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Ada COMPILER
VALIDATION SUMMARY REPORT:
Certificate Number: #881216N1.10015
Alsys Limited
AlsyCOMP_006 Version 4.1
IBM 9370 Model 90 / IBM 370 3084Q

Completion of On-Site Testing:
16th December 1988

Prepared By:
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United States Department of Defense
Washington DC 20301-3081

Ada Compiler Validation Summary Report:

Compiler Name : AlsyCOMP_006 Version 4.1

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Host : IBM 9370 Model 90 under
VM/IS CMS release 5.1

Target : IBM 370 3084Q under
MVS 3.2

Testing Completed 16th December 1988 Using ACVC 1.10

This report has been reviewed and is approved.

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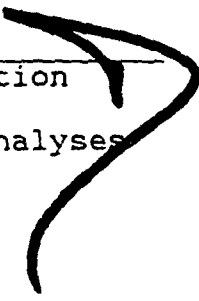
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CHAPTER 1INTRODUCTION

This Validation Summary Report (VSR) describes the extent to which a specific Ada compiler conforms to the Ada Standard, ANSI/MIL-STD-1815A. This report explains all technical terms used within it and thoroughly reports the results of testing this compiler using the Ada Compiler Validation Capability (ACVC). An Ada compiler must be implemented according to the Ada Standard, and any implementation-dependent features must conform to the requirements of the Ada Standard. The Ada Standard must be implemented in its entirety, and nothing can be implemented that is not in the Standard.

Even though all validated Ada compilers conform to the Ada Standard, it must be understood that some differences do exist between implementations. The Ada Standard permits some implementation dependencies--for example, the maximum length of identifiers or the maximum values of integer types. Other differences between compilers result from the characteristics of particular operating systems, hardware, or implementation strategies. All the dependencies observed during the process of testing this compiler are given in this report.

The information in this report is derived from the test results produced during validation testing. The validation process includes submitting a suite of standardized tests, the ACVC, as inputs to an Ada compiler and evaluating the results. The purpose of validating is to ensure conformity of the compiler to the Ada Standard by testing that the compiler properly implements legal language constructs and that it identifies and rejects illegal language constructs. The testing also identifies behaviour that is implementation-dependent but permitted by the Ada Standard. Six classes of tests are used. These tests are designed to perform checks at compile time, at link time, and during execution.

1.1 PURPOSE OF THIS VALIDATION SUMMARY REPORT

This VSR documents the results of the validation testing performed on an Ada compiler. Testing was carried out for the following purposes:

- o To attempt to identify any language constructs supported by the compiler that do not conform to the Ada Standard
- o To attempt to identify any language constructs not supported by the compiler but required by the Ada Standard
- o To determine that the implementation-dependent behaviour is allowed by the Ada Standard

Testing of this compiler was conducted by The National Computing Centre Limited according to procedures established by the Ada Joint Program Office and administered by the Ada Validation Organization (AVO). On-site testing was completed 16th December 1988 at Alslys Limited, Partridge House, Newtown Road, Henley-on-Thames, Oxfordshire, RG9 1EN, United Kingdom.

1.2 USE OF THIS VALIDATION SUMMARY REPORT

Consistent with the national laws of the originating country, the AVO may make full and free public disclosure of this report. In the United States, this is provided in accordance with the "Freedom of Information Act" (5 U.S.C.#552). The results of this validation apply only to the computers, operating systems, and compiler versions identified in this report.

The organizations represented on the signature page of this report do not represent or warrant that all statements set forth in this report are accurate and complete, or that the subject compiler has no nonconformities to the Ada Standard other than those presented. Copies of this report are available to the public from:

Ada Information Clearinghouse
Ada Joint Program Office
OUSDRE
The Pentagon, Rm 3D-139 (Fern Street)
Washington DC 20301-3081

INTRODUCTION

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Questions regarding this report or the validation test results should be directed to the AVF listed above or to:

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1.3 REFERENCES

1. Reference Manual for the Ada Programming Language, ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.
2. Ada Compiler Validation Procedures and Guidelines, Ada Joint Program Office, 1 January 1987.
3. Ada Compiler Validation Capability Implementers' Guide, SofTech Inc., December 1986.
4. Ada Compiler Validation Capability User's Guide, December 1986.

1.4 DEFINITION OF TERMS

ACVC	The Ada Compiler Validation Capability. The set of Ada programs that tests the conformity of an Ada compiler to the Ada programming language.
Ada Commentary	An Ada Commentary contains all information relevant to the point addressed by a comment on the Ada Standard. These comments are given a unique identification number having the form AI-ddddd.
Ada Standard	ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.

INTRODUCTION

Applicant	The agency requesting validation.
AVF	The Ada Validation Facility. The AVF is responsible for conducting compiler validations according to procedures contained in the <u>Ada Compiler Validation Procedures and Guidelines</u> .
AVO	The Ada Validation Organization. The AVO has oversight authority over all AVF practices for the purpose of maintaining a uniform process for validation of Ada compilers. The AVO provides administrative and technical support for Ada validations to ensure consistent practices.
Compiler	A processor for the Ada language. In the context of this report, a compiler is any language processor, including cross-compilers, translators, and interpreters.
Failed test	An ACVC test for which the compiler generates a result that demonstrates nonconformity to the Ada Standard.
Host	The computer on which the compiler resides.
Inapplicable test	An ACVC test that uses features of the language that a compiler is not required to support or may legitimately support in a way other than the one expected by the test.
Passed test	An ACVC test for which a compiler generates the expected result.
Target	The computer for which a compiler generates code.
Test	A program that checks a compiler's conformity regarding a particular feature or a combination of features to the Ada Standard. In the context of this report, the term is used to designate a single test, which may comprise one or more files.

Withdrawn test An ACVC test found to be incorrect and not used to check conformity to the Ada Standard. A test may be incorrect because it has an invalid test objective, fails to meet its test objective, or contains illegal or erroneous use of the language.

1.5 ACVC TEST CLASSES

Conformity to the Ada Standard is measured using the ACVC. The ACVC contains both legal and illegal Ada programs structured into six test classes: A, B, C, D, E, and L. The first letter of a test name identifies the class to which it belongs. Class A, C, D, and E tests are executable, and special program units are used to report their results during execution. Class B tests are expected to produce compilation errors. Class L tests are expected to produce errors because of the way a program library is used.

Class A tests check that legal Ada programs can be successfully compiled and executed. There are no explicit program components in a Class A test to check semantics. For example, a Class A test checks that reserved words of another language (other than those already reserved in the Ada language) are not treated as reserved words by an Ada compiler. A Class A test is passed if no errors are detected at compile time and the program executes to produce a PASSED message.

Class B tests check that a compiler detects illegal language usage. Class B tests are not executable. Each test in this class is compiled and the resulting compilation listing is examined to verify that every syntax or semantic error in the test is detected. A Class B test is passed if every illegal construct that it contains is detected by the compiler.

Class C tests check that legal Ada programs can be correctly compiled and executed. Each Class C test is self-checking and produces a PASSED, FAILED, or NOT APPLICABLE message indicating the result when it is executed.

Class D tests check the compilation and execution capacities of a compiler. Since there are no capacity requirements placed on a compiler by the Ada Standard for some parameters--for example, the number of identifiers permitted in a compilation or the number of units in a library--a compiler may refuse to compile a Class D test and still be a conforming compiler. Therefore, if a Class D test fails to compile because the capacity of the

compiler is exceeded, the test is classified as inapplicable. If a Class D test compiles successfully, it is self-checking and produces a PASSED or FAILED message during execution.

Each Class E test is self-checking and produces a NOT APPLICABLE, PASSED, or FAILED message when it is compiled and executed. However, the Ada Standard permits an implementation to reject programs containing some features addressed by Class E tests during compilation. Therefore, a Class E test is passed by a compiler if it is compiled successfully and executes to produce a PASSED message, or if it is rejected by the compiler for an allowable reason.

Class L tests check that incomplete or illegal Ada programs involving multiple, separately compiled units are detected and not allowed to execute. Class L tests are compiled separately and execution is attempted. A Class L test passes if it is rejected at link time--that is, an attempt to execute the main program must generate an error message before any declarations in the main program or any units referenced by the main program are elaborated. In some cases an implementation may legitimately detect errors during compilation of the test.

Two library units, the package REPORT and the procedure CHECK_FILE, support the self-checking features of the executable tests. The package REPORT provides the mechanism by which executable tests report PASSED, FAILED, or NOT APPLICABLE results. It also provides a set of identity functions used to defeat some compiler optimizations allowed by the Ada Standard that would circumvent a test objective. The procedure CHECK_FILE is used to check the contents of text files written by some of the Class C tests for chapter 14 of the Ada Standard. The operation of REPORT and CHECK_FILE is checked by a set of executable tests. These tests produce messages that are examined to verify that the units are operating correctly. If these units are not operating correctly, then the validation is not attempted.

The text of the tests in the ACVC follow conventions that are intended to ensure that the tests are reasonably portable without modification. For example, the tests make use of only the basic set of 55 characters, contain lines with a maximum length of 72 characters, use small numeric values, and place features that may not be supported by all implementations in separate tests. However, some tests contain values that require the test to be customized according to implementation-specific values--for example, an illegal file name. A list of the values used for this validation is provided in Appendix C.

A compiler must correctly process each of the tests in the suite and demonstrate conformity to the Ada Standard by either meeting the pass criteria given for the test or by showing that the test is inapplicable to the implementation. The applicability of a test to an implementation is considered each time the implementation is validated. A test that is inapplicable for one validation is not necessarily inapplicable for a subsequent validation. Any test that was determined to contain an illegal language construct or an erroneous language construct is withdrawn from the ACVC and, therefore, is not used in testing a compiler. The tests withdrawn at the time of this validation are given in Appendix D.

CONFIGURATION INFORMATION

CHAPTER 2

CONFIGURATION INFORMATION

2.1 CONFIGURATION TESTED

The candidate compilation system for this validation was tested under the following configuration:

Compiler	: AlsyCOMP_006 Version 4.1
ACVC Version	: 1.10
Certificate Number	: #881216N1.10015
Host Computer	:
Machine	: IBM 9370 Model 90
Operating System	: VM/IS CMS release 5.1
Memory Size	: 8 Mbytes
Target Computer	:
Machine	: IBM 370 3084Q
Operating System	: MVS 3.2
Memory Size	: 1 Mbyte
Communications Network	: Magnetic media

2.2 IMPLEMENTATION CHARACTERISTICS

One of the purposes of validating compilers is to determine the behaviour of a compiler in those areas of the Ada Standard that permit implementations to differ. Class D and E tests specifically check for such implementation differences. However, tests in other classes also characterize an implementation. The tests demonstrate the following characteristics:

- o Capacities.

The compiler correctly processes a compilation containing 723 variables in the same declarative part. (See test D29002K.)

The compiler correctly processes tests containing loop statements nested to 65 levels. (See tests D55A03A..H (8 tests).)

The compiler correctly processes tests containing block statements nested to 65 levels. (See test D56001B.)

The compiler correctly processes tests containing recursive procedures separately compiled as subunits nested to 17 levels. (See tests D64005E..G (3 tests).)

- o Predefined types.

This implementation supports the additional predefined types `SHORT_INTEGER`, `SHORT_SHORT_INTEGER`, `SHORT_FLOAT` and `LONG_FLOAT` in the package `STANDARD`. (See tests B86001T..Z (7 tests).)

- o Expression evaluation.

The order in which expressions are evaluated and the time at which constraints are checked are not defined by the language. While the ACVC tests do not specifically attempt to determine the order of evaluation of expressions, test results indicate the following:

No default initialization expressions for record components are evaluated before any value is checked to belong to a component's subtype. (See test C32117A.)

CONFIGURATION INFORMATION

Assignments for subtypes are performed with the same precision as the base type. (See test C35712B.)

This implementation uses no extra bits for extra precision and uses all extra bits for extra range. (See test C35903A.)

NUMERIC_ERROR is raised when an integer literal operand in a comparison or membership test is outside the range of the base type. (See test C45232A.)

NUMERIC_ERROR is raised when a literal operand in a fixed-point comparison or membership test is outside the range of the base type. (See test C45252A.)

Underflow is not gradual. (See tests C45524A..Z.)

- o Rounding.

The method by which values are rounded in type conversions is not defined by the language. While the ACVC tests do not specifically attempt to determine the method of rounding, test results indicate the following:

The method used for rounding to integer is round away from zero. (See tests C46012A..Z.)

The method used for rounding to longest integer is round away from zero. (See tests C46012A..Z.)

The method used for rounding to integer in static universal real expressions is round away from zero. (See test C4A014A.)

- o Array types.

An implementation is allowed to raise NUMERIC_ERROR or CONSTRAINT_ERROR for an array having a 'LENGTH' that exceeds STANDARD.INTEGER'LAST and/or SYSTEM.MAX_INT. For this implementation:

Declaration of an array type or subtype declaration with more than SYSTEM.MAX_INT components raises NUMERIC_ERROR. (See test C36003A.)

CONFIGURATION INFORMATION

NUMERIC_ERROR is raised when an array type with INTEGER'LAST + 2 components is declared. (See test C36202A.)

NUMERIC_ERROR is raised when an array type with SYSTEM.MAX_INT + 2 components is declared. (See test C36202B.)

A packed BOOLEAN array having a 'LENGTH exceeding INTEGER'LAST raises NUMERIC_ERROR when the array type is declared. (See test C52103X.)

A packed two-dimensional BOOLEAN array with more than INTEGER'LAST components raises NUMERIC_ERROR when subtypes are declared. (See test C52104Y.)

A null array with one dimension of length greater than INTEGER'LAST may raise NUMERIC_ERROR or CONSTRAINT_ERROR either when declared or assigned. Alternatively, an implementation may accept the declaration. However, lengths must match in array slice assignments. This implementation raises NUMERIC_ERROR when the array type is declared. (See test E52103Y.)

In assigning one-dimensional array types, the expression appears to be evaluated in its entirety before CONSTRAINT_ERROR is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

In assigning two-dimensional array types, the expression does not appear to be evaluated in its entirety before CONSTRAINT_ERROR is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

- o Discriminated types.

In assigning record types with discriminants, the expression appears to be evaluated in its entirety before CONSTRAINT_ERROR is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

- o Aggregates.

In the evaluation of a multi-dimensional aggregate, all choices appear to be evaluated before checking against the index type. (See tests C43207A and C43207B.)

In the evaluation of an aggregate containing subaggregates, not all choices are evaluated before being checked for identical bounds. (See test E43212B.)

CONSTRAINT_ERROR is raised after all choices are evaluated when a bound in a non-null range of a non-null aggregate does not belong to an index subtype. (See test E43211B.)

- o Pragas.

The pragma INLINE is supported for function or procedure calls within a body. The pragma INLINE for function calls within a declaration is not supported. (See tests LA3004A..B, EA3004C..D, and CA3004E..F.)

- o Generics.

Generic specifications and bodies can be compiled in separate compilations. (See tests CA1012A, CA2009C, CA2009F, BC3204C, and BC3205D.)

Generic unit bodies and their subunits can be compiled in separate compilations. (See test CA3011A.)

Generic subprogram declarations and bodies can be compiled in separate compilations. (See tests CA1012A and CA2009F.)

Generic library subprogram specifications and bodies can be compiled in separate compilations. (See test CA1012A.)

Generic non-library subprogram bodies can be compiled in separate compilations from their stubs. (See test CA2009F.)

Generic package declarations and bodies can be compiled in separate compilations. (See tests CA2009C, BC3204C, and BC3205D.)

CONFIGURATION INFORMATION

Generic library package specifications and bodies can be compiled in separate compilations. (See tests BC3204C and BC3205D.)

Generic non-library package bodies as subunits can be compiled in separate compilations. (See test CA2009C.)

Generic unit bodies and their subunits can be compiled in separate compilations. (See test CA3011A.)

- o Input and output.

The package `SEQUENTIAL_IO` can be instantiated with unconstrained array types and record types with discriminants without defaults. (See tests AE2101C, EE2201D, and EE2201E.)

The package `DIRECT_IO` cannot be instantiated with unconstrained array types or record types with discriminants without defaults. (See tests AE2101H, EE2401D, and EE2401G.)

Modes `IN_FILE` and `OUT_FILE` are supported for `SEQUENTIAL_IO`. (See tests CE2102D..E, CE2102N, and CE2102P.)

Modes `IN_FILE`, `OUT_FILE`, and `INOUT_FILE` are supported for `DIRECT_IO`. (See tests CE2102F, CE2102I..J, CE2102R, CE2102T, and CE2102V.)

Modes `IN_FILE` and `OUT_FILE` are supported for text files. (See tests CE3102E and CE3102I..K.)

`RESET` and `DELETE` operations are supported for `SEQUENTIAL_IO`. (See tests CE2102G and CE2102X.)

`RESET` and `DELETE` operations are supported for `DIRECT_IO`. (See tests CE2102K and CE2102Y.)

`RESET` and `DELETE` operations are supported for text files. (See tests CE3102F..G, CE3104C, CE3110A, and CE3114A.)

Overwriting to a sequential file does not truncate the file. (See test CE2208B.)

CONFIGURATION INFORMATION

Temporary sequential files are given names and deleted when closed. (See test CE2108A.)

Temporary direct files are given names and deleted when closed. (See test CE2108C.)

Temporary text files are given names and deleted when closed. (See test CE3112A.)

More than one internal file can be associated with each external file for sequential files when reading only. (See tests CE2107A..E, CE2102L, CE2110B, and CE2111D.)

More than one internal file can be associated with each external file for direct files when reading only. (See tests CE2107F..I, CE2110D and CE2111H.)

More than one internal file can be associated with each external file for text files when reading only. (See tests CE3111A..E, CE3114B, and CE3115A.)

CHAPTER 3TEST INFORMATION3.1 TEST RESULTS

Version 1.10 of the ACVC comprises 3717 tests. When this compiler was tested, 36 tests had been withdrawn because of test errors. The AVF determined that 342 tests were inapplicable to this implementation. All inapplicable tests were processed during validation testing except for 159 executable tests that use floating-point precision exceeding that supported by the implementation. Modifications to the code, processing, or grading for 45 tests were required to successfully demonstrate the test objective. (See section 3.6.)

The AVF concludes that the testing results demonstrate acceptable conformity to the Ada Standard.

3.2 SUMMARY OF TEST RESULTS BY CLASS

RESULT	TEST CLASS						TOTAL
	A	B	C	D	E	L	
Passed	128	1133	1983	17	32	46	3339
Inapplicable	1	5	334	0	2	0	342
Withdrawn	1	2	33	0	0	0	36
TOTAL	130	1140	2350	17	34	46	3717

3.3 SUMMARY OF TEST RESULTS BY CHAPTER

RESULT	CHAPTER													TOTAL
	2	3	4	5	6	7	8	9	10	11	12	13	14	
Passed	202	593	569	245	172	99	162	333	137	36	252	258	281	3339
Inappl	11	56	111	3	0	0	4	0	0	0	0	117	40	342
Wdrn	0	1	0	0	0	0	0	1	0	0	1	29	4	36
TOTAL	213	650	680	248	172	99	166	334	137	36	253	404	325	3717

3.4 WITHDRAWN TESTS

The following 36 tests were withdrawn from ACVC Version 1.10 at the time of this validation:

A39005G	B97102E
BC3009B	CD2A62D
CD2A63A..D (4 tests)	CD2A66A..D (4 tests)
CD2A73A..D (4 tests)	CD2A76A..D (4 tests)
CD2A81G	CD2A83G
CD2A84M..N (2 tests)	CD50110
CD2B15C	CD7205C
CD5007B	CD7105A
CD7203B	CD7204B
CD7205D	CE2107I
CE3111C	CE3301A
CE3411B	

See Appendix D for the reason that each of these tests was withdrawn.

