or larger. Returns 0 on success and a system specific error code otherwise.

Example: See Section 8.270 [STAT], page 292, for an example.

Standard: GNU extension

See also: To stat an open file:
 Section 8.122 [FSTAT], page 202,
 To stat a file:
 Section 8.270 [STAT], page 292,

8.189 LTIME — Convert time to local time info

Synopsis: `CALL LTIME(TIME, VALUES)`

Description:

Given a system time value *TIME* (as provided by the Section 8.282 [TIME], page 301, intrinsic), fills *VALUES* with values extracted from it appropriate to the local time zone using `localtime(3)`.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 8.87 [DATE_AND_TIME], page 178, intrinsic defined by the Fortran 95 standard.

Class: Subroutine

Arguments:

TIME An `INTEGER` scalar expression corresponding to a system time, with `INTENT(IN)`.

VALUES A default `INTEGER` array with 9 elements, with `INTENT(OUT)`.

Return value:

The elements of *VALUES* are assigned as follows:

1. Seconds after the minute, range 0–59 or 0–61 to allow for leap seconds
2. Minutes after the hour, range 0–59
3. Hours past midnight, range 0–23
4. Day of month, range 1–31
5. Number of months since January, range 0–11
6. Years since 1900
7. Number of days since Sunday, range 0–6
8. Days since January 1, range 0–365
9. Daylight savings indicator: positive if daylight savings is in effect, zero if not, and negative if the information is not available.

Standard: GNU extension

See also: Section 8.87 [DATE_AND_TIME], page 178,
 Section 8.86 [CTIME], page 177,
 Section 8.137 [GMTIME], page 211,
 Section 8.282 [TIME], page 301,
 Section 8.283 [TIME8], page 301,

8.190 MALLOC — Allocate dynamic memory

Synopsis: PTR = MALLOC(SIZE)

Description:

MALLOC(SIZE) allocates SIZE bytes of dynamic memory and returns the address of the allocated memory. The MALLOC intrinsic is an extension intended to be used with Cray pointers, and is provided in GNU Fortran to allow the user to compile legacy code. For new code using Fortran 95 pointers, the memory allocation intrinsic is ALLOCATE.

Class: Function

Arguments:

SIZE The type shall be INTEGER.

Return value:

The return value is of type INTEGER(K), with K such that variables of type INTEGER(K) have the same size as C pointers (sizeof(void *)).

Example: The following example demonstrates the use of MALLOC and FREE with Cray pointers.

```

program test_malloc
  implicit none
  integer i
  real*8 x(*), z
  pointer(ptr_x,x)

  ptr_x = malloc(20*8)
  do i = 1, 20
    x(i) = sqrt(1.0d0 / i)
  end do
  z = 0
  do i = 1, 20
    z = z + x(i)
  end do
  print *, z
  call free(ptr_x)
end program test_malloc

```

Standard: GNU extension

See also: Section 8.120 [FREE], page 200,

8.191 MASKL — Left justified mask

Synopsis: RESULT = MASKL(I[, KIND])

Description:

`MASKL(I[, KIND])` has its leftmost *I* bits set to 1, and the remaining bits set to 0.

Class: Elemental function

Arguments:

I Shall be of type INTEGER.
KIND Shall be a scalar constant expression of type INTEGER.

Return value:

The return value is of type INTEGER. If *KIND* is present, it specifies the kind value of the return type; otherwise, it is of the default integer kind.

Standard: Fortran 2008 and later

See also: Section 8.192 [MASKR], page 245,

8.192 MASKR — Right justified mask

Synopsis: `RESULT = MASKR(I[, KIND])`

Description:

`MASKR(I[, KIND])` has its rightmost *I* bits set to 1, and the remaining bits set to 0.

Class: Elemental function

Arguments:

I Shall be of type INTEGER.
KIND Shall be a scalar constant expression of type INTEGER.

Return value:

The return value is of type INTEGER. If *KIND* is present, it specifies the kind value of the return type; otherwise, it is of the default integer kind.

Standard: Fortran 2008 and later

See also: Section 8.191 [MASKL], page 244,

8.193 MATMUL — matrix multiplication

Synopsis: `RESULT = MATMUL(MATRIX_A, MATRIX_B)`

Description:

Performs a matrix multiplication on numeric or logical arguments.

Class: Transformational function

Arguments:

MATRIX_A An array of INTEGER, REAL, COMPLEX, UNSIGNED or LOGICAL type, with a rank of one or two.

MATRIX_B An array of `INTEGER`, `REAL`, or `COMPLEX` type if **MATRIX_A** is of `INTEGER`, `REAL`, or `COMPLEX` type. Otherwise, if **MATRIX_A** is an array of `UNSIGNED` or `LOGICAL` type, the type shall be the same as that of **MATRIX_A**. The rank shall be one or two, and the first (or only) dimension of **MATRIX_B** shall be equal to the last (or only) dimension of **MATRIX_A**. **MATRIX_A** and **MATRIX_B** shall not both be rank one arrays.

Return value:

The matrix product of **MATRIX_A** and **MATRIX_B**. The type and kind of the result follow the usual type and kind promotion rules, as for the `*` or `.AND.` operators.

Standard: Fortran 90 and later. Extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

8.194 MAX — Maximum value of an argument list

Synopsis: `RESULT = MAX(A1, A2 [, A3 [, ...]])`

Description:

Returns the argument with the largest (most positive) value.

Class: Elemental function

Arguments:

A1 The type shall be `INTEGER`, `REAL` or `UNSIGNED`.
A2, A3, ... An expression of the same type and kind as **A1**. (As a GNU extension, arguments of different kinds are permitted.)

Return value:

The return value corresponds to the maximum value among the arguments, and has the same type and kind as the first argument.

Specific names:

Name	Argument	Return type	Standard
MAX0(A1)	<code>INTEGER(4) A1</code>	<code>INTEGER(4)</code>	Fortran 77 and later
AMAX0(A1)	<code>INTEGER(4) A1</code>	<code>REAL(MAX(X))</code>	Fortran 77 and later
MAX1(A1)	<code>REAL A1</code>	<code>INT(MAX(X))</code>	Fortran 77 and later
AMAX1(A1)	<code>REAL(4) A1</code>	<code>REAL(4)</code>	Fortran 77 and later
DMAX1(A1)	<code>REAL(8) A1</code>	<code>REAL(8)</code>	Fortran 77 and later

Standard: Fortran 77 and later. Extension for `UNSIGNED` (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.196 [MAXLOC], page 247,
 Section 8.197 [MAXVAL], page 248,
 Section 8.202 [MIN], page 251,

8.195 MAXEXPONENT — Maximum exponent of a real kind

Synopsis: `RESULT = MAXEXPONENT(X)`

Description:

`MAXEXPONENT(X)` returns the maximum exponent in the model of the type of `X`.

Class: Inquiry function

Arguments:

`X` Shall be of type `REAL`.

Return value:

The return value is of type `INTEGER` and of the default integer kind.

Example:

```
program exponents
  real(kind=4) :: x
  real(kind=8) :: y

  print *, minexponent(x), maxexponent(x)
  print *, minexponent(y), maxexponent(y)
end program exponents
```

Standard: Fortran 90 and later

8.196 MAXLOC — Location of the maximum value within an array

Synopsis:

```
RESULT = MAXLOC(ARRAY, DIM [, MASK] [,KIND] [,BACK])
RESULT = MAXLOC(ARRAY [, MASK] [,KIND] [,BACK])
```

Description:

Determines the location of the element in the array with the maximum value, or, if the *DIM* argument is supplied, determines the locations of the maximum element along each row of the array in the *DIM* direction. If *MASK* is present, only the elements for which *MASK* is `.TRUE.` are considered. If more than one element in the array has the maximum value, the location returned is that of the first such element in array element order if the *BACK* is not present, or is false; if *BACK* is true, the location returned is that of the last such element. If the array has zero size, or all of the elements of *MASK* are `.FALSE.`, then the result is an array of zeroes. Similarly, if *DIM* is supplied and all of the elements of *MASK* along a given row are zero, the result value for that row is zero.