3.5 INAPPLICABLE TESTS

Some tests do not apply to all compilers because they make use of features that a compiler is not required by the Ada Standard to support. Others may depend on the result of another test that is either inapplicable or withdrawn. The applicability of a test to an implementation is considered each time a validation is attempted. A test that is inapplicable for one validation attempt is not necessarily inapplicable for a subsequent attempt. For this validation attempt, 342 tests were inapplicable for the reasons indicated:

- o The following 159 tests are not applicable because they have floating-point type declarations requiring more digits than `SYSTEM.MAX_DIGITS`:

C241130..Y (11 tests)	C357050..Y (11 tests)
C357060..Y (11 tests)	C357070..Y (11 tests)
C357080..Y (11 tests)	C358020..Z (12 tests)
C452410..Y (11 tests)	C453210..Y (11 tests)
C454210..Y (11 tests)	C455210..Z (12 tests)
C455240..Z (12 tests)	C456210..Z (12 tests)
C456410..Y (11 tests)	C460120..Z (12 tests)

TEST INFORMATION

- o The following 16 tests are not applicable because this implementation does not support a predefined type `LONG_INTEGER`:

C45231C	C45304C	C45502C	C45503C	C45504C
C45504F	C45611C	C45613C	C45614C	C45631C
C45632C	B52004D	C55B07A	B55B09C	B86001W
CD7101F				

- o C45531M..P (4 tests), C45532M..P (4 tests) are not applicable because the size of a matissa of a fixed point type is limited to 31 bits.
- o B86001Y is not applicable because this implementation supports no predefined fixed-point type other than `DURATION`.
- o B86001Z is not applicable because this implementation supports no predefined floating-point type with a name other than `FLOAT`, `LONG_FLOAT`, or `SHORT_FLOAT`.
- o C86001F is not applicable because, for this implementation, the package `TEXT_IO` is dependent upon package `SYSTEM`. This test redefines package `SYSTEM`, making package `TEXT_IO`, and hence package `REPORT`, obsolete.
- o CD1009C, CD2A41A..E (5 tests) and CD2A42A..J (10 tests) are not applicable because `SIZE` clause on `FLOAT` is not supported.
- o The following 26 tests are all inapplicable for this implementation because length clauses on a type derived from a private type are not supported outside the defining package.

CD1C04A	CD2A21C	CD2A21D	CD2A22C	CD2A22D
CD2A22G	CD2A22H	CD2A31C	CD2A31D	CD2A32C
CD2A32D	CD2A32G	CD2A32H	CD2A51C	CD2A51D
CD2A52C	CD2A52D	CD2A52G	CD2A52H	CD2A53D
CD2A54D	CD2A54H	CD2A72A	CD2A72B	CD2A75A
CD2A75B				

- o CD1C04B, CD1C04E and CD4051A..D (4 tests) are not applicable because representation clauses on derived records or derived tasks are not supported.

TEST INFORMATION

- o The following 25 tests are inapplicable because LENGTH clause on an array or record would require change of representation of the components or elements.

CD2A61A..D (4 tests)	CD2A61F
CD2A61H..L (5 tests)	CD2A62A..C (3 tests)
CD2A71A..D (4 tests)	CD2A72C..D (2 tests)
CD2A74A..D (4 tests)	CD2A75C..D (2 tests)

- o CD2A84B..I (8 tests) and CD2A84K..L (2 tests) are not applicable because the minimum size for a 'SIZE clause applied to the access type is 32 bits.
- o The following 30 tests are not applicable because ADDRESS clauses for constants are not supported.

CD5011B	CD5011D	CD5011F	CD5011H	CD5011L
CD5011N	CD5011R	CD5011S	CD5012C	CD5012D
CD5012G	CD5012H	CD5012L	CD5013B	CD5013D
CD5013F	CD5013H	CD5013L	CD5013N	CD5013R
CD5014B	CD5014D	CD5014F	CD5014H	CD5014J
CD5014L	CD5014N	CD5014R	CD5014U	CD5014W

- o CD5012J, CD5013S and CD5014S are not applicable because ADDRESS clauses for tasks are not supported.
- o AE2101H, EE2401D and EE2401G use instantiations of package DIRECT_IO with unconstrained array types and record types with discriminants without defaults. These instantiations are rejected by this compiler.
- o CE2102D is inapplicable because this implementation supports CREATE with IN_FILE mode for SEQUENTIAL_IO.
- o CE2102E is inapplicable because this implementation supports CREATE with OUT_FILE mode for SEQUENTIAL_IO.
- o CE2102F is inapplicable because this implementation supports CREATE with INOUT_FILE mode for DIRECT_IO.
- o CE2102I is inapplicable because this implementation supports CREATE with IN_FILE mode for DIRECT_IO.
- o CE2102J is inapplicable because this implementation supports CREATE with OUT_FILE mode for DIRECT_IO.
- o CE2102N is inapplicable because this implementation supports OPEN with IN_FILE mode for SEQUENTIAL_IO.

TEST INFORMATION

- CE2102O is inapplicable because this implementation supports RESET with IN_FILE mode for SEQUENTIAL_IO.
- CE2102P is inapplicable because this implementation supports open with OUT_FILE mode for SEQUENTIAL_IO.
- CE2102Q is inapplicable because this implementation supports RESET with OUT_FILE mode for SEQUENTIAL_IO.
- CE2102R is inapplicable because this implementation supports open with INOUT_FILE mode for DIRECT_IO.
- CE2102S is inapplicable because this implementation supports RESET with INOUT_FILE mode for DIRECT_IO.
- CE2102T is inapplicable because this implementation supports open with IN_FILE mode for DIRECT_IO.
- CE2102U is inapplicable because this implementation supports RESET with IN_FILE mode for DIRECT_IO.
- CE2102V is inapplicable because this implementation supports open with OUT_FILE mode for DIRECT_IO.
- CE2102W is inapplicable because this implementation supports RESET with OUT_FILE mode for DIRECT_IO.
- CE2107B..E (4 tests), CE2107L, CE2110B and CE2111D are not applicable because multiple internal files cannot be associated with the same external file when one or more files is writing for sequential files. The proper exception is raised when multiple access is attempted.
- CE2107G..H (2 tests), CE2110D and CE2111H are not applicable because multiple internal files cannot be associated with the same external file when one or more files is writing for direct files. The proper exception is raised when multiple access is attempted.
- CE3102E is inapplicable because this implementation supports CREATE with IN_FILE mode for text files.
- CE3102F is inapplicable because this implementation supports RESET for text files.
- CE3102G is inapplicable because this implementation supports deletion of an external file for text files.

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- o CE3102I is inapplicable because this implementation supports CREATE with OUT_FILE mode for text files.
- o CE3102J is inapplicable because this implementation supports OPEN with IN_FILE mode for text files.
- o CE3102K is inapplicable because this implementation supports OPEN with OUT_FILE mode for text files.
- o CE3111B, CE3111D..E (2 tests), CE3114B, and CE3115A are not applicable because multiple internal files cannot be associated with the same external file when one or more files is writing for text files. The proper exception is raised when multiple access is attempted.

3.6 TEST, PROCESSING, AND EVALUATION MODIFICATIONS

It is expected that some tests will require modifications of code, processing, or evaluation in order to compensate for legitimate implementation behavior. Modifications are made by the AVF in cases where legitimate implementation behavior prevents the successful completion of an (otherwise) applicable test. Examples of such modifications include: adding a length clause to alter the default size of a collection; splitting a Class B test into subtests so that all errors are detected; and confirming that messages produced by an executable test demonstrate conforming behavior that wasn't anticipated by the test (such as raising one exception instead of another).

Modifications were required for 45 tests.

The following tests were split because syntax errors at one point resulted in the compiler not detecting other errors in the test:

B23004A	B24007A	B24009A	B26005A	B28003A
B28003C	B32202A	B32202B	B32202C	B33001A
B37004A	B45102A	B61012A	B62001B	B62001C
B62001D	B74304A	B74401F	B74401R	B91004A
B95069A	B95069B	B97103A	BA1101B	BC2001D
BC3009C	BD5005B			

The following tests were split in order to show that features not supported caused errors to be raised.

CD2A62A..B (2 tests)	CD2A72A..B (2 tests)
CD2A75A..B (2 tests)	CD2A84B..I (8 tests)

EA3004D, when processed, produces only two of the expected three errors: the implementation fails to detect an error on line 27 of file EA3004D6M. This is because the pragma INLINE has no effect when its object is within a package specification. The task was reordered to compile files D2 and D3 after file D5 (the re-compilation of the "with"ed package that makes the various earlier units obsolete), the re-ordered test executed and produced the expected NOT_APPLICABLE result (as though INLINE were not supported at all). The re-ordering of EA3004D test files was: 0-1-4-5-2-3-6. The AVO ruled that the test should be counted as passed.

3.7 ADDITIONAL TESTING INFORMATION

3.7.1 Prevalidation

Prior to validation, a set of test results for ACVC Version 1.10 produced by the AlsyCOMP_006 Version 4.1 was submitted to the AVF by the applicant for review. Analysis of these results demonstrated that the compiler successfully passed all applicable tests, and the compiler exhibited the expected behavior on all inapplicable tests.

3.7.2 Test Method

Testing of the AlsyCOMP_006 using ACVC Version 1.10 was conducted on-site by a validation team from the AVF. The configuration in which the testing was performed is described by the following designations of hardware and software components:

Host computer	:	IBM 9370
Host operating system	:	VM/IS CMS release 5.1
Target computer	:	IBM 9370
Target operating system	:	VM/IS CMS release 5.1
Compiler	:	AlsyCOMP_006 Version 4.1
Pre-linker	:	AlsyCOMP_006 Version 4.1
Assembler	:	AlsyCOMP_006 Version 4.1
Linker	:	VM/IS CMS release 5.1
Runtime System	:	AlsyCOMP_006 Version 4.1

A magnetic tape containing all tests except for withdrawn tests and tests requiring unsupported floating-point precisions was taken on-site by the validation team for processing. Tests that make use of implementation-specific values were customized before being written to the magnetic tape. Tests requiring

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modifications during the prevalidation testing were not included in their modified form on the magnetic tape.

The contents of the magnetic tape were not loaded directly onto the host computer.

The files were loaded onto a Sun 3/160 computer (using UNIX BSD 4.2) which then did all the required splits to the relevant tests using the UNIX ED editor. These tests were then loaded onto magnetic tape and transferred to the host machine.

The host machine then proceeded to compile, bind and the object images were transferred to the target machine where they were run. The output was transferred back to the Sun machine for printing. The procedure used to transfer the files back to the Sun machine was provided by Sun-IBM file transfer software.

The compiler was tested using command scripts provided by Alsys and reviewed by the validation team. The compiler was tested using all the following option settings.

<u>OPTION</u>	<u>EFFECT</u>
SOURCE => source_name	expects the file 'source_file' to contain Ada source code.
LIBRARY => library_name	expects this to reference the Ada library.
ERRORS => 999	maximum number of compilation errors permitted before the compiler terminates the compilation.
LEVEL => CODE	a complete compilation takes place, transferring source code into object code.
CHECKS => ALL	all run time checks are performed.
GENERICCS => INLINE	places the code generic instantiations inline in the same unit as the unit that contains the instantiation.
OUTPUT => filename	writes the output to a file with name filename.

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WARNING => NO	does not include the warning messages in the compilation listings.
TEXT => YES	prints the complete compilation listing.
DETAIL => YES	includes detailed error messages.
ASSEMBLY => NONE	does not include any object code or map information.
CALLS => NORMAL	uses the normal mode for subroutine calls.
REDUCTION => NONE	no action is taken with reference to the optimization of checks or loops.
OBJECT => PEEPHOLE	
TREE => NO	does not save the abstract tree representation.
STACK => 1024	indicate the maximum size of a stack object that can be placed in the stack segment.
GLOBAL => 1024	indicate the maximum size of a global object that can be placed in the stack segment.
UNNESTED => 16	
SHOW => NONE	does not include banners in the listing file.
FILE_WIDTH => 80	width of the listing file is 80 characters.
FILE_LENGTH => NO	No maximum page length given.

Tests were compiled, linked, and executed (as appropriate) using a single computer. Test output, compilation listings, and job logs were captured on a magnetic tape and archived at the AVF. The listings examined on-site by the validation team were also archived.

3.7.3 Test Site

Testing was conducted at Alsys Limited, Partridge House, Newtown Road, Henley-on-Thames, Oxfordshire, RG9 1EN, and was completed on 16th December 1988.

APPENDIX A

DECLARATION OF CONFORMANCE

Alsys Limited has submitted the following Declaration
of Conformance concerning the AlsyCOMP_006.

DECLARATION OF CONFORMANCE

Compiler Implementor: Alsys Limited
 Partridge House
 Newtown Road
 Henley-on-Thames
 Oxfordshire RG9 1EN

Ada Validation Facility: The National Computing Centre Limited,
 Oxford Road
 Manchester
 M1 7ED
 United Kingdom

Ada Compiler Validation Capability (ACVC) Version: 1.10

Base Configuration

Base Compiler Name: AlsyCOMP_006 version 4.1

Host Architecture ISA: IBM 9370 Model 90

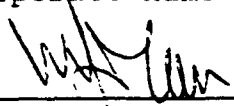
Host Operating System: VM/IS CMS release 5.1

Target Architecture ISA: IBM 370 3084Q

Target Operating System: MVS 3.2

Implementor's Declaration

I, the undersigned, representing Alsys Limited, have implemented no deliberate extensions to the Ada Language Standard ANSI/MIL-STD-1815A in the compiler(s) listed in this declaration. I declare that Alsys Limited is the owner of record of the Ada language compiler(s) listed above and, as such, is responsible for maintaining said compiler(s) in conformance to ANSI/MIL-STD-1815A. All certificates and registrations for Ada language compiler(s) listed in this declaration shall be made only in the owner's corporate name.

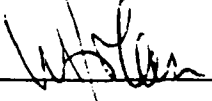
Signed 

Date 15/12/88

Title DIRECTOR

Owner's Declaration

I, the undersigned, representing Alsys Limited, take full responsibility for implementation and maintenance of the Ada compiler(s) listed above, and agree to the public disclosure of the final Validation Summary Report. I declare that all of the Ada language compilers listed, and their host/target performance, are in compliance with the Ada Language Standard ANSI/MIL-STD-1815A.

Signed Date 15/12/88Title DIRECTOR

APPENDIX BAPPENDIX F OF THE Ada STANDARD

The only allowed implementation dependencies correspond to implementation-dependent pragmas, to certain machine-dependent conventions as mentioned in chapter 13 of the Ada Standard, and to certain allowed restrictions on representation clauses. The implementation-dependent characteristics of the AlsyCOMP_006 Version 4.1, are described in this Appendix provided by Alsys Limited for this compiler. Any reference in this appendix are to compiler documentation and not to this report. Implementation-specific portions of the package STANDARD--not a part of Appendix F--are:

package STANDARD is

...

type INTEGER is range -2147483648 .. 2147483647;

type SHORT_INTEGER is range -32768 .. 32767;

type SHORT_SHORT_INTEGER is range -128 .. 127;

type FLOAT is digits 15 range -7.24E+75 .. 7.24E+75;

type SHORT_FLOAT is digits 6 range -7.24E+75 .. 7.24E+75;

type LONG_FLOAT is digits 18 range -7.24E+75 .. 7.24E+75;

type DURATION is delta 2.0**-14 range -86400.0 .. 86400.0;

...

end STANDARD;

APPENDIX F OF THE Ada STANDARD

Alsys IBM 370 Ada* Compiler

APPENDIX F
for VM/CMS and MVS
(including MVS/XA)
Implementation - Dependent Characteristics

Version 4.0

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PREFACE

This *Alsys IBM 370 Ada Compiler Appendix F* is for programmers, software engineers, project managers, educators and students who want to develop an Ada program for any IBM System/370 processor that runs VM/CMS, MVS or MVS/XA.

This appendix is a required part of the *Reference Manual for the Ada Programming Language*, ANSI/MIL-STD 1815A, February 1983 (throughout this appendix, citations in square brackets refer to this manual). It assumes that the user is already familiar with the CMS and MVS operating systems, and has access to the following IBM documents:

CMS User Guide, Release 3, SC19-6210

CMS Command and Macro Reference, Release 3, SC19-6209

OS/VS2 MVS Overview, GC28-0984

OS/VS2 System Programming Library: Job Management, GC28-1303

MVS/370 JCL Reference, GC28-1350

IBM System/370 Principles of Operation, GA22-7000

IBM System/370 System Summary, GA22-7001

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APPENDIX F

Implementation-Dependent Characteristics

This appendix summarises the implementation-dependent characteristics of the Alsys IBM 370 Ada Compiler for VM/CMS, MVS and MVS/XA. This document should be considered as the Appendix F to the Reference Manual for the Ada Programming Language ANSI/MIL-STD 1815 A - January 1983, as appropriate to the Alsys Ada implementation for the IBM 370 under VM/CMS, MVS and MVS/XA.

Sections 1 to 8 of this appendix correspond to the various information required in Appendix F [F]*; sections 9 and 10 provide other information relevant to the Alsys implementation. The contents of these sections is described below:

1. The form, allowed places, and effect of every implementation-dependent pragma.
2. The name and type of every implementation-dependent attribute.
3. The specification of the package SYSTEM [13.7].
4. The list of all restrictions on representation clauses [13.1].
5. The conventions used for any implementation-generated names denoting implementation-dependent components [13.4].
6. The interpretation of expressions that appear in address clauses, including those for interrupts [13.5].
7. Any restrictions on unchecked conversions [13.10.2].
8. Any implementation-dependent characteristics of the input-output packages [14].
9. Characteristics of numeric types.
10. Other implementation-dependent characteristics.

Throughout this appendix, the name *Ada Run-Time Executive* refers to the run-time library routines provided for all Ada programs. These routines implement the Ada heap, exceptions, tasking control, I/O, and other utility functions.

* Throughout this manual, citations in square brackets refer to the *Reference Manual for the Ada Programming Language*, ANSI/MIL-STD-1815A, January 1983.

1 Implementation-Dependent Pragmas

1.1 INLINE

Pragma `INLINE` is fully supported; however, it is not possible to inline a function called in a declarative part.

1.2 INTERFACE

Ada programs can interface to subprograms written in assembler or other languages through the use of the predefined pragma `INTERFACE` [13.9] and the implementation-defined pragma `INTERFACE_NAME`.

Pragma `INTERFACE` specifies the name of an interfaced subprogram and the name of the programming language for which calling and parameter passing conventions will be generated. Pragma `INTERFACE` takes the form specified in the *Reference Manual*:

```
pragma INTERFACE (language_name, subprogram_name);
```

where

- *language_name* is the name of the other language whose calling and parameter passing conventions are to be used.
- *subprogram_name* is the name used within the Ada program to refer to the interfaced subprogram.

The only language name currently accepted by pragma `INTERFACE` is `ASSEMBLER`.

The language name used in the pragma `INTERFACE` does not necessarily correspond to the language used to write the interfaced subprogram. It is used only to tell the compiler how to generate subprogram calls, that is, which calling conventions and parameter passing techniques to use.

The language name `ASSEMBLER` is used to refer to the standard IBM 370 calling and parameter passing conventions. The programmer can use the language name `ASSEMBLER` to interface Ada subprograms with subroutines written in any language that follows the standard IBM 370 calling conventions.

1.2.1 Calling Conventions

The following calling conventions are required for code to be interfaced to Ada by use of the pragma interface to `ASSEMBLER`.

The contents of the general purpose registers 12 and 13 must be restored to their original values by the interfaced code before returning to Ada.

On entry to the subprogram, register 13 contains the address of a register save area provided by the caller.

Registers 15 and 14 contain the entry point address and return address, respectively, of the called subprogram.

The Ada Run-Time Executive treats any program interruption occurring during the execution of the body of the subprogram as an exception being raised at the point of call of the subprogram. The exception raised following a program interruption in interfaced code is a `NUMERIC_ERROR` for the following cases:

- Fixed-pt overflow *
- Fixed-pt divide
- Decimal overflow *
- Decimal divide
- Exponent overflow
- Exponent underflow *
- Significance *
- Floating-pt divide

In other cases, `PROGRAM_ERROR` is raised. The classes of interruptions marked with an asterisk (*) may be masked by setting the program mask. On entry to the interfaced code exponent underflow and significance interruptions are suppressed. Note that the program mask should be restored to its original value (i.e. X'C') before returning to Ada code.

1.2.2 Parameter-Passing Conventions

On entry to the subprogram, register 1 contains the address of a parameter address list. Each word in this list is an address corresponding to a parameter. The last word in the list has its most significant (sign) bit set to indicate the end of the list.