Class: Transformational function

Arguments:

ARRAY Shall be an array of type `INTEGER`, `REAL`, `UNSIGNED` or `CHARACTER`.

DIM (Optional) Shall be a scalar of type `INTEGER`, with a value between one and the rank of *ARRAY*, inclusive. It may not be an optional dummy argument.

<i>MASK</i>	Shall be of type LOGICAL , and conformable with <i>ARRAY</i> .
<i>KIND</i>	(Optional) A scalar INTEGER constant expression indicating the kind parameter of the result.
<i>BACK</i>	(Optional) A scalar of type LOGICAL .

Return value:

If *DIM* is absent, the result is a rank-one array with a length equal to the rank of *ARRAY*. If *DIM* is present, the result is an array with a rank one less than the rank of *ARRAY*, and a size corresponding to the size of *ARRAY* with the *DIM* dimension removed. If *DIM* is present and *ARRAY* has a rank of one, the result is a scalar. If the optional argument *KIND* is present, the result is an integer of kind *KIND*, otherwise it is of default kind.

Standard: Fortran 95 and later; *ARRAY* of **CHARACTER** and the *KIND* argument are available in Fortran 2003 and later. The *BACK* argument is available in Fortran 2008 and later. Extension for **UNSIGNED** (see Section 5.1.34 [Unsigned integers], page 67).

See also: Section 8.113 [FINDLOC], page 195,
 Section 8.194 [MAX], page 246,
 Section 8.197 [MAXVAL], page 248,

8.197 MAXVAL — Maximum value of an array

Synopsis:

```
RESULT = MAXVAL(ARRAY, DIM [, MASK])
RESULT = MAXVAL(ARRAY [, MASK])
```

Description:

Determines the maximum value of the elements in an array value, or, if the *DIM* argument is supplied, determines the maximum value along each row of the array in the *DIM* direction. If *MASK* is present, only the elements for which *MASK* is **.TRUE.** are considered. If the array has zero size, or all of the elements of *MASK* are **.FALSE.**, then the result is **-HUGE(ARRAY)** if *ARRAY* is of type **INTEGER** or **REAL**, 0 if it is type **UNSIGNED**. or a string of nulls if *ARRAY* is of character type.

Class: Transformational function

Arguments:

<i>ARRAY</i>	Shall be an array of type INTEGER , REAL , UNSIGNED or CHARACTER .
<i>DIM</i>	(Optional) Shall be a scalar of type INTEGER , with a value between one and the rank of <i>ARRAY</i> , inclusive. It may not be an optional dummy argument.
<i>MASK</i>	(Optional) Shall be of type LOGICAL , and conformable with <i>ARRAY</i> .

Return value:

If *DIM* is absent, or if *ARRAY* has a rank of one, the result is a scalar. If *DIM* is present, the result is an array with a rank one less than the rank of *ARRAY*, and a size corresponding to the size of *ARRAY* with the *DIM* dimension removed. In all cases, the result is of the same type and kind as *ARRAY*.

Standard: Fortran 90 and later, extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.194 [MAX], page 246,
Section 8.196 [MAXLOC], page 247,

8.198 MCLOCK — Time function

Synopsis: RESULT = MCLOCK()

Description:

Returns the number of clock ticks since the start of the process, based on the function `clock(3)` in the C standard library.

This intrinsic is not fully portable, such as to systems with 32-bit `INTEGER` types but supporting times wider than 32 bits. Therefore, the values returned by this intrinsic might be, or become, negative, or numerically less than previous values, during a single run of the compiled program.

Class: Function

Return value:

The return value is a scalar of type `INTEGER(4)`, equal to the number of clock ticks since the start of the process, or -1 if the system does not support `clock(3)`.

Standard: GNU extension

See also: Section 8.86 [CTIME], page 177,
Section 8.137 [GMTIME], page 211,
Section 8.189 [LTIME], page 243,
Section 8.198 [MCLOCK], page 249,
Section 8.282 [TIME], page 301,

8.199 MCLOCK8 — Time function (64-bit)

Synopsis: RESULT = MCLOCK8()

Description:

Returns the number of clock ticks since the start of the process, based on the function `clock(3)` in the C standard library.

Warning: this intrinsic does not increase the range of the timing values over that returned by `clock(3)`. On a system with a 32-bit `clock(3)`, `MCLOCK8` returns a 32-bit value, even though it is converted to a 64-bit `INTEGER(8)` value. That means overflows of the 32-bit value can still occur. Therefore, the values returned by this intrinsic might be or become negative or numerically less than previous values during a single run of the compiled program.

Class: Function

Return value:

The return value is a scalar of type `INTEGER(8)`, equal to the number of clock ticks since the start of the process, or `-1` if the system does not support `clock(3)`.

Standard: GNU extension

See also: Section 8.86 [CTIME], page 177,
 Section 8.137 [GMTIME], page 211,
 Section 8.189 [LTIME], page 243,
 Section 8.198 [MCLOCK], page 249,
 Section 8.283 [TIME8], page 301,

8.200 MERGE — Merge variables

Synopsis: `RESULT = MERGE(TSOURCE, FSOURCE, MASK)`

Description:

Select values from two arrays according to a logical mask. The result is equal to *TSOURCE* if *MASK* is `.TRUE.`, or equal to *FSOURCE* if it is `.FALSE.`.

Class: Elemental function

Arguments:

TSOURCE May be of any type.
FSOURCE Shall be of the same type and type parameters as
TSOURCE.
MASK Shall be of type `LOGICAL`.

Return value:

The result is of the same type and type parameters as *TSOURCE*.

Standard: Fortran 90 and later

8.201 MERGE_BITS — Merge of bits under mask

Synopsis: `RESULT = MERGE_BITS(I, J, MASK)`

Description:

`MERGE_BITS(I, J, MASK)` merges the bits of *I* and *J* as determined by the mask. The *i*-th bit of the result is equal to the *i*-th bit of *I* if the *i*-th bit of *MASK* is 1; it is equal to the *i*-th bit of *J* otherwise.

Class: Elemental function

Arguments:

I Shall be of type `INTEGER`, `UNSIGNED` or a boz-literal-constant. *I* and *J* shall not both be boz-literal-constants.
J The type shall be the same type as *I* with the same kind type parameter or a boz-literal-constant.

MASK Shall be of the same type as *I*, *J* or a boz-literal-constant.

Return value:

The result is of the same type and kind as *I*.

Standard: Fortran 2008 and later, extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

8.202 MIN — Minimum value of an argument list

Synopsis: **RESULT** = MIN(*A1*, *A2* [, *A3*, ...])

Description:

Returns the argument with the smallest (most negative) value.

Class: Elemental function

Arguments:

A1 The type shall be INTEGER, REAL or UNSIGNED.
A2, *A3*, ... An expression of the same type and kind as *A1*. (As a GNU extension, arguments of different kinds are permitted.)

Return value:

The return value corresponds to the minimum value among the arguments, and has the same type and kind as the first argument.

Specific names:

Name	Argument	Return type	Standard
MIN0(<i>A1</i>)	INTEGER(4) <i>A1</i>	INTEGER(4)	Fortran 77 and later
AMIN0(<i>A1</i>)	INTEGER(4) <i>A1</i>	REAL(4)	Fortran 77 and later
MIN1(<i>A1</i>)	REAL <i>A1</i>	INTEGER(4)	Fortran 77 and later
AMIN1(<i>A1</i>)	REAL(4) <i>A1</i>	REAL(4)	Fortran 77 and later
DMIN1(<i>A1</i>)	REAL(8) <i>A1</i>	REAL(8)	Fortran 77 and later

Standard: Fortran 77 and later, extension for UNSIGNED (see Section 5.1.34 [Unsigned integers], page 67)

See also: Section 8.194 [MAX], page 246,
 Section 8.204 [MINLOC], page 252,
 Section 8.205 [MINVAL], page 253,

8.203 MINEXPONENT — Minimum exponent of a real kind

Synopsis: **RESULT** = MINEXPONENT(*X*)

Description:

MINEXPONENT(*X*) returns the minimum exponent in the model of the type of *X*.

Class: Inquiry function

Arguments:

X Shall be of type REAL.