For formal parameters of mode `in`, which are of scalar or access type, the address passed is that of a copy of the value of the actual parameter. For all other parameters the address passed is the address of the actual parameter itself.

Since all non-scalar and non-access parameters to interfaced subprograms are passed by address, they cannot be protected from modification by the called subprogram, even though they may be formally declared to be of mode `in`. It is the programmer's responsibility to ensure that the semantics of the Ada parameter modes are honoured in these cases.

If the address of an Ada object is passed explicitly as a parameter to an interfaced subprogram (i.e. to a formal parameter of type `SYSTEM.ADDRESS`) it is the address of the address which is passed in the parameter list: a value of type `SYSTEM.ADDRESS` being treated identically to any other scalar value.

If the subprogram is a function, register 0 is used to return the result. Scalar values are returned in general register 0. Floating point values are returned in floating point register 0. Non-scalar values are returned by address in general register 0.

No consistency checking is performed between the subprogram parameters declared in Ada and the corresponding parameters of the interfaced subprogram. It is the programmer's responsibility to ensure correct access to the parameters.

An example of an interfaced subprogram is:

```

* 64-bit integer addition:
*
* type DOUBLE is
*   record
*     HIGH    : INTEGER;
*     LOW     : INTEGER;
*   end record
* for DOUBLE use
*   record
*     HIGH    at 0 range 0..31;
*     LOW     at 4 range 0..31;
*   end record;
* procedure ADD (LEFT, RIGHT : in DOUBLE;
*               RESULT       : out DOUBLE);
ADD  CSECT
      USING ADD,15
      STM  2,6,12(13)
      L    2,0(1)      Address of LEFT
      LM   3,4,0(2)    Value of LEFT
      L    2,4(1)      Address of RIGHT
      AL   4,4(2)      Add low-order components (no interruption)
      BC   12,$1       Branch if no carry
      A    3,=F'1'     Add carry (NUMERIC_ERROR possible)
$1    A    3,0(2)      Add high-order (NUMERIC_ERROR possible)
      L    2,8(1)      Address of RESULT
      STM  3,4,0(2)    Value of result
      LM   2,6,12(13)
      BR   14
      LTORG
      DROP
      END

```

1.2.3 Parameter Representations

This section describes the representation of values of the types that can be passed as parameters to an interfaced subprogram. The discussion assumes no representation clauses have been used to alter the default representations of the types involved. Chapter 4 describes the effect of representation clauses on the representation of values.

Integer Types [3.5.4]

Ada integer types are represented in two's complement form and occupy 8 (SHORT_SHORT_INTEGER), 16 (SHORT_INTEGER) or 32 (INTEGER) bits.

Boolean Types [3.5.3]

Booleans are represented as 8 bit values. FALSE is represented by the value 0, and TRUE is represented by the value 1.

Enumeration Types [3.5.1]

Values of an Ada enumeration type are represented internally as unsigned values representing their position in the list of enumeration literals defining the type. The first literal in the list corresponds to a value of zero.

Enumeration types with 256 elements or fewer are represented in 8 bits, those with between 256 and 65536 (2^{16}) elements in 16 bits and all others in 32 bits. The maximum number of values an enumeration type can include is 2^{31} .

Consequently, the Ada predefined type CHARACTER [3.5.2] is represented in 8 bits, using the standard ASCII codes [C].

Floating Point Types [3.5.7, 3.5.8]

Ada floating-point values occupy 32 (SHORT_FLOAT), 64 (FLOAT) or 128 (LONG_FLOAT) bits, and are held in IBM 370 (short, long or extended floating point) format.

Fixed Point Types [3.5.9, 3.5.10]

Ada fixed-point types are managed by the Compiler as the product of a signed *mantissa* and a constant *small*. The mantissa is implemented as a 16 or 32 bit integer value. *Small* is a compile-time quantity which is the power of two equal or immediately inferior to the delta specified in the declaration of the type.

The attribute MANTISSA is defined as the smallest number such that:

$$2^{**} \text{ MANTISSA} \geq \max(\text{abs}(\text{upper_bound}), \text{abs}(\text{lower_bound})) / \text{small}$$

The size of a fixed point type is:

MANTISSA	Size
1 .. 15	16 bits
16 .. 31	32 bits

Fixed point types requiring a MANTISSA greater than 31 are not supported.

Access Types [3.8]

Values of access types are represented internally by the 31-bit address of the designated object held in a 32 bit word. Users should not alter any bits of this word, including those which are ignored by the architecture on which the program is running. The value zero is used to represent null.

Array Types [3.6]

Ada arrays are passed by reference; the value passed is the address of the first element of the array. The elements of the array are allocated by row. When an array is passed as a parameter to an interfaced subprogram, the usual consistency checking between the array bounds declared in the calling program and the subprogram is not enforced. It is the programmer's responsibility to ensure that the subprogram does not violate the bounds of the array.

Values of the predefined type `STRING` [3.6.3] are arrays, and are passed in the same way: the address of the first character in the string is passed. Elements of a string are represented in 8 bits, using the standard ASCII codes.

Record Types [3.7]

Ada records are passed by reference; the value passed is the address of the first component of the record. Components of a record are aligned on their natural boundaries (e.g. `INTEGER` on a word boundary) and the components may be re-ordered by the compiler so as to minimise the total size of objects of the record type. If a record contains discriminants or components having a dynamic size, implicit components may be added to the record. Thus the default layout of the internal structure of the record may not be inferred directly from its Ada declaration. The use of a representation clause to control the layout of any record type whose values are to be passed to interfaced subprograms is recommended.

1.2.4 Restrictions on Interfaced Subprograms

The Ada Run-Time Executive uses the `SPIE` and `ESPIE` macros (SVC 14). Interfaced subprograms should avoid use of this facility, or else restore interruption processing to its original state before returning to the Ada program. Failure to do so may lead to unpredictable results.

Similarly, interfaced subprograms must not change the program mask in the Program Status Word (PSW) of the machine without restoring it before returning.

1.3 INTERFACE_NAME

Pragma `INTERFACE_NAME` associates the name of an interfaced subprogram, as declared in Ada, with its name in the language of origin. If pragma `INTERFACE_NAME` is not used, then the two names are assumed to be identical.

This pragma takes the form

```
pragma INTERFACE_NAME (subprogram_name, string_literal);
```

where

- *subprogram_name* is the name used within the Ada program to refer to the interfaced subprogram.

- *string_literal* is the name by which the interfaced subprogram is referred to at link-time.

The use of `INTERFACE_NAME` is optional, and is not needed if a subprogram has the same name in Ada as in the language of origin. It is useful, for example, if the name of the subprogram in its original language contains characters that are not permitted in Ada identifiers. Ada identifiers can contain only letters, digits and underscores, whereas the IBM 370 linkage editor/loader allows external names to contain other characters, e.g. the plus or minus sign. These characters can be specified in the *string_literal* argument of the pragma `INTERFACE_NAME`.

The pragma `INTERFACE_NAME` is allowed at the same places of an Ada program as the pragma `INTERFACE` [13.9]. However, the pragma `INTERFACE_NAME` must always occur after the pragma `INTERFACE` declaration for the interfaced subprogram.

In order to conform to the naming conventions of the IBM 370 linkage editor/loader, the link-time name of an interfaced subprogram will be truncated to 8 characters and converted to upper case.

Example

```
package SAMPLE_DATA is
  function SAMPLE_DEVICE (X : INTEGER) return INTEGER;
  function PROCESS_SAMPLE (X : INTEGER) return INTEGER;
private
  pragma INTERFACE (ASSEMBLER, SAMPLE_DEVICE);
  pragma INTERFACE (ASSEMBLER, PROCESS_SAMPLE);
  pragma INTERFACE_NAME (PROCESS_SAMPLE, "PSAMPLE");
end SAMPLE_DATA;
```

1.4 INDENT

This pragma is only used with the Alsys Reformatter (*AdaReformat*); this tool offers the functionalities of a source reformatter in an Ada environment. The Alsys Reformatter is currently available only with the Alsys IBM 370 Ada compiler hosted under VM/CMS.

The pragma is placed in the source file and interpreted by the Reformatter.

```
pragma INDENT(OFF)
```

The Reformatter does not modify the source lines after the OFF pragma `INDENT`.

```
pragma INDENT(ON)
```

The Reformatter resumes its action after the ON pragma `INDENT`. Therefore any source lines that are bracketed by the OFF and ON pragma `INDENT`s are not modified by the Alsys Reformatter.

1.5 RMODE

Pragma RMODE associates a residence mode with the objects designated by the access values belonging to a given access type.

This pragma takes the form:

```
pragma RMODE (access_type_name, residence_mode);
```

```
residence_mode ::= A24 | ANY
```

where

- *access_type_name* is the name of the access type defining the collection of objects whose residence mode is to be specified.
- *residence_mode* is the residence mode to be associated with the designated objects.

A24: Indicates that the designated objects must reside within 24 bit addressable virtual storage (that is, below the 16 megabyte virtual storage line under MVS/XA).

ANY: Indicates that the designated objects may reside anywhere in virtual storage (that is, either above or below the 16 megabyte virtual storage line under MVS/XA).

Under CMS or MVS on non-extended architecture machines the pragma is effectively ignored, since only 16 megabytes of virtual address space are available and all virtual addresses implicitly meet the A24 residence mode criteria.

Under MVS/XA the pragma is significant for data whose residence mode must be explicitly controlled, e.g. data which is to be passed to non-Ada code via the pragma INTERFACE.

In the absence of the pragma RMODE, the default residence mode associated with the objects designated by an access type is ANY.

The *access_type_name* must be a simple name. The pragma RMODE and the access type declaration to which it refers must both occur immediately within the same declarative part, package specification or task specification; the declaration must occur before the pragma.

1.6 Other Pragas

Pragas IMPROVE and PACK are discussed in detail in the section on representation clauses (Chapter 4).

Pragma PRIORITY is accepted with the range of priorities running from 1 to 10 (see the definition of the predefined package SYSTEM in Chapter 3). The undefined priority (no pragma PRIORITY) is treated as though it were less than any defined priority value.

In addition to pragma SUPPRESS, it is possible to suppress all checks in a given compilation by the use of the Compiler option CHECKS.

The following language defined pragmas are not implemented.

CONTROLLED
MEMORY_SIZE
OPTIMIZE
STORAGE_UNIT
SYSTEM_NAME

Note that all access types are implemented by default as controlled collections as described in [4.8] (see section 10.1).

2 Implementation-Dependent Attributes

In addition to the Representation Attributes of [13.7.2] and [13.7.3], the four attributes listed in section 5 (Conventions for Implementation-Generated Names), for use in record representation clauses, and the attributes described below are provided:

T'DEScriptor_SIZE For a prefix T that denotes a type or subtype, this attribute yields the size (in bits) required to hold a descriptor for an object of the type T, allocated on the heap or written to a file. If T is constrained, T'DEScriptor_SIZE will yield the value 0.

T'IS_ARRAY For a prefix T that denotes a type or subtype, this attribute yields the value TRUE if T denotes an array type or an array subtype; otherwise, it yields the value FALSE.

Limitations on the use of the attribute ADDRESS

The attribute ADDRESS is implemented for all prefixes that have meaningful addresses. The following entities do not have meaningful addresses and will therefore cause a compilation error if used as a prefix to ADDRESS:

- A constant that is implemented as an immediate value i.e. does not have any space allocated for it.
- A package specification that is not a library unit.
- A package body that is not a library unit or subunit.

3 Specification of the Package SYSTEM

package SYSTEM is

type NAME is (IBM_370);

SYSTEM_NAME : constant NAME := NAME'FIRST;

MIN_INT : constant := -(2**31);

MAX_INT : constant := 2**31-1;

MEMORY_SIZE : constant := 2**31;

type ADDRESS is range MIN_INT .. MAX_INT;

STORAGE_UNIT : constant := 8;

MAX_DIGITS : constant := 18;

MAX_MANTISSA : constant := 31;

FINE_DELTA : constant := 2#1.0#e-31;

TICK : constant := 0.01;

NULL_ADDRESS : constant ADDRESS := 0;

subtype PRIORITY is INTEGER range 1 .. 10;

-- These subprograms are provided to perform

-- READ/WRITE operations in memory.

generic

type ELEMENT_TYPE is private;

function FETCH (FROM : ADDRESS) return ELEMENT_TYPE;

generic

type ELEMENT_TYPE is private;

procedure STORE (INTO : ADDRESS; OBJECT : ELEMENT_TYPE);

end SYSTEM;

The generic function FETCH may be used to read data objects from given addresses in store. The generic procedure STORE may be used to write data objects to given addresses in store.

On the non-extended architecture (AMODE 24) the top byte of a value of type address is ignored (i.e. does not form part of the address). On an extended architecture (31 bit addressing) the top bit of a value of type address is similarly ignored.

4 Restrictions on Representation Clauses

This section explains how objects are represented and allocated by the Alsys IBM 370 Ada Compiler and how it is possible to control this using representation clauses.

The representation of an object is closely connected with its type. For this reason this section addresses successively the representation of enumeration, integer, floating point, fixed point, access, task, array and record types. For each class of type the representation of the corresponding objects is described.

Except in the case of array and record types, the description of each class of type is independent of the others. To understand the representation of an array types it is necessary to understand first the representation of its components. The same rule applies to record types.

Apart from implementation defined pragmas, Ada provides three means to control the size of objects:

- a (predefined) pragma PACK, when the object is an array, an array component, a record or a record component
- a record representation clause, when the object is a record or a record component
- a size specification, in any case.

For each class of types the effect of a size specification is described. Interaction between size specifications, packing and record representation clauses is described under array and record types.

Representation clauses on derived record types or derived task types is not supported.

Size representation clauses on types derived from private types are not supported when the derived type is declared outside the private part of the defining package.

For each class of types the effect of a size specification alone is described. Interference between size specifications, packing and record representation clauses is described under array and record types.

4.1 Enumeration Types

Internal codes of enumeration literals

When no enumeration representation clause applies to an enumeration type, the internal code associated with an enumeration literal is the position number of the enumeration literal. Then, for an enumeration type with n elements, the internal codes are the integers 0, 1, 2, .. , $n-1$.

An enumeration representation clause can be provided to specify the value of each internal code as described in RM 13.3. The Alsys compiler fully implements enumeration representation clauses.

As internal codes must be machine integers the internal codes provided by an enumeration representation clause must be in the range $-2^{31} .. 2^{31}-1$.

Encoding of enumeration values

An enumeration value is always represented by its internal code in the program generated by the compiler.

Minimum size of an enumeration subtype

The minimum size of an enumeration subtype is the minimum number of bits that is necessary for representing the internal codes of the subtype values in normal binary form.

For a static subtype, if it has a null range its minimum size is 1. Otherwise, if m and M are the values of the internal codes associated with the first and last enumeration values of the subtype, then its minimum size L is determined as follows. For $m \geq 0$, L is the smallest positive integer such that $M \leq 2^L - 1$. For $m < 0$, L is the smallest positive integer such that $-2^{L-1} \leq m$ and $M \leq 2^{L-1} - 1$.

```
type COLOR is (GREEN, BLACK, WHITE, RED, BLUE, YELLOW);  
-- The minimum size of COLOR is 3 bits.
```

```
subtype BLACK_AND_WHITE is COLOR range BLACK .. WHITE;  
-- The minimum size of BLACK_AND_WHITE is 2 bits.
```

```
subtype BLACK_OR_WHITE is BLACK_AND_WHITE range X .. X;  
-- Assuming that X is not static, the minimum size of BLACK_OR_WHITE is  
-- 2 bits (the same as the minimum size of its type mark BLACK_AND_WHITE).
```

Size of an enumeration subtype

When no size specification is applied to an enumeration type or first named subtype, the objects of that type or first named subtype are represented as signed machine integers. The machine provides 8, 16 and 32 bit integers, and the compiler selects automatically the smallest signed machine integer which can hold each of the internal codes of the enumeration type (or subtype). The size of the enumeration type and of any of its subtypes is thus 8, 16 or 32 bits.

When a size specification is applied to an enumeration type, this enumeration type and each of its subtypes has the size specified by the length clause. The same rule applies to a first named subtype. The size specification must of course specify a value greater than or equal to the minimum size of the type or subtype to which it applies:

type EXTENDED is

(-- The usual American ASCII

characters.

NUL,	SOH,	STX,	ETX,	EOT,	ENQ,	ACK,	BEL,
BS,	HT,	LF,	VT,	FF,	CR,	SO,	SI,
DLE,	DC1,	DC2,	DC3,	DC4,	NAK,	SYN,	ETB,
CAN,	EM,	SUB,	ESC,	FS,	GS,	RS,	US,
';',	'"',	'"',	'#',	'\$',	'%',	'&',	'"',
'(',	')',	'*',	'+',	'-',	'-',	'-',	'/',
'0',	'1',	'2',	'3',	'4',	'5',	'6',	'7',
'8',	'9',	'-',	'-',	'<',	'=',	'>',	'?',
'@',	'A',	'B',	'C',	'D',	'E',	'F',	'G',
'H',	'I',	'J',	'K',	'L',	'M',	'N',	'O',
'P',	'Q',	'R',	'S',	'T',	'U',	'V',	'W',
'X',	'Y',	'Z',	'[',	'\',	']',	'^',	'_',
'"',	'a',	'b',	'c',	'd',	'e',	'f',	'g',
'h',	'i',	'j',	'k',	'l',	'm',	'n',	'o',
'p',	'q',	'r',	's',	't',	'u',	'v',	'w',
'x',	'y',	'z',	'{',	' ',	'}',	'~',	DEL,

-- Extended characters

LEFT_ARROW,
 RIGHT_ARROW,
 UPPER_ARROW,
 LOWER_ARROW,
 UPPER_LEFT_CORNER,
 UPPER_RIGHT_CORNER,
 LOWER_RIGHT_CORNER,
 LOWER_LEFT_CORNER,
 ...);

for EXTENDED'SIZE use 8;

-- The size of type EXTENDED will be one byte. Its objects will be represented
 -- as unsigned 8 bit integers.

The Alslys compiler fully implements size specifications. Nevertheless, as enumeration values are coded using integers, the specified length cannot be greater than 32 bits.

Size of the objects of an enumeration subtype

Provided its size is not constrained by a record component clause or a pragma PACK, an object of an enumeration subtype has the same size as its subtype.

Alignment of an enumeration subtype

An enumeration subtype is byte aligned if the size of the subtype is less than or equal to 8 bits, halfword aligned if the size of the subtype is less than or equal to 16 bits and word aligned otherwise.

Address of an object of an enumeration subtype

Provided its alignment is not constrained by a record representation clause or a pragma PACK, the address of an object of an enumeration subtype is a multiple of the alignment of the corresponding subtype.

4.2 Integer Types

Predefined integer types

There are three predefined integer types in the Alsys implementation for IBM 370 machines:

```
type SHORT_SHORT_INTEGER is range -2**07 .. 2**07-1;
type SHORT_INTEGER       is range -2**15 .. 2**15-1;
type INTEGER              is range -2**31 .. 2**31-1;
```

Selection of the parent of an integer type

An integer type declared by a declaration of the form:

```
type T is range L .. R;
```

is implicitly derived from either the SHORT_INTEGER or INTEGER predefined integer type. The compiler automatically selects the predefined integer type whose range is the shortest that contains the values L to R inclusive. Note that the SHORT_SHORT_INTEGER representation is never automatically selected by the compiler.

Encoding of integer values

Binary code is used to represent integer values. Negative numbers are represented using two's complement.

Minimum size of an integer subtype

The minimum size of an integer subtype is the minimum number of bits that is necessary for representing the internal codes of the subtype values in normal binary form.

For a static subtype, if it has a null range its minimum size is 1. Otherwise, if m and M are the lower and upper bounds of the subtype, then its minimum size L is determined as follows. For $m \geq 0$, L is the smallest positive integer such that $M \leq 2^L - 1$. For $m < 0$, L is the smallest positive integer that $-2^{L-1} \leq m$ and $M \leq 2^{L-1} - 1$.

```
subtype S is INTEGER range 0 .. 7;
-- The minimum size of S is 3 bits.
```

```
subtype D is S range X .. Y;
-- Assuming that X and Y are not static, the minimum size of
-- D is 3 bits (the same as the minimum size of its type mark S).
```

Size of an integer subtype

The sizes of the predefined integer types `SHORT_SHORT_INTEGER`, `SHORT_INTEGER` and `INTEGER` are respectively 8, 16 and 32 bits.