Return value:

The return value is of type `INTEGER` and of the default integer kind.

Example: See `MAXEXPONENT` for an example.

Standard: Fortran 90 and later

8.204 MINLOC — Location of the minimum value within an array

Synopsis:

```
RESULT = MINLOC(ARRAY, DIM [, MASK] [,KIND] [,BACK])
RESULT = MINLOC(ARRAY [, MASK] [,KIND] [,BACK])
```

Description:

Determines the location of the element in the array with the minimum value, or, if the *DIM* argument is supplied, determines the locations of the minimum element along each row of the array in the *DIM* direction. If *MASK* is present, only the elements for which *MASK* is `.TRUE.` are considered. If more than one element in the array has the minimum value, the location returned is that of the first such element in array element order if the *BACK* is not present, or is false; if *BACK* is true, the location returned is that of the last such element. If the array has zero size, or all of the elements of *MASK* are `.FALSE.`, then the result is an array of zeroes. Similarly, if *DIM* is supplied and all of the elements of *MASK* along a given row are zero, the result value for that row is zero.

Class: Transformational function

Arguments:

<i>ARRAY</i>	Shall be an array of type <code>INTEGER</code> , <code>REAL</code> , <code>CHARACTER</code> or <code>UNSIGNED</code> .
<i>DIM</i>	(Optional) Shall be a scalar of type <code>INTEGER</code> , with a value between one and the rank of <i>ARRAY</i> , inclusive. It may not be an optional dummy argument.
<i>MASK</i>	Shall be of type <code>LOGICAL</code> , and conformable with <i>ARRAY</i> .
<i>KIND</i>	(Optional) A scalar <code>INTEGER</code> constant expression indicating the kind parameter of the result.
<i>BACK</i>	(Optional) A scalar of type <code>LOGICAL</code> .

Return value:

If *DIM* is absent, the result is a rank-one array with a length equal to the rank of *ARRAY*. If *DIM* is present, the result is an array with a rank one less than the rank of *ARRAY*, and a size corresponding to the size of *ARRAY* with the *DIM* dimension removed. If *DIM* is present and *ARRAY* has a rank of one, the result is a scalar. If the optional argument *KIND* is present, the result is an integer of kind *KIND*, otherwise it is of default kind.

Standard: Fortran 90 and later; *ARRAY* of `CHARACTER` and the *KIND* argument are available in Fortran 2003 and later. The *BACK* argument is available in Fortran


```
omp_proc_bind_false  
omp_proc_bind_true  
omp_proc_bind_primary  
omp_proc_bind_master  
omp_proc_bind_close  
omp_proc_bind_spread
```

The following scalar integer named constants are of the kind `omp_lock_hint_kind`:

```
omp_lock_hint_none  
omp_lock_hint_uncontended  
omp_lock_hint_contended  
omp_lock_hint_nonspeculative  
omp_lock_hint_speculative  
omp_sync_hint_none  
omp_sync_hint_uncontended  
omp_sync_hint_contended  
omp_sync_hint_nonspeculative  
omp_sync_hint_speculative
```

And the following two scalar integer named constants are of the kind `omp_pause_resource_kind`:

```
omp_pause_soft  
omp_pause_hard
```

The following scalar integer named constants are of the kind `omp_alloctrail_key_kind`:

```
omp_atk_sync_hint  
omp_atk_alignment  
omp_atk_access  
omp_atk_pool_size  
omp_atk_fallback  
omp_atk_fb_data  
omp_atk_pinned  
omp_atk_partition
```

The following scalar integer named constants are of the kind `omp_alloctrail_val_kind`:

```
omp_alloctrail_key_kind:
```

```

omp_atv_default
omp_atv_false
omp_atv_true
omp_atv_contended
omp_atv_uncontended
omp_atv_serialized
omp_atv_sequential
omp_atv_private
omp_atv_all
omp_atv_thread
omp_atv_ptesteam
omp_atv_cgroup
omp_atv_default_mem_fb
omp_atv_null_fb
omp_atv_abort_fb
omp_atv_allocator_fb
omp_atv_environment
omp_atv_nearest
omp_atv_blocked