When no size specification is applied to an integer type or to its first named subtype (if any), its size and the size of any of its subtypes is the size of the predefined type from which it derives, directly or indirectly. For example:

```
type S is range 80 .. 100;
-- S is derived from SHORT_INTEGER, its size is 16 bits.
```

```
type J is range 0 .. 65535;
-- J is derived from INTEGER, its size is 32 bits.
```

```
type N is new J range 80 .. 100;
-- N is indirectly derived from INTEGER, its size is 32 bits.
```

When a size specification is applied to an integer type, this integer type and each of its subtypes has the size specified by the length clause. The same rule applies to a first named subtype. The size specification must of course specify a value greater than or equal to the minimum size of the type or subtype to which it applies:

```
type S is range 80 .. 100;
for S'SIZE use 32;
-- S is derived from SHORT_INTEGER, but its size is 32 bits
-- because of the size specification.
```

```
type J is range 0 .. 255;
for J'SIZE use 8;
-- J is derived from SHORT_INTEGER, but its size is 8 bits because
-- of the size specification.
```

```
type N is new J range 80 .. 100;
-- N is indirectly derived from SHORT_INTEGER, but its size is 8 bits
-- because N inherits the size specification of J.
```

The Alsys compiler fully implements size specifications. Nevertheless, as integers are implemented using machine integers, the specified length cannot be greater than 32 bits.

Size of the objects of an integer subtype

Provided its size is not constrained by a record component clause or a pragma PACK, an object of an integer subtype has the same size as its subtype.

Alignment of an integer subtype

An integer subtype is byte aligned if the size of the subtype is less than or equal to 8 bits, halfword aligned if the size of the subtype is less than or equal to 16 bits and word aligned otherwise.

Address of an object of an integer subtype

Provided its alignment is not constrained by a record representation clause or a pragma PACK, the address of an object of an integer subtype is a multiple of the alignment of the corresponding subtype.

4.3 Floating Point Types

Predefined floating point types

There are three predefined floating point types in the Alsys implementation for IBM 370 machines:

```
type SHORT_FLOAT is
  digits 6 range -2.0**252*(1.0-2.0**-24) .. 2.0**252*(1.0-2.0**-24);
type FLOAT is
  digits 15 range -2.0**252*(1.0-2.0**-56) .. 2.0**252*(1.0-2.0**-56);
type LONG_FLOAT is
  digits 18 range -2.0**252*(1.0-2.0**-112) .. 2.0**252*(1.0-2.0**-112);
```

Selection of the parent of a floating point type

A floating point type declared by a declaration of the form:

```
type T is digits D [range L .. R];
```

is implicitly derived from a predefined floating point type. The compiler automatically selects the smallest predefined floating point type whose number of digits is greater than or equal to D and which contains the values L to R inclusive.

Encoding of floating point values

In the program generated by the compiler, floating point values are represented using the IBM 370 data formats for single precision, double precision and extended precision floating point values respectively.

Values of the predefined type `SHORT_FLOAT` are represented using the single precision format, values of the predefined type `FLOAT` are represented using the double precision format and values of the predefined type `LONG_FLOAT` are represented using the extended precision format. The values of any other floating point type are represented in the same way as the values of the predefined type from which it derives, directly or indirectly.

Minimum size of a floating point subtype

The minimum size of a floating point subtype is 32 bits if its base type is `SHORT_FLOAT` or a type derived from `SHORT_FLOAT`, 64 bits if its base type is `FLOAT` or a type derived from `FLOAT` and 128 bits if its base type is `LONG_FLOAT` or a type derived from `LONG_FLOAT`.

Size of a floating point subtype

The sizes of the predefined floating point types `SHORT_FLOAT`, `FLOAT` and `LONG_FLOAT` are respectively 32 and 64 and 128 bits.

The size of a floating point type and the size of any of its subtypes is the size of the predefined type from which it derives directly or indirectly.

The only size that can be specified for a floating point type or first named subtype using a size specification is its usual size (32, 64 or 128 bits).

Size of the objects of a floating point subtype

An object of a floating point subtype has the same size as its subtype.

Alignment of a floating point subtype

A floating point subtype is word aligned if its size is 32 bits and double word aligned otherwise.

Address of an object of a floating point subtype

Provided its alignment is not constrained by a record representation clause or a pragma `PACK`, the address of an object of a floating point subtype is a multiple of the alignment of the corresponding subtype.

4.4 Fixed Point Types

Small of a fixed point type

If no specification of `small` applies to a fixed point type, then the value of `small` is determined by the value of `delta` as defined by RM 3.5.9.

A specification of small can be used to impose a value of small. The value of small is required to be a power of two.

Predefined fixed point types

To implement fixed point types, the Alsys compiler for IBM 370 machines uses a set of anonymous predefined types of the form:

```
type FIXED is delta D range (-2**15-1)*S .. 2**15*S;  
for FIXED'SMALL use S;
```

```
type LONG_FIXED is delta D range (-2**31-1)*S .. 2**31*S;  
for LONG_FIXED'SMALL use S;
```

where D is any real value and S any power of two less than or equal to D.

Selection of the parent of a fixed point type

A fixed point type declared by a declaration of the form:

```
type T is delta D range L .. R;
```

possibly with a small specification:

```
for T'SMALL use S;
```

is implicitly derived from a predefined fixed point type. The compiler automatically selects the predefined fixed point type whose small and delta are the same as the small and delta of T and whose range is the shortest that includes the values L to R inclusive.

Encoding of fixed point values

In the program generated by the compiler, a safe value V of a fixed point subtype F is represented as the integer:

$$V / F\text{'BASE'SMALL}$$

Minimum size of a fixed point subtype

The minimum size of a fixed point subtype is the minimum number of binary digits that is necessary for representing the values of the range of the subtype using the small of the base type.

For a static subtype, if it has a null range its minimum size is 1. Otherwise, s and S being the bounds of the subtype, if i and I are the integer representations of m and M, the smallest and the greatest model numbers of the base type such that $s < m$ and $M < S$, then the minimum size L is determined as follows. For $i \geq 0$, L is the smallest positive integer such that $I \leq 2^L - 1$. For $i < 0$, L is the smallest positive integer such that $-2^{L-1} \leq i$ and $I \leq 2^{L-1} - 1$.

type F is delta 2.0 range 0.0 .. 500.0;

-- The minimum size of F is 8 bits.

subtype S is F delta 16.0 range 0.0 .. 250.0;

-- The minimum size of S is 7 bits.

subtype D is S range X .. Y;

-- Assuming that X and Y are not static, the minimum size of D is 7 bits

-- (the same as the minimum size of its type mark S).

Size of a fixed point subtype

The sizes of the predefined fixed point types *FIXED* and *LONG_FIXED* are 16 and 32 bits respectively.

When no size specification is applied to a fixed point type or to its first named subtype, its size and the size of any of its subtypes is the size of the predefined type from which it derives directly or indirectly. For example:

type F is delta 0.01 range 0.0 .. 2.0;

-- F is derived from a 16 bit predefined fixed type, its size is 16 bits.

type L is delta 0.01 range 0.0 .. 300.0;

-- L is derived from a 32 bit predefined fixed type, its size is 32 bits.

type N is new L range 0.0 .. 2.0;

-- N is indirectly derived from a 32 bit predefined fixed type, its size is 32 bits.

When a size specification is applied to a fixed point type, this fixed point type and each of its subtypes has the size specified by the length clause. The same rule applies to a first named subtype. The size specification must of course specify a value greater than or equal to the minimum size of the type or subtype to which it applies:

type F is delta 0.01 range 0.0 .. 2.0;

for F'SIZE use 32;

-- F is derived from a 16 bit predefined fixed type, but its size is 32 bits

-- because of the size specification.

type L is delta 0.01 range 0.0 .. 300.0;

for F'SIZE use 16;

-- F is derived from a 32 bit predefined fixed type, but its size is 16 bits

-- because of the size specification.

type N is new F range 0.8 .. 1.0;

-- N is indirectly derived from a 16 bit predefined fixed type, but its size is

-- 32 bits because N inherits the size specification of F.

The Alsys compiler fully implements size specifications. Nevertheless, as fixed point objects are represented using machine integers, the specified length cannot be greater than 32 bits.

Size of the objects of a fixed point subtype

Provided its size is not constrained by a record component clause or a pragma PACK, an object of a fixed point type has the same size as its subtype.

Alignment of a fixed point subtype

A fixed point subtype is byte aligned if its size is less than or equal to 8 bits, halfword aligned if the size of the subtype is less than or equal to 16 bits and word aligned otherwise.

Address of an object of a fixed point subtype

Provided its alignment is not constrained by a record representation clause or a pragma PACK, the address of an object of a fixed point subtype is a multiple of the alignment of the corresponding subtype.

4.5 Access Types

Collection Size

When no specification of collection size applies to an access type, no storage space is reserved for its collection, and the value of the attribute STORAGE_SIZE is then 0.

As described in RM 13.2, a specification of collection size can be provided in order to reserve storage space for the collection of an access type. The Alsys compiler fully implements this kind of specification.

Encoding of access values.

Access values are machine addresses.

Minimum size of an access subtype

The minimum size of an access subtype is 32 bits.

Size of an access subtype

The size of an access subtype is 32 bits, the same as its minimum size.

The only size that can be specified for an access type using a size specification is its usual size (32 bits).

Size of an object of an access subtype

An object of an access subtype has the same size as its subtype, thus an object of an access subtype is always 32 bits long.

Alignment of an access subtype.

An access subtype is always word aligned.

Address of an object of an access subtype

Provided its alignment is not constrained by a record representation clause or a pragma PACK, the address of an object of an access subtype is always on a word boundary, since its subtype is word aligned.

4.6 Task Types

Storage for a task activation

When no length clause is used to specify the storage space to be reserved for a task activation, the storage space indicated at bind time is used for this activation.

As described in RM 13.2, a length clause can be used to specify the storage space for the activation of each of the tasks of a given type. In this case the value indicated at bind time is ignored for this task type, and the length clause is obeyed.

It is not allowed to apply such a length clause to a derived type. The same storage space is reserved for the activation of a task of a derived type as for the activation of a task of the parent type.

Encoding of task values.

Task values are machine addresses.

Minimum size of a task subtype

The minimum size of a task subtype is 32 bits.

Size of a task subtype

The size of a task subtype is 32 bits, the same as its minimum size.

A size specification has no effect on a task type. The only size that can be specified using such a length clause is its minimum size.

Size of the objects of a task subtype

An object of a task subtype has the same size as its subtype. Thus an object of a task subtype is always 32 bits long.

Alignment of a task subtype

A task subtype is always word aligned.

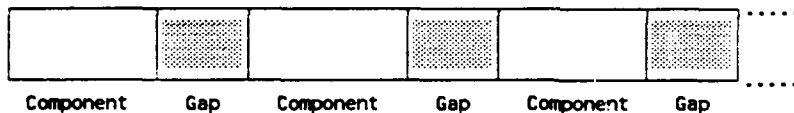
Address of an object of a task subtype

Provided its alignment is not constrained by a record representation clause, the address of an object of a task subtype is always on a word boundary, since its subtype is word aligned.

4.7 Array Types

Layout of an array

Each array is allocated in a contiguous area of storage units. All the components have the same size. A gap may exist between two consecutive components (and after the last one). All the gaps have the same size.



Components

If the array is not packed, the size of the components is the size of the subtype of the components:

```
type A is array (1 .. 8) of BOOLEAN;
-- The size of the components of A is the size of the type BOOLEAN: 8 bits.

type DECIMAL_DIGIT is range 0 .. 9;
for DECIMAL_DIGIT'SIZE use 4;
type BINARY_CODED_DECIMAL is
    array (INTEGER range <>) of DECIMAL_DIGIT;
-- The size of the type DECIMAL_DIGIT is 4 bits. Thus in an array of
-- type BINARY_CODED_DECIMAL each component will be represented on
-- 4 bits as in the usual BCD representation.
```

If the array is packed and its components are neither records nor arrays, the size of the components is the minimum size of the subtype of the components:

```

type A is array (1 .. 8) of BOOLEAN;
pragma PACK(A);
-- The size of the components of A is the minimum size of the type BOOLEAN;
-- 1 bit.

type DECIMAL_DIGIT is range 0 .. 9;
type BINARY_CODED_DECIMAL is
  array (INTEGER range <>) of DECIMAL_DIGIT;
pragma PACK(BINARY_CODED_DECIMAL);
-- The size of the type DECIMAL_DIGIT is 16 bits, but, as
-- BINARY_CODED_DECIMAL is packed, each component of an array of this
-- type will be represented on 4 bits as in the usual BCD representation.

```

Packing the array has no effect on the size of the components when the components are records or arrays.

Gaps

If the components are records or arrays, no size specification applies to the subtype of the components and the array is not packed, then the compiler may choose a representation with a gap after each component; the aim of the insertion of such gaps is to optimise access to the array components and to their subcomponents. The size of the gap is chosen so that the relative displacement of consecutive components is a multiple of the alignment of the subtype of the components. This strategy allows each component and subcomponent to have an address consistent with the alignment of its subtype:

```

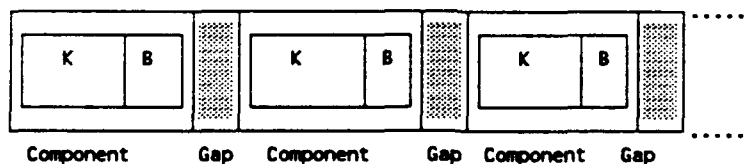
type R is
  record
    K : INTEGER; -- INTEGER is word aligned.
    B : BOOLEAN; -- BOOLEAN is byte aligned.
  end record;
-- Record type R is word aligned. Its size is 40 bits.

```

```

type A is array (1 .. 10) of R;
-- A gap of three bytes is inserted after each component in order to respect the
-- alignment of type R. The size of an array of type A will be 640 bits.

```



Array of type A: each subcomponent K has a word offset.

If a size specification applies to the subtype of the components or if the array is packed, no gaps are inserted:

```

type R is
  record
    K : INTEGER;
    B : BOOLEAN;
  end record;

```

```

type A is array (1 .. 10) of R;
pragma PACK(A);
-- There is no gap in an array of type A because
-- A is packed.
-- The size of an object of type A will be 400 bits.

```

```

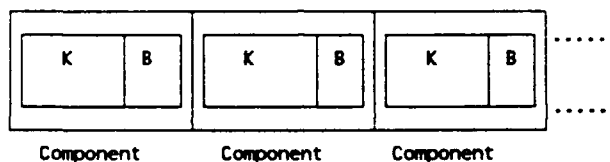
type NR is new R;
for NR'SIZE use 40;

```

```

type B is array (1 .. 10) of NR;
-- There is no gap in an array of type B because
-- NR has a size specification.
-- The size of an object of type B will be 400 bits.

```



Array of type A or B: a subcomponent K can have any byte offset.

Size of an array subtype

The size of an array subtype is obtained by multiplying the number of its components by the sum of the size of the components and the size of the gaps (if any). If the subtype is unconstrained, the maximum number of components is considered.

The size of an array subtype cannot be computed at compile time

- if it has non-static constraints or is an unconstrained array type with non-static index subtypes (because the number of components can then only be determined at run time).
- if the components are records or arrays and their constraints or the constraints of their subcomponents (if any) are not static (because the size of the components and the size of the gaps can then only be determined at run time).

As has been indicated above, the effect of a pragma PACK on an array type is to suppress the gaps and to reduce the size of the components. The consequence of packing an array type is thus to reduce its size.

If the components of an array are records or arrays and their constraints or the constraints of their subcomponents (if any) are not static, the compiler ignores any pragma PACK applied to the array type but issues a warning message. Apart from this limitation, array packing is fully implemented by the Alsys compiler.

A size specification applied to an array type or first named subtype has no effect. The only size that can be specified using such a length clause is its usual size. Nevertheless, such a length clause can be useful to verify that the layout of an array is as expected by the application.

Size of the objects of an array subtype

The size of an object of an array subtype is always equal to the size of the subtype of the object.

Alignment of an array subtype

If no pragma PACK applies to an array subtype and no size specification applies to its components, the array subtype has the same alignment as the subtype of its components.

If a pragma PACK applies to an array subtype or if a size specification applies to its components (so that there are no gaps), the alignment of the array subtype is the lesser of the alignment of the subtype of its components and the relative displacement of the components.

Address of an object of an array subtype

Provided its alignment is not constrained by a record representation clause, the address of an object of an array subtype is a multiple of the alignment of the corresponding subtype.

4.8 Record Types

Layout of a record

Each record is allocated in a contiguous area of storage units. The size of a record component depends on its type. Gaps may exist between some components.

The positions and the sizes of the components of a record type object can be controlled using a record representation clause as described in RM 13.4. In the Alsys implementation for IBM 370 machines there is no restriction on the position that can be specified for a component of a record. If a component is not a record or an array, its size can be any size from the minimum size to the size of its subtype. If a component is a record or an array, its size must be the size of its subtype:

```

type ACCESS_KEY is range 0..15;
-- The size of ACCESS_KEY is 16 bits, the minimum size is 4 bits

type CONDITIONS is (ZERO, LESS_THAN, GREATER_THAN, OVERFLOW);
-- The size of CONDITIONS is 8 bits, the minimum size is 2 bits

type PROG_EXCEPTION is (FIX_OVFL, DEC_OVFL, EXP_UNDFL, SIGNIF);
type PROG_MASK is array (PROG_EXCEPTION) of BOOLEAN;
pragma PACK (PROG_MASK);
-- The size of PROG_MASK is 4 bits

type ADDRESS is range 0..2**24-1;
for ADDRESS'SIZE use 24;
-- ADDRESS represents a 24 bit memory address

type PSW is
  record
    PER_MASK          : BOOLEAN;
    DAT_MODE          : BOOLEAN;
    IO_MASK           : BOOLEAN;
    EXTERNAL_MASK     : BOOLEAN;
    PSW_KEY           : ACCESS_KEY;
    EC_MODE           : BOOLEAN;
    MACHINE_CHECK     : BOOLEAN;
    WAIT_STATE        : BOOLEAN;
    PROBLEM_STATE     : BOOLEAN;
    ADDRESS_SPACE     : BOOLEAN;
    CONDITION_CODE    : CONDITIONS;
    PROGRAM_MASK      : PROG_MASK;
    INSTR_ADDRESS     : ADDRESS;
  end record;
-- This type can be used to map the program status word of the IBM 370

for PSW use
  record at mod 8;
    PER_MASK          at 0   range 1..1;
    DAT_MODE          at 0   range 5..5;
    IO_MASK           at 0   range 6..6;
    EXTERNAL_MASK     at 0   range 7..7;
    PSW_KEY           at 1   range 0..3;
    EC_MODE           at 1   range 4..4;
    MACHINE_CHECK     at 1   range 5..5;
    WAIT_STATE        at 1   range 6..6;
    PROBLEM_STATE     at 1   range 7..7;
    ADDRESS_SPACE     at 2   range 0..0;
    CONDITION_CODE    at 2   range 2..3;
    PROGRAM_MASK      at 2   range 4..7;
    INSTR_ADDRESS     at 5   range 0..23;
  end record;

```

A record representation clause need not specify the position and the size for every component.

If no component clause applies to a component of a record, its size is the size of its subtype. Its position is chosen by the compiler so as to optimise access to the components of the record: the offset of the component is chosen as a multiple of the alignment of the component subtype. Moreover, the compiler chooses the position of the component so as to reduce the number of gaps and thus the size of the record objects.

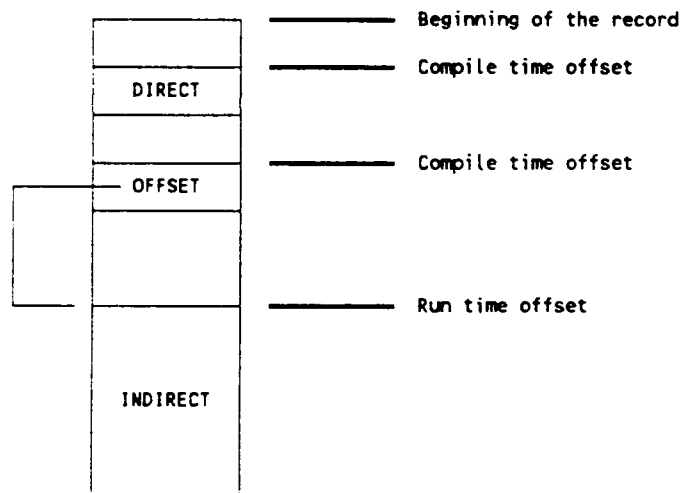
Because of these optimisations, there is no connection between the order of the components in a record type declaration and the positions chosen by the compiler for the components in a record object.

Pragma PACK has no further effect on records. The Alsys compiler always optimises the layout of records as described above.

In the current version, it is not possible to apply a record representation clause to a derived type. The same storage representation is used for an object of a derived type as for an object of the parent type.

Indirect components

If the offset of a component cannot be computed at compile time, this offset is stored in the record objects at run time and used to access the component. Such a component is said to be indirect while other components are said to be direct:



A direct and an indirect component

If a record component is a record or an array, the size of its subtype may be evaluated at run time and may even depend on the discriminants of the record. We will call these components dynamic components:

```
type DEVICE is (SCREEN, PRINTER);
```

```
type COLOR is (GREEN, RED, BLUE);
```

```

type SERIES is array (POSITIVE range <>) of INTEGER;

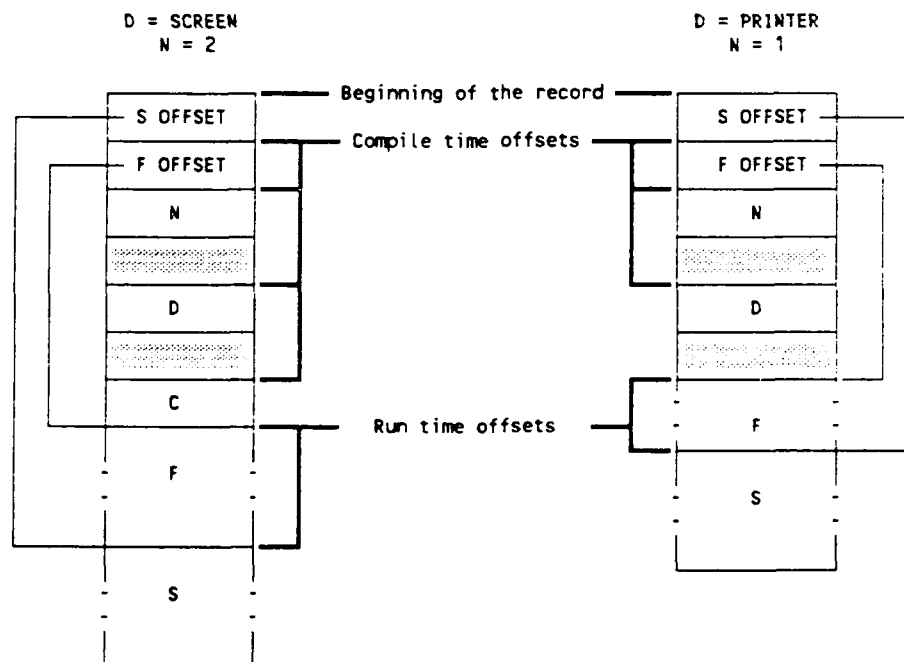
type GRAPH (L : NATURAL) is
  record
    X : SERIES(1 .. L); -- The size of X depends on L
    Y : SERIES(1 .. L); -- The size of Y depends on L
  end record;

Q : POSITIVE;

type PICTURE (N : NATURAL; D : DEVICE) is
  record
    F : GRAPH(N); -- The size of F depends on N
    S : GRAPH(Q); -- The size of S depends on Q
  case D is
    when SCREEN =>
      C : COLOUR;
    when PRINTER =>
      null;
  end case;
end record;

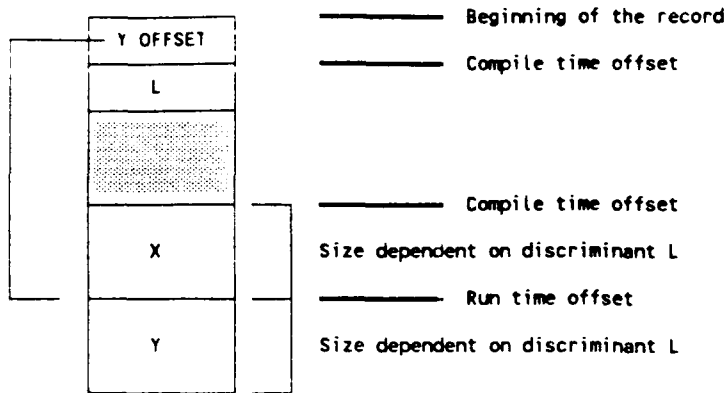
```

Any component placed after a dynamic component has an offset which cannot be evaluated at compile time and is thus indirect. In order to minimize the number of indirect components, the compiler groups the dynamic components together and places them at the end of the record:



The record type PICTURE: F and S are placed at the end of the record

Thanks to this strategy, the only indirect components are dynamic components. But not all dynamic components are necessarily indirect: if there are dynamic components in a component list which is not followed by a variant part, then exactly one dynamic component of this list is a direct component because its offset can be computed at compilation time (the only dynamic components that are direct components are in this situation):



The record type GRAPH: the dynamic component X is a direct component.

The offset of an indirect component is always expressed in storage units.

The space reserved for the offset of an indirect component must be large enough to store the size of any value of the record type (the maximum potential offset). The compiler evaluates an upper bound MS of this size and treats an offset as a component having an anonymous integer type whose range is 0 .. MS.

If C is the name of an indirect component, then the offset of this component can be denoted in a component clause by the implementation generated name C'OFFSET.

Implicit components

In some circumstances, access to an object of a record type or to its components involves computing information which only depends on the discriminant values. To avoid useless recomputation the compiler stores this information in the record objects, updates it when the values of the discriminants are modified and uses it when the objects or its components are accessed. This information is stored in special components called implicit components.

An implicit component may contain information which is used when the record object or several of its components are accessed. In this case the component will be included in any record object (the implicit component is considered to be declared before any variant part in the record type declaration). There can be two components of this kind; one is called RECORD_SIZE and the other VARIANT_INDEX.

On the other hand an implicit component may be used to access a given record component. In that case the implicit component exists whenever the record component exists (the implicit component is considered to be declared at the same place as the record component). Components of this kind are called `ARRAY_DESCRIPTORs` or `RECORD_DESCRIPTORs`.

▪ *RECORD_SIZE*

This implicit component is created by the compiler when the record type has a variant part and its discriminants are defaulted. It contains the size of the storage space necessary to store the current value of the record object (note that the storage effectively allocated for the record object may be more than this).

The value of a `RECORD_SIZE` component may denote a number of bits or a number of storage units. In general it denotes a number of storage units, but if any component clause specifies that a component of the record type has an offset or a size which cannot be expressed using storage units, then the value designates a number of bits.

The implicit component `RECORD_SIZE` must be large enough to store the maximum size of any value of the record type. The compiler evaluates an upper bound `MS` of this size and then considers the implicit component as having an anonymous integer type whose range is `0 .. MS`.

If `R` is the name of the record type, this implicit component can be denoted in a component clause by the implementation generated name `R'RECORD_SIZE`.

▪ *VARIANT_INDEX*

This implicit component is created by the compiler when the record type has a variant part. It indicates the set of components that are present in a record value. It is used when a discriminant check is to be done.

Component lists that do not contain a variant part are numbered. These numbers are the possible values of the implicit component `VARIANT_INDEX`.

```

type VEHICLE is (AIRCRAFT, ROCKET, BOAT, CAR);

type DESCRIPTION (KIND : VEHICLE := CAR) is
  record
    SPEED : INTEGER;
    case KIND is
      when AIRCRAFT | CAR =>
        WHEELS : INTEGER;
        case KIND is
          when AIRCRAFT =>           -- 1
            WINGSPAN : INTEGER;
          when others => -- 2
            null;
        end case;
      when BOAT =>           -- 3
        STEAM : BOOLEAN;
      when ROCKET =>        -- 4
        STAGES : INTEGER;
    end case;
  end record;

```

The value of the variant index indicates the set of components that are present in a record value:

Variant Index	Set
1	{KIND, SPEED, WHEELS, WINGSPAN}
2	{KIND, SPEED, WHEELS}
3	{KIND, SPEED, STEAM}
4	{KIND, SPEED, STAGES}

A comparison between the variant index of a record value and the bounds of an interval is enough to check that a given component is present in the value:

Component	Interval
KIND	--
SPEED	--
WHEELS	1 .. 2
WINGSPAN	1 .. 1
STEAM	3 .. 3
STAGES	4 .. 4

The implicit component `VARIANT_INDEX` must be large enough to store the number `V` of component lists that don't contain variant parts. The compiler treats this implicit component as having an anonymous integer type whose range is `1 .. V`.

If `R` is the name of the record type, this implicit component can be denoted in a component clause by the implementation generated name `R'VARIANT_INDEX`.

■ *ARRAY_DESCRIPTOR*

An implicit component of this kind is associated by the compiler with each record component whose subtype is an anonymous array subtype that depends on a discriminant of the record. It contains information about the component subtype.

The structure of an implicit component of kind *ARRAY_DESCRIPTOR* is not described in this documentation. Nevertheless, if a programmer is interested in specifying the location of a component of this kind using a component clause, he can obtain the size of the component using the *ASSEMBLY* parameter in the *COMPILE* command.

The compiler treats an implicit component of the kind *ARRAY_DESCRIPTOR* as having an anonymous array type. If *C* is the name of the record component whose subtype is described by the array descriptor, then this implicit component can be denoted in a component clause by the implementation generated name *C'ARRAY_DESCRIPTOR*.

■ *RECORD_DESCRIPTOR*

An implicit component of this kind is associated by the compiler with each record component whose subtype is an anonymous record subtype that depends on a discriminant of the record. It contains information about the component subtype.

The structure of an implicit component of kind *RECORD_DESCRIPTOR* is not described in this documentation. Nevertheless, if a programmer is interested in specifying the location of a component of this kind using a component clause, he can obtain the size of the component using the *ASSEMBLY* parameter in the *COMPILE* command.

The compiler treats an implicit component of the kind *RECORD_DESCRIPTOR* as having an anonymous array type. if *C* is the name of the record component whose subtype is described by the record descriptor, then this implicit component can be denoted in a component clause by the implementation generated name *C'RECORD_DESCRIPTOR*.

Suppression of implicit components

The Alsys implementation provides the capability of suppressing the implicit components *RECORD_SIZE* and/or *VARIANT_INDEX* from a record type. This can be done using an implementation defined pragma called *IMPROVE*. The syntax of this pragma is as follows:

```
pragma IMPROVE ( TIME | SPACE , [ON =>] simple_name );
```

The first argument specifies whether *TIME* or *SPACE* is the primary criterion for the choice of the representation of the record type that is denoted by the second argument.

If TIME is specified, the compiler inserts implicit components as described above. If on the other hand SPACE is specified, the compiler only inserts a VARIANT_INDEX or a RECORD_SIZE component if this component appears in a record representation clause that applies to the record type. A record representation clause can thus be used to keep one implicit component while suppressing the other.

A pragma IMPROVE that applies to a given record type can occur anywhere that a representation clause is allowed for this type.

Size of a record subtype

Unless a component clause specifies that a component of a record type has an offset or a size which cannot be expressed using storage units, the size of a record subtype is rounded up to the a whole number of storage units.

The size of a constrained record subtype is obtained by adding the sizes of its components and the sizes of its gaps (if any). This size is not computed at compile time

- when the record subtype has non-static constraints,
- when a component is an array or a record and its size is not computed at compile time.

The size of an unconstrained record subtype is obtained by adding the sizes of the components and the sizes of the gaps (if any) of its largest variant. If the size of a component or of a gap cannot be evaluated exactly at compile time an upper bound of this size is used by the compiler to compute the subtype size.

A size specification applied to a record type or first named subtype has no effect. The only size that can be specified using such a length clause is its usual size. Nevertheless, such a length clause can be useful to verify that the layout of a record is as expected by the application.

Size of an object of a record subtype

An object of a constrained record subtype has the same size as its subtype.

An object of an unconstrained record subtype has the same size as its subtype if this size is less than or equal to 8 kb. If the size of the subtype is greater than this, the object has the size necessary to store its current value; storage space is allocated and released as the discriminants or the record change.

Alignment of a record subtype

When no record representation clause applies to its base type, a record subtype has the same alignment as the component with the highest alignment requirement.

When a record representation clause that does not contain an alignment clause applies to its base type, a record subtype has the same alignment as the component with the highest alignment requirement which has not been overridden by its component clause.

When a record representation clause that contains an alignment clause applies to its base type, a record subtype has an alignment that obeys the alignment clause.

Address of an object of a record subtype

Provided its alignment is not constrained by a representation clause, the address of an object of a record subtype is a multiple of the alignment of the corresponding subtype.

5 Conventions for Implementation-Generated Names

Special record components are introduced by the compiler for certain record type definitions. Such record components are implementation-dependent; they are used by the compiler to improve the quality of the generated code for certain operations on the record types. The existence of these components is established by the compiler depending on implementation-dependent criteria. Attributes have been defined for referring to them in record representation clauses. An error message is issued by the compiler if the user refers to an implementation-dependent attribute that does not exist. If the implementation-dependent component exists, the compiler checks that the storage location specified in the component clause is compatible with the treatment of this component and the storage locations of other components. An error message is issued if this check fails.

There are four such attributes:

- T'RECORD_SIZE** For a prefix T that denotes a record type. This attribute refers to the record component introduced by the compiler in a record to store the size of the record object. This component exists for objects of a record type with defaulted discriminants when the sizes of the record objects depend on the values of the discriminants.
- T'VARIANT_INDEX** For a prefix T that denotes a record type. This attribute refers to the record component introduced by the compiler in a record to assist in the efficient implementation of discriminant checks. This component exists for objects of a record type with variant type.
- C'ARRAY_DESCRIPTOR** For a prefix C that denotes a record component of an array type whose component subtype definition depends on discriminants. This attribute refers to the record component introduced by the compiler in a record to store information on subtypes of components that depend on discriminants.
- C'RECORD_DESCRIPTOR** For a prefix C that denotes a record component of a record type whose component subtype definition depends on discriminants. This attribute refers to the record component introduced by the compiler in a record to store information on subtypes of components that depend on discriminants.

6 Address Clauses

6.1 Address Clauses for Objects

An address clause can be used to specify an address for an object as described in RM 13.5. When such a clause applies to an object no storage is allocated for it in the program generated by the compiler. The program accesses the object using the address specified in the clause.

An address clause is not allowed for task objects, nor for unconstrained records whose size is greater than 8 kb.

6.2 Address Clauses for Program Units

Address clauses for program units are not implemented in the current version of the compiler.

6.3 Address Clauses for Entries

Address clauses for entries are not implemented in the current version of the compiler.

7 Restrictions on Unchecked Conversions

Unconstrained arrays are not allowed as target types.

Unconstrained record types without defaulted discriminants are not allowed as target types.

If the source and the target types are each scalar or access types, the sizes of the objects of the source and target types must be equal. If a composite type is used either as the source type or as the target type this restriction on the size does not apply.

If the source and the target types are each of scalar or access type or if they are both of composite type, the effect of the function is to return the operand.

In other cases the effect of unchecked conversion can be considered as a copy:

- if an unchecked conversion is achieved of a scalar or access source type to a composite target type, the result of the function is a copy of the source operand: the result has the size of the source.
- if an unchecked conversion is achieved of a composite source type to a scalar or access target type, the result of the function is a copy of the source operand: the result has the size of the target.

8 Input-Output Packages

The predefined input-output packages `SEQUENTIAL_IO` [14.2.3], `DIRECT_IO` [14.2.5], and `TEXT_IO` [14.3.10] are implemented as described in the Language Reference Manual, as is the package `IO_EXCEPTIONS` [14.5], which specifies the exceptions that can be raised by the predefined input-output packages.

The package `LOW_LEVEL_IO` [14.6], which is concerned with low-level machine-dependent input-output, has not been implemented.

8.1 NAME Parameter

8.1.1 VM/CMS

The NAME parameter supplied to the Ada procedures `CREATE` or `OPEN` [14.2.1] may represent a CMS file name or DDNAME specified using a `FILEDEF` command.

The syntax of a CMS file name as specified in the Ada NAME parameter is as follows:

$$\text{file_name} ::= fn [ft [fm]] \mid \%ddname$$

where

fn is the CMS filename

ft is the CMS filetype

fm is the CMS filemode

If the filenames or filetypes exceed 8 characters then they are truncated. As indicated above, the filetype and filemode fields are not mandatory components of the NAME parameter. If the filemode is omitted, it defaults to "A1" for files being created; for files being opened all accessed minidisks are searched and the CMS filemode is set to that of the first file with the appropriate filename and filetype. If, in addition, the filetype is omitted it defaults to "FILE". The case of the characters of the filename is not significant.

The NAME parameter may also be a DDNAME. If the file name parameter starts with a % character, the remainder of the string (excluding trailing blanks) is taken as a DDNAME previously specified using the `FILEDEF` command. If the DDNAME has not been specified using `FILEDEF`, `NAME_ERROR` will be raised.

The effect of calling `CREATE` and `DELETE` for a file opened using a DDNAME is as if `OPEN` or `CLOSE` (respectively) had been called.

8.1.2 MVS

The NAME parameter supplied to the Ada procedures `CREATE` or `OPEN` [14.2.1] may represent an MVS dataset name or DDNAME.

The syntax of an MVS dataset name as specified in the Ada NAME parameter is as follows:

```
dataset_name ::= [&]dsname{(member)} |  
                'dsname{(member)}'|  
                %ddname
```

where

dsname is the MVS dataset name. If prefixed by an ampersand (&) the system assigns a temporary dataset name.

member is the MVS member, generation or area name.

An unqualified name (not enclosed in apostrophes) is first prefixed by the string (if any) given as the QUALIFIER parameter in the program PARM field when the program is run. An intervening period is added if required.

The QUALIFIER parameter may be specified as in the following example:

```
//STEP20 EXEC PGM=IEB73,PARM='/QUALIFIER(PAYROLL.ADA)'
```

A fully qualified name (enclosed in apostrophes) is not so prefixed. The result of the NAME function is always in the form of a fully qualified name, i.e. enclosed in single quotes.

The NAME parameter may also be a DDNAME. If the file name parameter starts with a % character, the remainder of the string (excluding trailing blanks) is taken as a DDNAME previously allocated. If the DDNAME has not been allocated, NAME_ERROR will be raised.

The effect of calling CREATE and DELETE for a file opened using a DDNAME is as if OPEN or CLOSE (respectively) had been called.

8.2 FORM Parameter

The FORM parameter comprises a set of attributes formulated according to the lexical rules of [2], separated by commas. The FORM parameter may be given as a null string except when DIRECT_IO is instantiated with an unconstrained type; in this case the RECORD_SIZE attribute must be provided. Attributes are comma-separated; blanks may be inserted between lexical elements as desired. In the descriptions below the meanings of *natural*, *positive*, etc., are as in Ada; attribute keywords (represented in upper case) are identifiers [2.3] and as such may be specified without regard to case.

USE_ERROR is raised if the FORM parameter does not conform to these rules.

The attributes are as follows:

File sharing attribute

This attribute allows control over the sharing of one external file between several internal files within a single program. In effect it establishes rules for subsequent OPEN and CREATE calls which specify the same external file. If such rules are violated or if a different file sharing attribute is specified in a later OPEN or CREATE call, USE_ERROR will be raised. The syntax is as follows:

```
NOT_SHARED |  
SHARED => access_mode
```

where

```
access_mode ::= READERS | SINGLE_WRITER | ANY
```

A file sharing attribute of:

```
NOT_SHARED
```

implies only one internal file may access the external file.

```
SHARED => READERS
```

imposes no restrictions on internal files of mode IN_FILE, but prevents any internal files of mode OUT_FILE or INOUT_FILE being associated with the external file.

```
SHARED => SINGLE_WRITER
```

is as SHARED => READERS, but in addition allows a single internal file of mode OUT_FILE or INOUT_FILE.

```
SHARED => ANY
```

places no restrictions on external file sharing.