```

The following scalar integer named constants are of the kind `omp_allocator_handle_kind`:

```

omp_null_allocator
omp_default_mem_alloc
omp_large_cap_mem_alloc
omp_const_mem_alloc
omp_high_bw_mem_alloc
omp_low_lat_mem_alloc
omp_cgroup_mem_alloc
omp_ptesteam_mem_alloc
omp_thread_mem_alloc

```

The following scalar integer named constants are of the kind `omp_memspace_handle_kind`:

```

omp_default_mem_space
omp_large_cap_mem_space
omp_const_mem_space
omp_high_bw_mem_space
omp_low_lat_mem_space

```

9.5 OpenACC Module OPENACC

Standard: OpenACC Application Programming Interface v2.6

The OpenACC Fortran runtime library routines are provided both in a form of a Fortran 90 module, named `OPENACC`, and in form of a Fortran `include` file named `openacc_lib.h`. The procedures provided by `OPENACC` can be found in the Section “Introduction” in *GNU Offloading and Multi Processing Runtime Library* manual, the named constants defined in the modules are listed below.

For details refer to the actual OpenACC Application Programming Interface v2.6 (<https://www.openacc.org/>).

OPENACC provides the scalar default-integer named constant `openacc_version` with a value of the form `yyyymm`, where `yyyy` is the year and `mm` the month of the OpenACC version; for OpenACC v2.6 the value is 201711.

Contributing

Free software is only possible if people contribute to efforts to create it. We're always in need of more people helping out with ideas and comments, writing documentation and contributing code.

If you want to contribute to GNU Fortran, have a look at the long lists of projects you can take on. Some of these projects are small, some of them are large; some are completely orthogonal to the rest of what is happening on GNU Fortran, but others are “mainstream” projects in need of enthusiastic hackers. All of these projects are important! We will eventually get around to the things here, but they are also things doable by someone who is willing and able.

Contributors to GNU Fortran

Most of the parser was hand-crafted by *Andy Vaught*, who is also the initiator of the whole project. Thanks Andy! Most of the interface with GCC was written by *Paul Brook*.

The following individuals have contributed code and/or ideas and significant help to the GNU Fortran project (in alphabetical order):

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type alias print 64
 type cast 303

U

UBOUND 305
 UCOBOUND 306
 UINT 306
 UMASK 306
 UMASKL 307
 UMASKR 307
 underflow 21
 underscore 27, 28
 unformatted sequential 46
 UNION 61
 UNLINK 308
 UNPACK 308
 UNROLL directive 80
 Unsigned integers 67
 unsigned kind 281
 unused dummy argument 21
 unused parameter 21
 user id 211

V

variable attributes 64
 variable interoperability with C 74
 Varying length strings 3
 vector product 181
 VECTOR directive 80
 VERIFY 309
 version of the compiler 169
 VOLATILE 71

W

warning, C binding type 19
 warnings, aliasing 19
 warnings, alignment of COMMON blocks 21
 warnings, all 18
 warnings, ampersand 19
 warnings, argument mismatch 19
 warnings, array temporaries 19
 warnings, character truncation 19
 warnings, conversion 19

warnings, division of integers 20
 warnings, extra 20
 warnings, function elimination 21
 warnings, implicit interface 20
 warnings, implicit procedure 20
 warnings, integer division 20
 warnings, intrinsic 21
 warnings, intrinsics of other standards 20
 warnings, line truncation 19
 warnings, loop interchange 20
 warnings, nonstandard intrinsics 20
 warnings, overwrite recursive 20
 warnings, q exponent-letter 20
 warnings, suppressing 18
 warnings, suspicious code 20
 warnings, tabs 21
 warnings, to errors 22
 warnings, undefined do loop 21
 warnings, underflow 21
 warnings, unused dummy argument 21
 warnings, unused parameter 21
 warnings, use statements 21
 write character, stream mode 198, 199

X

XOR 310
 XOR reduction 263

Z

ZABS 120
 ZCOS 171
 ZCOSD 171
 zero bits 234, 302
 ZEXP 191
 ZLOG 239
 ZSIN 285
 ZSIND 286
 ZSQRT 291