If a file of the same name has previously been opened or created, the default is taken from that file's sharing attribute, otherwise the default depends on the mode of the file: for mode IN_FILE the default is SHARED => READERS, for modes INOUT_FILE and OUT_FILE the default is NOT_SHARED.

Record format attribute

This attribute controls the record format (RECFM) of an external file created in Ada. The attribute may only be used in the FORM parameter of the CREATE command; if used in the FORM parameter of the OPEN command, USE_ERROR will be raised.

By default, files are created according to the following rules:

- for TEXT_IO, and instantiations of SEQUENTIAL_IO of unconstrained types, variable-length record files (RECFM = V) are created.
- for DIRECT_IO, and instantiations of SEQUENTIAL_IO of constrained types, fixed-length record files (RECFM = F) are created.

The syntax of the record format attribute is as follows:

RECFM => V | F

Record size attribute

This attribute controls the logical record length (LRECL) of an external file created in Ada. The attribute may only be used in the FORM parameter of the CREATE command; if used in the FORM parameter of the OPEN command, USE_ERROR will be raised.

In the case of RECFM F files (see record format attribute) the record size attribute specifies the record length of each record; in the case of RECFM V files, the record size attribute specifies the maximum record length.

In the case of DIRECT_IO.CREATE for unconstrained types the user is required to specify the RECORD_SIZE attribute (otherwise USE_ERROR will be raised by the OPEN or CREATE procedures).

In the case of DIRECT_IO and SEQUENTIAL_IO for constrained types the value given must not be smaller than ELEMENT_TYPE'SIZE / SYSTEM.STORAGE_UNIT; USE_ERROR will be raised if this rule is violated.

In the case of DIRECT_IO and SEQUENTIAL_IO for unconstrained types the value given must not be smaller than ELEMENT_TYPE'DEScriptor_SIZE / SYSTEM.STORAGE_UNIT plus the size of the largest record which is to be read or written. If a larger record is processed, DATA_ERROR will be raised by the READ or WRITE.

In the case of TEXT_IO, output lines will be padded to the requisite length with spaces; this fact should be borne in mind when re-reading files generated using TEXT_IO with the record size attribute set.

The syntax of the record size attribute is as follows:

RECORD_SIZE | LRECL => *natural*

where *natural* is a size in bytes.

For input-output of constrained types the default is:

RECORD_SIZE => *element_length*

where

$$element_length = ELEMENT_TYPE'SIZE / SYSTEM.STORAGE_UNIT$$

For input-output of unconstrained types other than via `DIRECT_IO`, in which case the `RECORD_SIZE` attribute must be provided by the user, variable size records are used (`RECFM V`).

Block size attribute

This attribute controls the block size of an external file. The block size must be at least as large as the record size (if specified) or must obey the same rules for specifying the record size.

The default is

$$BLOCK_SIZE \Rightarrow record_size$$

for `RECFM F` files and

$$BLOCK_SIZE \Rightarrow 4096$$

for `RECFM V` files.

Carriage control

This attribute applies to `TEXT_IO` only, and is intended for files destined to be sent to a printer.

For a file of mode `OUT_FILE`, this attribute causes the output procedures of `TEXT_IO` to place a carriage control character as the first character of every output record; '1' (skip to channel 1) if the record follows a page terminator, or space (skip to next line) otherwise. Subsequent characters are output as normal as the result of calls of the output subprograms of `TEXT_IO`.

For a file of mode `IN_FILE`, this attribute causes the input procedures of `TEXT_IO` to interpret the first character of each record as a carriage control character, as described in the previous paragraph. Carriage control characters are not explicitly returned as a result of an input subprogram, but will (for example) affect the result of `END_OF_PAGE`.

The user should naturally be careful to ensure the carriage control attribute of a file of mode `IN_FILE` has the same value as that specified when creating the file.

The syntax of the carriage control attribute is as follows:

$$CARRIAGE_CONTROL [\Rightarrow boolean]$$

The default is set according to the filetype of the file: if the filetype is LISTING, the default is CARRIAGE_CONTROL => TRUE otherwise the default is CARRIAGE_CONTROL => FALSE. If the attribute alone is specified without a boolean value it defaults to TRUE.

Truncate

This attribute applies to TEXT_IO files of mode IN_FILE, and causes the input procedures of TEXT_IO to remove trailing blanks from records read.

The syntax of the TRUNCATE attribute is as follows:

TRUNCATE [=> *boolean*]

The default is TRUNCATE => FALSE.

Note that truncation is always performed for TEXT_IO files for which the record size attribute is set (i.e. RECFM = F). If the attribute alone is specified without a boolean value it defaults to TRUE.

Append

This attribute may only be used in the FORM parameter of the OPEN command; if used in the FORM parameter of the CREATE command, USE_ERROR will be raised.

The affect of this attribute is to cause writing to commence at the end of the existing file.

The syntax of the APPEND attribute is as follows:

APPEND [=> *boolean*]

The default is APPEND => FALSE. If the attribute alone is specified without a boolean value it defaults to TRUE.

Eof string

This attribute applies only to files associated with the terminal opened using TEXT_IO, and controls the logical *end_of_file* string. If a line equal to the logical *end_of_file* string is typed in, END_OF_FILE will become TRUE. If an attempt is made to read from a file for which END_OF_FILE is TRUE, END_ERROR will be raised.

The syntax of the EOF_STRING attribute is as follows:

EOF_STRING => *sequence_of_characters*

The default is EOF_STRING => /*

The EOF_STRING may not contain commas or spaces.

If the `END_OF_FILE` function is called, a "look-ahead read" will be required. This means that (for example) a question-and-answer session at the terminal coded as follows:

```
while not END_OF_FILE loop
    PUT_LINE ("Enter value:");
    GET_LINE ( ... );
end loop;
```

will cause the prompt to appear only after the first value has been input. If the example is recoded without the explicit call to `END_OF_FILE` (but perhaps within a handler for `END_ERROR`) the behaviour will be appropriate.

The following additional FORM parameter attributes apply only to programs run under MVS.

Unit attribute

This attribute allows control over the unit on which a file is allocated. The syntax is as follows:

`UNIT => unit_name`

where *unit_name* specifies a group name, a device type or a specific unit address.

The default is the local installation specific default.

Volume attribute

This attribute allows control over the volume on which a file is allocated. The syntax is as follows:

`VOLUME => volume_name`

where *volume_name* specifies the volume serial number.

The default is the local installation specific default.

Primary attribute

This attribute allows control over the primary space allocation for a file. The syntax is as follows:

`PRIMARY => natural`

where *natural* is the number of blocks allocated to the file.

The default is the local installation specific default.

Secondary attribute

This attribute allows control over the secondary space allocation for a file. The syntax is as follows:

`SECONDARY => natural`

where *natural* is the number of additional blocks allocated to the file if more space is needed.

The default is the local installation specific default.

8.3 STANDARD_INPUT and STANDARD_OUTPUT

The Ada internal files `STANDARD_INPUT` and `STANDARD_OUTPUT` are associated with the external files `%SYSIN` and `%SYSOUT`, respectively. By default under CMS the DDNAMEs `SYSIN` and `SYSOUT` are defined to be the terminal, but the user may redefine their assignments using the `FILEDEF` command before running any program. Under MVS, the DDNAMEs must be allocated before any program is run, whether or not the corresponding Ada internal files are used.

The Ada internal files `STANDARD_INPUT` and `STANDARD_OUTPUT` are associated with the DD names `SYSIN` and `SYSOUT`, respectively. These DD names must be defined before any program can be run.

8.4 USE_ERROR

The following conditions will cause `USE_ERROR` to be raised:

- Specifying a `FORM` parameter whose syntax does not conform to the rules given above.
- Specifying the `EOF_STRING` `FORM` parameter attribute for files other than `TEXT_IO` files of mode `IN_FILE`.
- Specifying the `CARRIAGE_CONTROL` `FORM` parameter attribute for files other than `TEXT_IO` files.
- Specifying the `BLOCK_SIZE` `FORM` parameter attribute to have a value less than `RECORD_SIZE`.
- Specifying the `RECORD_SIZE` `FORM` parameter attribute to have a value of zero, or failing to specify `RECORD_SIZE` for instantiation of `DIRECT_IO` for unconstrained types.
- Specifying a `RECORD_SIZE` `FORM` parameter attribute to have a value less than that required to hold the element for instantiations of `DIRECT_IO` and `SEQUENTIAL_IO` for constrained types.
- Violating the file sharing rules stated above.

- For CMS, attempting to write a zero length record to other than the terminal.
- Errors detected whilst reading or writing (e.g. writing to a file on a read-only disk).

8.5 Text Terminators

Line terminators [14.3] are not implemented using a character, but are implied by the end of physical record.

Page terminators [14.3] are implemented using the EBCDIC character 0C (hexadecimal).

File terminators [14.3] are not implemented using a character, but are implied by the end of physical file. Note that for terminal input a line consisting of the EOF_STRING (see 8.1.1) is interpreted as a file terminator. Thus, entering such a line to satisfy a read from the terminal will raise the END_ERROR exception.

The user should avoid the explicit output of the character ASCII.FF [C], as this will not cause a page break to be emitted. If the user explicitly outputs the character ASCII.LF, this is treated as a call of NEW_LINE [14.3.4].

The following characters have special meaning for VM/SP; this should be borne in mind when reading from the display terminal:

<u>Character</u>	<u>Default VM/SP meaning</u>	<u>May be changed using</u>
#	logical line end symbol	CP TERMINAL LINEND
^	logical escape character	CP TERMINAL ESCAPE
@	logical character delete symbol	CP TERMINAL CHARDEL

8.6 EBCDIC and ASCII

All I/O using TEXT_IO is performed using ASCII/EBCDIC translation. CHARACTER and STRING values are held internally in ASCII but represented in external files in EBCDIC. For SEQUENTIAL_IO and DIRECT_IO no translation takes place, and the external file contains a binary image of the internal representation of the Ada element (see section 8.7).

It should be noted that the EBCDIC character set is larger than the (7 bit) ASCII and that the use of EBCDIC and ASCII control characters may not produce the desired results when using TEXT_IO (the input and output of control characters is in any case not defined by the Ada language [14.3]). Furthermore, the user is advised to exercise caution in the use of BAR (|) and SHARP (#), which are part of the lexis of Ada; if their use is prevented by translation between ASCII and EBCDIC, EXCLAM (!) and COLON (:), respectively, should be used instead [2.10].

Various translation tables exist to translate between ASCII and EBCDIC. The predefined package EBCDIC is provided to allow access to the translation facilities used by TEXT_IO and SYSTEM_ENVIRONMENT (see *Character Code Translation Tables* in the *Compiler User's Guide*).

The specification of this package is given in section 10.5.1.

8.7 Characteristics of Disk Files

A disk file that has already been created and is opened takes on the characteristics that are already associated with that file.

The characteristics of disk files that are created using the predefined input-output packages are set up as described below.

8.7.1 TEXT_IO

- A carriage control character is placed in column 1 if the CARRIAGE control attribute is specified in the FORM parameter.
- Data is translated between ASCII and EBCDIC so that the external file is readable using other System/370 tools.
- Under MVS, TEXT_IO files are implemented as DSORG PS (QSAM) datasets.

8.7.2 SEQUENTIAL_IO

- No translation is performed between ASCII and EBCDIC; the data in the external file is a memory image of the elements written, preceded by a descriptor in the case of unconstrained types.
- Under MVS, SEQUENTIAL_IO files are implemented as DSORG PS (QSAM) datasets.

8.7.3 DIRECT_IO

- No translation is performed between ASCII and EBCDIC; the data in the external file is a memory image of the elements written, preceded by a descriptor in the case of unconstrained types.
- Under CMS DIRECT_IO files may be read using SEQUENTIAL_IO (and vice-versa if a RECORD_SIZE component is specified).
- Under MVS, DIRECT_IO files are implemented as DSORG DA (BDAM) datasets.

9 Characteristics of Numeric Types

9.1 Integer Types

The ranges of values for integer types declared in package STANDARD are as follows:

SHORT_SHORT_INTEGER	-128 .. 127	-- 2**7 - 1
SHORT_INTEGER	-32768 .. 32767	-- 2**15 - 1
INTEGER	-2147483648 .. 2147483647	-- 2**31 - 1

For the packages DIRECT_IO and TEXT_IO, the ranges of values for types COUNT and POSITIVE_COUNT are as follows:

COUNT	0 .. 2147483647	-- 2**31 - 1
POSITIVE_COUNT	1 .. 2147483647	-- 2**31 - 1

For the package TEXT_IO, the range of values for the type FIELD is as follows:

FIELD	0 .. 255	-- 2**8 - 1
-------	----------	-------------

9.2 Floating Point Type Attributes

SHORT_FLOAT

		Approximate value
DIGITS	6	
MANTISSA	21	
EMAX	84	
EPSILON	$2.0^{** -20}$	9.54E-07
SMALL	$2.0^{** -85}$	2.58E-26
LARGE	$2.0^{** 84} * (1.0 - 2.0^{** -21})$	1.93E+25
SAFE_EMAX	252	
SAFE_SMALL	$2.0^{** -253}$	6.91E-77
SAFE_LARGE	$2.0^{** 127} * (1.0 - 2.0^{** -21})$	1.70E+38
FIRST	$-2.0^{** 252} * (1.0 - 2.0^{** -24})$	-7.24E+75
LAST	$2.0^{** 252} * (1.0 - 2.0^{** -24})$	7.24E+75
MACHINE_RADIX	16	
MACHINE_MANTISSA	6	
MACHINE_EMAX	63	
MACHINE_EMIN	-64	
MACHINE_ROUNDS	FALSE	
MACHINE_OVERFLOWS	TRUE	
SIZE	32	

FLOAT

		Approximate value
DIGITS	15	
MANTISSA	51	
EMAX	204	
EPSILON	$2.0^{** -50}$	8.88E-16
SMALL	$2.0^{** -205}$	1.94E-62
LARGE	$2.0^{** 204} * (1.0 - 2.0^{** -51})$	2.57E+61
SAFE_EMAX	252	
SAFE_SMALL	$2.0^{** -253}$	6.91E-77
SAFE_LARGE	$2.0^{** 252} * (1.0 - 2.0^{** -51})$	7.24E+75
FIRST	$-2.0^{** 252} * (1.0 - 2.0^{** -56})$	-7.24E+75
LAST	$2.0^{** 252} * (1.0 - 2.0^{** -56})$	7.24E+75
MACHINE_RADIX	16	
MACHINE_MANTISSA	14	
MACHINE_EMAX	63	
MACHINE_EMIN	-64	
MACHINE_ROUNDS	FALSE	
MACHINE_OVERFLOWS	TRUE	
SIZE	64	

LONG_FLOAT

		Approximate value
DIGITS	18	
MANTISSA	61	
EMAX	244	
EPSILON	$2.0^{** -60}$	$8.67E-19$
SMALL	$2.0^{** -245}$	$1.77E-74$
LARGE	$2.0^{** 244} * (1.0 - 2.0^{** -61})$	$2.83E+73$
SAFE_EMAX	252	
SAFE_SMALL	$2.0^{** -253}$	$6.91E-77$
SAFE_LARGE	$2.0^{** 252} * (1.0 - 2.0^{** -61})$	$7.24E+75$
FIRST	$-2.0^{** 252} * (1.0 - 2.0^{** -112})$	$-7.24E+75$
LAST	$2.0^{** 252} * (1.0 - 2.0^{** -112})$	$7.24E+75$
MACHINE_RADIX	16	
MACHINE_MANTISSA	28	
MACHINE_EMAX	63	
MACHINE_EMIN	-64	
MACHINE_ROUNDS	FALSE	
MACHINE_OVERFLOWS	TRUE	
SIZE	128	

9.3 Attributes of Type DURATION

DURATION'DELTA	$2.0^{** -14}$
DURATION'SMALL	$2.0^{** -14}$
DURATION'LARGE	131072.0
DURATION'FIRST	-86400.0
DURATION'LAST	86400.0

10 Other Implementation-Dependent Characteristics

10.1 Characteristics of the Heap

All objects created by allocators go into the program heap. In addition, portions of the Ada Run-Time Executive's representation of task objects, including the task stacks, are allocated in the program heap.

All objects on the heap belonging to a given collection have their storage reclaimed on exit from the innermost block statement, subprogram body or task body that encloses the access type declaration associated with the collection. For access types declared at the library level, this deallocation occurs only on completion of the main program.

There is no further automatic storage reclamation performed, i.e. in effect all access types are deemed to be controlled [4.8]. The explicit deallocation of the object designated by an access value can be achieved by calling an appropriate instantiation of the generic procedure `UNCHECKED_DEALLOCATION`.

Space for the heap is initially claimed from the system on program start up and additional space may be claimed as required when the initial allocation is exhausted. The size of both the initial allocation and the size of the individual increments claimed from the system may be controlled by the Binder options `SIZE` and `INCREMENT`. Corresponding run-time options also exist.

On an extended architecture machine space allocated from the program heap may be above or below the 16 megabyte virtual storage line. The implementation defined pragma `RMODE` (see section 1.4) is provided to control the residence mode of objects allocated from the program heap.

10.2 Characteristics of Tasks

The default task stack size is 16 Kbytes, but by using the Binder option `TASK` the size for all task stacks in a program may be set to any size from 4 Kbytes to 16 Mbytes. A corresponding run-time option also exists.

Timeslicing is implemented for task scheduling. The default time slice is 1000 milliseconds, but by using the Binder option `SLICE` the time slice may be set to any multiple of 10 milliseconds. A corresponding run-time option also exists. It is also possible to use this option to specify no timeslicing, i.e. tasks are scheduled only at explicit synchronisation points. Timeslicing is started only upon activation of the first task in the program, so the `SLICE` option has no effect for sequential programs.

Normal priority rules are followed for preemption, where `PRIORITY` values run in the range 1 .. 0. All tasks with "undefined" priority (no pragma `PRIORITY`) are considered to have a priority of 0.

The minimum timeable delay is 10 milliseconds.

The maximum number of active tasks is limited only by memory usage. Tasks release their storage allocation as soon as they have terminated.

The acceptor of a rendezvous executes the accept body code in its own stack. A rendezvous with an empty accept body (e.g. for synchronisation) does not cause a context switch.

The main program waits for completion of all tasks dependent on library packages before terminating. Such tasks may select a terminate alternative only after completion of the main program.

Abnormal completion of an aborted task takes place immediately, except when the abnormal task is the caller of an entry that is engaged in a rendezvous. Any such task becomes abnormally completed as soon as the rendezvous is completed.

If a global deadlock situation arises because every task (including the main program) is waiting for another task, the program is aborted and the state of all tasks is displayed.

10.3 Definition of a Main Program

A main program must be a non-generic, parameterless, library procedure.

10.4 Ordering of Compilation Units

The Alsys IBM 370 Ada Compiler imposes no additional ordering constraints on compilations beyond those required by the language.

10.5 Implementation Defined Packages

The following packages are defined by the Alsys Ada implementation for the IBM 370 under VM/CMS and MVS

10.5.1 Package EBCDIC

The implementation-defined package EBCDIC provides the user with access to the ASCII to EBCDIC and EBCDIC to ASCII translation facilities used by the TEXT_IO, SYSTEM_ENVIRONMENT and RECORD_IO packages.

The specification of package EBCDIC is as follows:

```
package EBCDIC is

  type EBCDIC_CHARACTER is (
    nul,      -- 0 = 0h
    soh,      -- 1 = 1h
    stx,      -- 2 = 2h
    etx,      -- 3 = 3h
    E_4,
    ht,       -- 5 = 5h
    E_6,
    del,      -- 7 = 7h
```

E_8,	
E_9,	
E_A,	
vt,	-- 11 = 08h
np,	-- 12 = 0Ch
cr,	-- 13 = 0Dh
so,	-- 14 = 0Eh
si,	-- 15 = 0Fh
dle,	-- 16 = 10h
dc1,	-- 17 = 11h
dc2,	-- 18 = 12h
dc3,	-- 19 = 13h
E_14,	
nl,	-- 21 = 15h
bs,	-- 22 = 16h
E_17,	
can,	-- 24 = 18h
em,	-- 25 = 19h
E_1A,	
E_1B,	
E_1C,	
gs,	-- 29 = 1Dh
rs,	-- 30 = 1Eh
us,	-- 31 = 1Fh
E_20,	
E_21,	
fs,	-- 34 = 22h
E_23,	
E_24,	
E_25,	
etb,	-- 38 = 26h
esc,	-- 39 = 27h
E_28,	
E_29,	
E_2A,	
E_2B,	
E_2C,	
enq,	-- 45 = 2Dh
ack,	-- 46 = 2Eh
bel,	-- 47 = 2Fh
E_30,	
E_31,	
syn,	-- 50 = 32h
E_33,	
E_34,	
E_35,	
E_36,	
eot,	-- 55 = 37h
E_38,	
E_39,	
E_3A,	
E_3B,	
dc4,	-- 60 = 3Ch

nak,	-- 61 = 3Dh
E_3E,	
sub,	-- 63 = 3Fh
' ',	-- 64 = 40h
E_41,	
E_42,	
E_43,	
E_44,	
E_45,	
E_46,	
E_47,	
E_48,	
E_49,	
E_4A,	
'.',	-- 75 = 48h
'<',	-- 76 = 4Ch
'(',	-- 77 = 4Dh
'+',	-- 78 = 4Eh
' ',	-- 79 = 4Fh
'&',	-- 80 = 50h
E_51,	
E_52,	
E_53,	
E_54,	
E_55,	
E_56,	
E_57,	
E_58,	
E_59,	
'!',	-- 90 = 5Ah
'\$',	-- 91 = 5Bh
'*',	-- 92 = 5Ch
')',	-- 93 = 5Dh
':',	-- 94 = 5Eh
','',	-- 95 = 5Fh
'-',	-- 96 = 60h
('/',	-- 97 = 61h
E_62,	
E_63,	
E_64,	
E_65,	
E_66,	
E_67,	
E_68,	
E_69,	
E_6A,	
' ',	--107 = 68h
'%',	--108 = 6Ch
'_',	--109 = 6Dh
'>',	--110 = 6Eh
'?',	--111 = 6Fh
E_70,	
E_71,	

E_72,	
E_73,	
E_74,	
E_75,	
E_76,	
E_77,	
E_78,	
' ',	--121 = 79h
'!',	--122 = 7Ah
'#',	--123 = 7Bh
'@',	--124 = 7Ch
'+',	--125 = 7Dh
'=',	--126 = 7Eh
'"',	--127 = 7Fh
E_80,	
'a',	--129 = 81h
'b',	--130 = 82h
'c',	--131 = 83h
'd',	--132 = 84h
'e',	--133 = 85h
'f',	--134 = 86h
'g',	--135 = 87h
'h',	--136 = 88h
'i',	--137 = 89h
E_8A,	
E_8B,	
E_8C,	
E_8D,	
E_8E,	
E_8F,	
E_90,	
'j',	--145 = 91h
'k',	--146 = 92h
'l',	--147 = 93h
'm',	--148 = 94h
'n',	--149 = 95h
'o',	--150 = 96h
'p',	--151 = 97h
'q',	--152 = 98h
'r',	--153 = 99h
E_9A,	
E_9B,	
E_9C,	
E_9D,	
E_9E,	
E_9F,	
E_A0,	
'-',	--161 = 0A1h
's',	--162 = 0A2h
't',	--163 = 0A3h
'u',	--164 = 0A4h
'v',	--165 = 0A5h
'w',	--166 = 0A6h

'x',	--167 = 0A7h
'y',	--168 = 0A8h
'z',	--169 = 0A9h
E_AA,	
E_AB,	
E_AC,	
'[',	--173 = 0ADh
E_AE,	
E_AF,	
E_B0,	
E_B1,	
E_B2,	
E_B3,	
E_B4,	
E_B5,	
E_B6,	
E_B7,	
E_B8,	
E_B9,	
E_BA,	
E_BB,	
E_BC,	
']',	--189 = 0BDh
E_BE,	
E_BF,	
'C',	--192 = 0C0h
'A',	--193 = 0C1h
'B',	--194 = 0C2h
'C',	--195 = 0C3h
'D',	--196 = 0C4h
'E',	--197 = 0C5h
'F',	--198 = 0C6h
'G',	--199 = 0C7h
'H',	--200 = 0C8h
'I',	--201 = 0C9h
E_CA,	
E_CB,	
E_CC,	
E_CD,	
E_CE,	
E_CF,	
']',	--208 = 0D0h
'J',	--209 = 0D1h
'K',	--210 = 0D2h
'L',	--211 = 0D3h
'M',	--212 = 0D4h
'N',	--213 = 0D5h
'O',	--214 = 0D6h
'P',	--215 = 0D7h
'Q',	--216 = 0D8h
'R',	--217 = 0D9h
E_DA,	
E_DB,	

```

E_DC,
E_DD,
E_DE,
E_DF,
'E',      --224 = 0E0h
E_E1,
'S',      --226 = 0E2h
'T',      --227 = 0E3h
'U',      --228 = 0E4h
'V',      --229 = 0E5h
'W',      --230 = 0E6h
'X',      --231 = 0E7h
'Y',      --232 = 0E8h
'Z',      --233 = 0E9h
E_EA,
E_EB,
E_EC,
E_ED,
E_EE,
E_EF,
'0',      --240 = 0F0h
'1',      --241 = 0F1h
'2',      --242 = 0F2h
'3',      --243 = 0F3h
'4',      --244 = 0F4h
'5',      --245 = 0F5h
'6',      --246 = 0F6h
'7',      --247 = 0F7h
'8',      --248 = 0F8h
'9',      --249 = 0F9h
E_FA,
E_FB,
E_FC,
E_FD,
E_FE,
E_FF);

```

```

SEL : constant EBCDIC_CHARACTER := E_4;
RNL : constant EBCDIC_CHARACTER := E_6;
GE  : constant EBCDIC_CHARACTER := E_8;
SPS : constant EBCDIC_CHARACTER := E_9;
RPT : constant EBCDIC_CHARACTER := E_A;
RES : constant EBCDIC_CHARACTER := E_4;
ENP : constant EBCDIC_CHARACTER := E_4;
POC : constant EBCDIC_CHARACTER := E_17;
UBS : constant EBCDIC_CHARACTER := E_1A;
CU1 : constant EBCDIC_CHARACTER := E_18;
IFS : constant EBCDIC_CHARACTER := E_1C;
DS  : constant EBCDIC_CHARACTER := E_20;
SOS : constant EBCDIC_CHARACTER := E_21;
WUS : constant EBCDIC_CHARACTER := E_23;
BYP : constant EBCDIC_CHARACTER := E_24;
INP : constant EBCDIC_CHARACTER := E_24;

```

```

LF      : constant EBCDIC_CHARACTER := E_25;
SA      : constant EBCDIC_CHARACTER := E_28;
SFE     : constant EBCDIC_CHARACTER := E_29;
SM      : constant EBCDIC_CHARACTER := E_2A;
SW      : constant EBCDIC_CHARACTER := E_2A;
CSP     : constant EBCDIC_CHARACTER := E_2B;
MFA     : constant EBCDIC_CHARACTER := E_2C;
IR      : constant EBCDIC_CHARACTER := E_33;
PP      : constant EBCDIC_CHARACTER := E_34;
TRN     : constant EBCDIC_CHARACTER := E_35;
NBS     : constant EBCDIC_CHARACTER := E_36;
SBS     : constant EBCDIC_CHARACTER := E_38;
IT      : constant EBCDIC_CHARACTER := E_39;
RFF     : constant EBCDIC_CHARACTER := E_3A;
CU3     : constant EBCDIC_CHARACTER := E_3B;
SP      : constant EBCDIC_CHARACTER := ' ';
RSP     : constant EBCDIC_CHARACTER := E_41;
CENT    : constant EBCDIC_CHARACTER := E_4A;
SHY     : constant EBCDIC_CHARACTER := E_4C;
HOOK    : constant EBCDIC_CHARACTER := E_4D;
FORK    : constant EBCDIC_CHARACTER := E_4E;
NSP     : constant EBCDIC_CHARACTER := E_4F;
CHAIR   : constant EBCDIC_CHARACTER := E_4F;
EO      : constant EBCDIC_CHARACTER := E_4F;
E_0     : constant EBCDIC_CHARACTER := nul;
E_1     : constant EBCDIC_CHARACTER := soh;
E_2     : constant EBCDIC_CHARACTER := stx;
E_3     : constant EBCDIC_CHARACTER := etx;
E_5     : constant EBCDIC_CHARACTER := ht;
E_7     : constant EBCDIC_CHARACTER := del;
E_B     : constant EBCDIC_CHARACTER := vt;
E_C     : constant EBCDIC_CHARACTER := np;
E_D     : constant EBCDIC_CHARACTER := cr;
E_E     : constant EBCDIC_CHARACTER := so;
E_F     : constant EBCDIC_CHARACTER := si;
E_10    : constant EBCDIC_CHARACTER := dle;
E_11    : constant EBCDIC_CHARACTER := dc1;
E_12    : constant EBCDIC_CHARACTER := dc2;
E_13    : constant EBCDIC_CHARACTER := dc3;
E_15    : constant EBCDIC_CHARACTER := nl;
E_16    : constant EBCDIC_CHARACTER := bs;
E_18    : constant EBCDIC_CHARACTER := can;
E_19    : constant EBCDIC_CHARACTER := em;
E_1D    : constant EBCDIC_CHARACTER := gs;
E_1E    : constant EBCDIC_CHARACTER := rs;
E_1F    : constant EBCDIC_CHARACTER := us;
E_22    : constant EBCDIC_CHARACTER := fs;
E_26    : constant EBCDIC_CHARACTER := etb;
E_27    : constant EBCDIC_CHARACTER := esc;
E_2D    : constant EBCDIC_CHARACTER := enq;
E_2E    : constant EBCDIC_CHARACTER := ack;
E_2F    : constant EBCDIC_CHARACTER := bel;
E_32    : constant EBCDIC_CHARACTER := syn;

```

```

E_37 : constant EBCDIC_CHARACTER := eot;
E_3C : constant EBCDIC_CHARACTER := dc4;
E_3D : constant EBCDIC_CHARACTER := nak;
E_3F : constant EBCDIC_CHARACTER := sub;
E_40 : constant EBCDIC_CHARACTER := ' ';
E_4B : constant EBCDIC_CHARACTER := '.,';
E_4C : constant EBCDIC_CHARACTER := '<';
E_4D : constant EBCDIC_CHARACTER := '(';
E_4E : constant EBCDIC_CHARACTER := '+';
E_4F : constant EBCDIC_CHARACTER := '|';
E_50 : constant EBCDIC_CHARACTER := '&';
E_5A : constant EBCDIC_CHARACTER := '!';
E_5B : constant EBCDIC_CHARACTER := '$';
E_5C : constant EBCDIC_CHARACTER := '*';
E_5D : constant EBCDIC_CHARACTER := ')';
E_5E : constant EBCDIC_CHARACTER := ',';
E_5F : constant EBCDIC_CHARACTER := '-';
E_60 : constant EBCDIC_CHARACTER := '-';
E_61 : constant EBCDIC_CHARACTER := '/';
E_68 : constant EBCDIC_CHARACTER := ',';
E_6C : constant EBCDIC_CHARACTER := '%';
E_6D : constant EBCDIC_CHARACTER := '_';
E_6E : constant EBCDIC_CHARACTER := '>';
E_6F : constant EBCDIC_CHARACTER := '?';
E_79 : constant EBCDIC_CHARACTER := '`';
E_7A : constant EBCDIC_CHARACTER := ':';
E_7B : constant EBCDIC_CHARACTER := '#';
E_7C : constant EBCDIC_CHARACTER := '@';
E_7D : constant EBCDIC_CHARACTER := ' ';
E_7E : constant EBCDIC_CHARACTER := '=';
E_7F : constant EBCDIC_CHARACTER := '"';
E_81 : constant EBCDIC_CHARACTER := 'a';
E_82 : constant EBCDIC_CHARACTER := 'b';
E_83 : constant EBCDIC_CHARACTER := 'c';
E_84 : constant EBCDIC_CHARACTER := 'd';
E_85 : constant EBCDIC_CHARACTER := 'e';
E_86 : constant EBCDIC_CHARACTER := 'f';
E_87 : constant EBCDIC_CHARACTER := 'g';
E_88 : constant EBCDIC_CHARACTER := 'h';
E_89 : constant EBCDIC_CHARACTER := 'i';
E_91 : constant EBCDIC_CHARACTER := 'j';
E_92 : constant EBCDIC_CHARACTER := 'k';
E_93 : constant EBCDIC_CHARACTER := 'l';
E_94 : constant EBCDIC_CHARACTER := 'm';
E_95 : constant EBCDIC_CHARACTER := 'n';
E_96 : constant EBCDIC_CHARACTER := 'o';
E_97 : constant EBCDIC_CHARACTER := 'p';
E_98 : constant EBCDIC_CHARACTER := 'q';
E_99 : constant EBCDIC_CHARACTER := 'r';
E_A1 : constant EBCDIC_CHARACTER := 's';
E_A2 : constant EBCDIC_CHARACTER := 's';
E_A3 : constant EBCDIC_CHARACTER := 't';
E_A4 : constant EBCDIC_CHARACTER := 'u';

```

```

E_A5 : constant EBCDIC_CHARACTER := 'v';
E_A6 : constant EBCDIC_CHARACTER := 'w';
E_A7 : constant EBCDIC_CHARACTER := 'x';
E_A8 : constant EBCDIC_CHARACTER := 'y';
E_A9 : constant EBCDIC_CHARACTER := 'z';
E_AD : constant EBCDIC_CHARACTER := '[';
E_BD : constant EBCDIC_CHARACTER := ']';
E_C0 : constant EBCDIC_CHARACTER := '<';
E_C1 : constant EBCDIC_CHARACTER := 'A';
E_C2 : constant EBCDIC_CHARACTER := 'B';
E_C3 : constant EBCDIC_CHARACTER := 'C';
E_C4 : constant EBCDIC_CHARACTER := 'D';
E_C5 : constant EBCDIC_CHARACTER := 'E';
E_C6 : constant EBCDIC_CHARACTER := 'F';
E_C7 : constant EBCDIC_CHARACTER := 'G';
E_C8 : constant EBCDIC_CHARACTER := 'H';
E_C9 : constant EBCDIC_CHARACTER := 'I';
E_D0 : constant EBCDIC_CHARACTER := ')';
E_D1 : constant EBCDIC_CHARACTER := 'J';
E_D2 : constant EBCDIC_CHARACTER := 'K';
E_D3 : constant EBCDIC_CHARACTER := 'L';
E_D4 : constant EBCDIC_CHARACTER := 'M';
E_D5 : constant EBCDIC_CHARACTER := 'N';
E_D6 : constant EBCDIC_CHARACTER := 'O';
E_D7 : constant EBCDIC_CHARACTER := 'P';
E_D8 : constant EBCDIC_CHARACTER := 'Q';
E_D9 : constant EBCDIC_CHARACTER := 'R';
E_E0 : constant EBCDIC_CHARACTER := '\';
E_E2 : constant EBCDIC_CHARACTER := 'S';
E_E3 : constant EBCDIC_CHARACTER := 'T';
E_E4 : constant EBCDIC_CHARACTER := 'U';
E_E5 : constant EBCDIC_CHARACTER := 'V';
E_E6 : constant EBCDIC_CHARACTER := 'W';
E_E7 : constant EBCDIC_CHARACTER := 'X';
E_E8 : constant EBCDIC_CHARACTER := 'Y';
E_E9 : constant EBCDIC_CHARACTER := 'Z';
E_F0 : constant EBCDIC_CHARACTER := '0';
E_F1 : constant EBCDIC_CHARACTER := '1';
E_F2 : constant EBCDIC_CHARACTER := '2';
E_F3 : constant EBCDIC_CHARACTER := '3';
E_F4 : constant EBCDIC_CHARACTER := '4';
E_F5 : constant EBCDIC_CHARACTER := '5';
E_F6 : constant EBCDIC_CHARACTER := '6';
E_F7 : constant EBCDIC_CHARACTER := '7';
E_F8 : constant EBCDIC_CHARACTER := '8';
E_F9 : constant EBCDIC_CHARACTER := '9';

```

```

type EBCDIC_STRING is array (POSITIVE range <>) of EBCDIC_CHARACTER;

```

```

function ASCII_TO_EBCDIC (S : STRING) return EBCDIC_STRING;
function ASCII_TO_EBCDIC (C : CHARACTER) return EBCDIC_CHARACTER;

```

```

-- CONSTRAINT_ERROR is raised if E_STRING'LENGTH /= A_STRING'LENGTH;
procedure ASCII_TO_EBCDIC (A_STRING : in STRING;
                          E_STRING : out EBCDIC_STRING);

function EBCDIC_TO_ASCII (S : EBCDIC_STRING) return STRING;
function EBCDIC_TO_ASCII (C : EBCDIC_CHARACTER) return CHARACTER;

-- CONSTRAINT_ERROR is raised if E_STRING'LENGTH /= A_STRING'LENGTH;
procedure EBCDIC_TO_ASCII (E_STRING : in EBCDIC_STRING;
                          A_STRING : out STRING);

end EBCDIC;

```

EBCDIC_CHARACTER

The type `EBCDIC_CHARACTER` provides an Ada character type [3.5.2] following the EBCDIC character set encoding.

EBCDIC_STRING

The type `EBCDIC_STRING` provides a one dimensional array of the type `EBCDIC_CHARACTER`, indexed by values of the predefined type `POSITIVE`.

`EBCDIC_STRING` implements strings of `EBCDIC_CHARACTER` in the same way that the predefined type `STRING` implements strings of the predefined type `CHARACTER`.

In many ways `EBCDIC_STRING`s may be manipulated exactly as the predefined type `STRING`; in particular, string literals and catenations are available.

ASCII_TO_EBCDIC

The subprograms `ASCII_TO_EBCDIC` convert ASCII encoded data to EBCDIC encoded data.

EBCDIC_TO_ASCII

The subprograms `EBCDIC_TO_ASCII` convert EBCDIC encoded data to ASCII encoded data.

The procedures `ASCII_TO_EBCDIC` and `EBCDIC_TO_ASCII` are much more efficient than the corresponding functions, as they do not make use of the program heap. If the in and out string parameters are of different lengths (i.e. `A_STRING'LENGTH /= E_STRING'LENGTH`), the procedures will raise the exception `CONSTRAINT_ERROR`.

The user may alter the ASCII to EBCDIC and EBCDIC to ASCII mappings used by the Alsys IBM 370 Ada compiler, as described in the *Installation Guides*.

10.5.2 Package SYSTEM_ENVIRONMENT

The implementation-defined package SYSTEM_ENVIRONMENT enables an Ada program to communicate with the environment in which it is executed.

The specification of package SYSTEM_ENVIRONMENT is as follows:

```
package SYSTEM_ENVIRONMENT is

    MVS : constant BOOLEAN := boolean_value;

    subtype EXIT_STATUS is INTEGER;
    type STACK_MODE is (LIFO, FIFO);

    function ARG_LINE return STRING;
    function ARG_LINE_LENGTH return NATURAL;
    procedure ARG_LINE (LINE : out STRING;
                       LAST : out NATURAL);
    function ARG_START return NATURAL;
    function ARG_COUNT return NATURAL;
    function ARG_VALUE (INDEX : in POSITIVE) return STRING;

    ARGUMENT_ERROR : exception;

    procedure SET_EXIT_STATUS (STATUS : in EXIT_STATUS);
    function GET_EXIT_STATUS return EXIT_STATUS;

    function EXECUTE_COMMAND (COMMAND : in STRING) return EXIT_STATUS;
    procedure EXECUTE_COMMAND (COMMAND : in STRING);

    procedure STACK (COMMAND : in STRING;
                   MODE : in STACK_MODE := LIFO);
    function SENTRIES return NATURAL;

    procedure ABORT_PROGRAM (STATUS : in EXIT_STATUS);

    function SYSTIME return DURATION;
    function USRTIME return DURATION;

    function EXISTS (FILE : in STRING) return BOOLEAN;

    function LAST_EXCEPTION_NAME return STRING;

end SYSTEM_ENVIRONMENT;
```

MVS

The MVS boolean provides a convenient way for a user to query at run time whether a program is running under MVS or VM/CMS. This facility allows for the conditional execution of operating system specific code.

The boolean constant has the value `TRUE` under MVS and `FALSE` under VM/CMS.

ARG_LINE

The `ARG_LINE` subprograms give access to the CMS command line, the TSO command line parameters or the program `PARM` string as specified in the JCL used to run an MVS program.

The procedure `ARG_LINE` is more efficient than the corresponding function, as it does not make use of the program heap. The out parameter `LAST` specifies the character in `LINE` which holds the last character of the command line. Note, if `LINE` is not long enough to hold the command line given, `CONSTRAINT_ERROR` will be raised.

Under CMS the command line returned includes the name of the program executed, but not any run-time options specified.

Under MVS the name of the program executed is not available, but any run-time options specified are excluded, as under CMS.

ARG_START

The function `ARG_START` returns the index in the command line of the first parameter, i.e. ignoring the executed program name, for CMS; for MVS it always returns the value 1.

ARG_COUNT

The function `ARG_COUNT` returns the number of parameters in the command line of the program. The executed program name which is part of the command line as returned by `ARG_LINE` under CMS is not included in the count. Thus, `ARG_COUNT` for a program without parameters returns zero under both CMS and MVS.

ARG_VALUE

The function `ARG_VALUE` returns the specified parameter from the command line. Parameters are considered to be indexed from 1. The executed program name which is part of the command line as returned by `ARG_LINE` under CMS is not considered as a parameter, i.e. `ARG_VALUE(1)` returns the first user parameter. The exception `ARGUMENT_ERROR` is raised if the specified index is greater than `ARG_COUNT`.

SET_EXIT_STATUS

The exit status of the program (returned in register 15 on exit) can be set by a call of SET_EXIT_STATUS. Subsequent calls of SET_EXIT_STATUS will modify the exit status; the status finally returned being that specified by the last executed call to SET_EXIT_STATUS. If SET_EXIT_STATUS is not called, a positive exit code may be set by the Ada Run-Time Executive if an unhandled exception is propagated out of the main subprogram, or if a deadlock situation is detected, otherwise the value 0 is returned.

The following exit codes relate to unhandled exceptions:

Exception	Code	Cause of exception
NUMERIC_ERROR:	1	divide by zero
	2	numeric overflow
CONSTRAINT_ERROR:	3	discriminant error
	4	lower bound index error
	5	upper bound index error
	6	length error
	7	lower bound range error
	8	upper bound range error
	9	null access value
STORAGE_ERROR:	10	frame overflow (overflow on subprogram entry)
	11	stack overflow (overflow otherwise)
	12	heap overflow
PROGRAM_ERROR:	13	access before elaboration
	14	function left without return
SPURIOUS_ERROR:	15-20	<an erroneous program>
NUMERIC_ERROR	21	(other than for the above reasons)
CONSTRAINT_ERROR	22	(other than for the above reasons)
	23	anonymously raised exception (an exception re-raised using the raise statement without an exception name)
	24	<unused>
	25	static exception (an exception raised using the raise statement with an exception name)

Code 100 is used if a deadlocking situation is detected and the program is aborted as a result.

Codes 1000-1999 are used to indicate other anomalous conditions in the initialisation of the program, messages concerning which are displayed on the terminal.

GET_EXIT_STATUS

The function GET_EXIT_STATUS returns the current exit status.

EXECUTE_COMMAND

Under CMS the EXECUTE_COMMAND subprograms with a non-null parameter execute the given CMS SUBSET command. The result of the EXECUTE_COMMAND function is the return code of the command. If a null string is given as the parameter, the program exits to the CMS subset level. This allows CMS SUBSET commands to be executed directly. Issuing the command RETURN from the CMS subset level will return to the Ada program. The return code of the EXECUTE_COMMAND function with a null COMMAND string is always zero.

Under MVS a call of the EXECUTE_COMMAND subprograms has no effect and the function always returns the value zero.

STACK

Under CMS the STACK procedure allows a command to be placed on the console stack: either last-in-first-out (LIFO) or first-in-first-out (FIFO).

Under MVS a call of the STACK procedure has no effect.

SENTRIES

Under CMS, the SENTRIES function returns the number of lines in the program stack.

Under MVS calls to the SENTRIES function always return the value 0.

ABORT_PROGRAM

The program may be aborted, returning the specified exit code, by a call of the ABORT_PROGRAM procedure.

SYSTIME, USRTIME

Under CMS the SYSTIME and USRTIME functions allow access to the amount of system and user time, respectively, used by the program since its execution.

Under MVS a call of either of these functions has no effect and returns the value 0.0.

EXISTS

The EXISTS function returns a boolean to indicate whether the file specified by the file name string exists or not.

LAST_EXCEPTION_NAME

The function LAST_EXCEPTION_NAME returns the name of the most recently raised exception in the current task. It may be used in handlers to identify the exception, e.g.:

```
...
when others =>
    TEXT_IO.PUT (SYSTEM_ENVIRONMENT.LAST_EXCEPTION_NAME);
    TEXT_IO.PUT_LINE (" raised");
```

10.5.3 Package RECORD_IO

The implementation-defined package RECORD_IO enables an Ada program to perform simple, record oriented I/O of an anonymous data type in an efficient manner.

RECORD_IO provides similar facilities to the predefined packages SEQUENTIAL_IO and DIRECT_IO in a non-generic form. The package is therefore "typeless": the data on which I/O is being performed being specified via its address and length. It is the programmer's responsibility to see that the data manipulated by the facilities of RECORD_IO is handled in a consistent manner.

The specification of package RECORD_IO is as follows:

```
with SYSTEM, IO_EXCEPTIONS;
package RECORD_IO is

    --          *****
    --          * TYPES *
    --          *****

    type COUNT is range 0..INTEGER'LAST;
    subtype POSITIVE_COUNT is COUNT range 1..COUNT'LAST;

    type FILE_TYPE is limited private;

    type FILE_MODE is (IN_FILE, INOUT_FILE, OUT_FILE);
    type FILE_ORGANISATION is (SEQUENTIAL, DIRECT);

    --          *****
    --          * FILE MANAGEMENT *
    --          *****

    procedure CREATE (FILE           : in out FILE_TYPE;
                     MODE            : in FILE_MODE := OUT_FILE;
                     NAME            : in STRING := "";
                     FORM            : in STRING := "";
                     ORGANISATION    : in FILE_ORGANISATION := SEQUENTIAL;
                     TRANSLATE      : in BOOLEAN := FALSE);
```

```

procedure OPEN (FILE      : in out FILE_TYPE;
               MODE      : in FILE_MODE;
               NAME      : in STRING;
               FORM      : in STRING := "";
               ORGANISATION : in FILE_ORGANISATION := SEQUENTIAL;
               TRANSLATE  : in BOOLEAN := FALSE);

procedure CLOSE (FILE : in out FILE_TYPE);
procedure DELETE (FILE : in out FILE_TYPE);
procedure RESET (FILE : in out FILE_TYPE;
               MODE : in FILE_MODE);
procedure RESET (FILE : in out FILE_TYPE);

function MODE (FILE : in FILE_TYPE) return FILE_MODE;
function NAME (FILE : in FILE_TYPE) return STRING;
function FORM (FILE : in FILE_TYPE) return STRING;

function IS_OPEN (FILE : in FILE_TYPE) return BOOLEAN;

--          *****
--          * INPUT / OUTPUT *
--          *****

procedure READ (FILE  : in FILE_TYPE;
               ITEM   : in SYSTEM.ADDRESS;
               LENGTH : in out NATURAL);

-- Only for DIRECT organisation files
procedure READ (FILE  : in FILE_TYPE;
               ITEM   : in SYSTEM.ADDRESS;
               LENGTH : in out NATURAL;
               FROM   : in POSITIVE_COUNT);

procedure WRITE (FILE  : in FILE_TYPE;
               ITEM   : in SYSTEM.ADDRESS;
               LENGTH : in NATURAL);

-- Only for DIRECT organisation files
procedure WRITE (FILE  : in FILE_TYPE;
               ITEM   : in SYSTEM.ADDRESS;
               LENGTH : in NATURAL;
               TO     : in POSITIVE_COUNT);

function END_OF_FILE (FILE : in FILE_TYPE) return BOOLEAN;

-- Only for DIRECT organisation files
procedure SET_INDEX (FILE : in FILE_TYPE;
                   TO   : in POSITIVE_COUNT);
function INDEX (FILE : in FILE_TYPE) return POSITIVE_COUNT;
function SIZE (FILE : in FILE_TYPE) return COUNT;

```

```

--          *****
--          * EXCEPTIONS *
--          *****

STATUS_ERROR : exception renames IO_EXCEPTIONS.STATUS_ERROR;
MODE_ERROR   : exception renames IO_EXCEPTIONS.MODE_ERROR;
NAME_ERROR   : exception renames IO_EXCEPTIONS.NAME_ERROR;
USE_ERROR    : exception renames IO_EXCEPTIONS.USE_ERROR;
DEVICE_ERROR : exception renames IO_EXCEPTIONS.DEVICE_ERROR;
END_ERROR    : exception renames IO_EXCEPTIONS.END_ERROR;
DATA_ERROR   : exception renames IO_EXCEPTIONS.DATA_ERROR;

private
.
.
.
end RECORD_IO;

```

The specification of `RECORD_IO` is similar to that of the predefined generic packages `SEQUENTIAL_IO` and `DIRECT_IO`. The file management facilities provided are analogous, with `CREATE`, `OPEN`, `CLOSE`, `DELETE` and `RESET` procedures, in addition to `MODE`, `NAME`, `FORM` and `IS_OPEN` functions as in the predefined packages. The syntax and semantics of file names and form strings are identical to those of the predefined packages, as described in section 8 of this appendix. The `CREATE` and `OPEN` procedures take two additional parameters, as below:

■ ORGANISATION

The `ORGANISATION` parameter specifies the organisation of the file being created or opened. Two types of organisations may be specified:

SEQUENTIAL

Sequential organised files correspond to files that could be created via an instantiation of the generic package `SEQUENTIAL_IO`. Records in a sequential organisation file are variable length according to the length data written to them. A sequential organisation file is implemented as a QSAM file under MVS.

A sequential organised file must be written and read sequentially. An attempt to pass a `FILE_TYPE` value representing a sequential organised file to the `READ` or `WRITE` procedures with an explicit specification of the file record to be read or written (`FROM` or `TO` parameters), or to use those subprograms which directly manipulate the file index (`SET_INDEX`, etc.) will raise `USE_ERROR`.

DIRECT

Direct organised files correspond to files that could be created via an instantiation of the generic package `DIRECT_IO`. Records in a direct organisation file are fixed length according to the *record_length* form parameter, which the user must specify when creating a direct organisation file. Failure to specify the *record_length* form parameter on creating a direct organisation file will raise `USE_ERROR`, since there is no Ada type associated with the file to whose size the record length may default. A direct organisation file is implemented as a BDAM file under MVS.

■ TRANSLATE

The `TRANSLATE` parameter specifies whether ASCII to EBCDIC translation is to be performed on the data on output and whether EBCDIC to ASCII translation is to be correspondingly performed on input.

Use of the `TRANSLATE` parameter allows records of the external file to hold character data in an appropriate form for manipulation by other 370 tools expecting EBCDIC encoded character data.

The input output facilities themselves are represented by overloaded `READ` and `WRITE` procedures.

These procedures are analogous to those of `SEQUENTIAL_IO` and `DIRECT_IO`. The data is specified via its address (`ITEM`) and length (`LENGTH`).

The external file is characterised by its `RECFM` and `LRECL` attributes. These may be explicitly controlled via the `FORM` parameter (see section 8.2) or else default as below:

<u>Organisation</u>	<u>Attribute</u>	<u>Default</u>
Sequential	<code>RECFM</code>	V
	<code>LRECL</code>	4096
Direct	<code>RECFM</code>	F
	<code>LRECL</code>	No default

On output, `LENGTH` bytes of data are written to the appropriate record of the file from the address specified. If the `LENGTH` specified is greater than `LRECL` then `DATA_ERROR` is raised. If the `LENGTH` specified is less than `LRECL` and `RECFM` is F then the data is written at the start of the record. The remaining portion of the record will contain EBCDIC space characters (i.e. bytes whose value is 16#40#). If the `LENGTH` specified is less than `LRECL` and `RECFM` is V then a record of exactly `LENGTH` bytes is written, the `LRECL` specifying the maximum permissible record length.

On input, the appropriate record of the file is read at the address specified. If the length of the appropriate record of the file is less than LENGTH bytes, the entire record is read and the actual record length returned in LENGTH. If the length of the appropriate record of the file is greater than LENGTH bytes then DATA_ERROR is raised. Note that for a direct organisation file the uninitialised portion of the record is considered to be part of the record length on input. It is the programmer's responsibility to read and write records via the facilities of RECORD_IO in a consistent manner.

READ and WRITE procedures with explicit specification of the file record to be read or written (FROM and TO parameters) are only applicable to files opened or created with direct organisation. Application of these procedures to a sequential organisation file will raise USE_ERROR.

The remaining input output facilities are analogous to the corresponding subprograms in SEQUENTIAL_IO or DIRECT_IO, with END_OF_FILE, SET_INDEX, INDEX and SIZE subprograms. END_OF_FILE is applicable to both sequential and direct organisation files. The remainder, however, are only supported for files opened or created with direct organisation. Application of these procedures to a sequential organisation file will raise USE_ERROR.

All other exceptional conditions raise the corresponding exceptions to those of the predefined I/O packages.

10.5.4 Package STRINGS

The implementation-defined package STRINGS is a utility package providing the user with many commonly required string manipulation facilities.

The specification of package STRINGS is as follows:

```
with UNCHECKED_DEALLOCATION;
package STRINGS is

  --          *****
  --          * TYPES *
  --          *****

  type ACCESS_STRING is access STRING;
  procedure DEALLOCATE_STRING is new UNCHECKED_DEALLOCATION (STRING,
                                                             ACCESS_STRING);

  --          *****
  --          * UTILITIES *
  --          *****

  function UPPER (C : in CHARACTER) return CHARACTER;
  function UPPER (S : in STRING) return STRING;
  procedure UPPER (S : in out STRING);

  function LOWER (C : in CHARACTER) return CHARACTER;
  function LOWER (S : in STRING) return STRING;
```

```

procedure LOWER (S : in out STRING);

function CAPITAL (S : in STRING) return STRING;
procedure CAPITAL (S : in out STRING);

function REMOVE_LEADING_BLANKS (S : in STRING) return STRING;
function REMOVE_TRAILING_BLANKS (S : in STRING) return STRING;
function TRIM (S : in STRING) return STRING;

function INDEX (C      : in CHARACTER;
                INTO   : in STRING;
                START  : in POSITIVE := 1) return NATURAL;
function INDEX (S      : in STRING;
                INTO   : in STRING;
                START  : in POSITIVE := 1) return NATURAL;

function NOT_INDEX (C      : in CHARACTER;
                   INTO   : in STRING;
                   START  : in POSITIVE := 1) return NATURAL;
function NOT_INDEX (S      : in STRING;
                   INTO   : in STRING;
                   START  : in POSITIVE := 1) return NATURAL;

function IS_AN_ABBREV (ABBREV      : in STRING;
                      FULL_WORD   : in STRING;
                      IGNORE_CASE : in BOOLEAN := TRUE) return BOOLEAN;

function MATCH_PATTERN (S          : in STRING;
                       PATTERN    : in STRING;
                       IGNORE_CASE : in BOOLEAN := TRUE) return BOOLEAN;

function '&' (LEFT : in STRING; RIGHT : in STRING) return STRING;
function '&' (LEFT : in STRING; RIGHT : in CHARACTER) return STRING;
function '&' (LEFT : in CHARACTER; RIGHT : in STRING) return STRING;
function '&' (LEFT : in CHARACTER; RIGHT : in CHARACTER) return STRING;

end STRINGS;

```

ACCESS_STRING

The `ACCESS_STRING` type is a convenient declaration of the commonly used access to string type.

DEALLOCATE_STRING

The **DEALLOCATE_STRING** procedure is an instantiation of **UNCHECKED_DEALLOCATION** for the type **ACCESS_STRING**. Note that since the type **ACCESS_STRING** is declared at the library level, the scope of the corresponding collection is only exited at program completion. For this reason, **STRING** objects belonging to this collection are never automatically deallocated. It is the programmer's responsibility to manage the deallocation of objects within this collection.

UPPER

The **UPPER** subprograms convert any lower case letters in their parameters to the corresponding upper case letters. Characters which are not lower case letters are unaffected. The procedure is more efficient than the corresponding function, as it does not make use of the program heap.

LOWER

The **LOWER** subprograms convert any upper case letters in their parameters to the corresponding lower case letters. Characters which are not upper case letters are unaffected. The procedure is more efficient than the corresponding function, as it does not make use of the program heap.

CAPITAL

The **CAPITAL** subprograms "capitalise" their parameters. That is they **UPPER** the first character and **LOWER** all subsequent characters of the string. The procedure is more efficient than the corresponding function, as it does not make use of the program heap.

REMOVE_LEADING_BLANKS

The **REMOVE_LEADING_BLANKS** function returns its parameter string with all leading spaces removed.

REMOVE_TRAILING_BLANKS

The **REMOVE_TRAILING_BLANKS** function returns its parameter string with all trailing spaces removed.

TRIM

The **TRIM** function returns its parameter string with all leading and all trailing spaces removed.

INDEX

The INDEX subprograms return the index into the specified string (INTO) of the first character of the first occurrence of a given substring (S) or character (C). The search for the substring or character commences at the index specified by START. If the substring or character is not found, the functions return the value 0. Case is considered significant.

NOT_INDEX

The NOT_INDEX subprograms return the index into the specified string (INTO) of the first character which does not occur in the given string (S) or does not match the given character (C). The search for the non-matching character commences at the index specified by START. If all the characters of the string match, the functions return the value 0. Case is considered significant.

IS_AN_ABBREV

The IS_AN_ABBREV function determines whether the string ABBREV is an abbreviation for the string FULL_WORD. Leading and trailing spaces in ABBREV are first removed and the trimmed string is then considered to be an abbreviation for FULL_WORD if it is a proper prefix of FULL_WORD.

The parameter IGNORE_CASE controls whether case is considered significant or not.

MATCH_PATTERN

The MATCH_PATTERN function determines whether the string S matches the pattern specified in PATTERN. A pattern is simply a string in which the character '*' is considered a wild-card which can match any number of any characters.

For example the string "ABCDEFGH" is considered to match the pattern "A*G" and the pattern "ABCD*EFG*"

The parameter IGNORE_CASE controls whether case is considered significant or not.

The package STRINGS also provides overloaded subprograms designated by '&'. These are identical to the corresponding subprograms declared in package STANDARD, except that the concatenations are performed out of line. By performing concatenations out of line the size of the inline generated code is minimised at the expense of execution speed.

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APPENDIX CTEST PARAMETERS

Certain tests in the ACVC make use of implementation-dependent values, such as the maximum length of an input line and invalid file names. A test that makes use of such values is identified by the extension .TST in its file name. Actual values to be substituted are represented by names that begin with a dollar sign. A value must be substituted for each of these names before the test is run. The values used for this validation are given below.

MACRO DEFINITIONS

<u>Name and Meaning</u>	<u>Value</u>
\$ACC_SIZE An integer literal whose value is the number of bits sufficient to hold any value of an access type.	32
\$BIG_ID1 Identifier the size of the maximum input line length with varying last character.	(1..254=>'A', 255=>1)
\$BIG_ID2 Identifier the size of the maximum input line length with varying last character.	(1..254=>'A', 255=>2)
\$BIG_ID3 Identifier the size of the maximum input line length with varying middle character.	(1..127=>'A', 128=>3, 129..255=>'A')
\$BIG_ID4 Identifier the size of the maximum input line length with varying middle character.	(1..127=>'A', 128=>4, 129..255=>'A')
\$BIG_INT_LIT	(1..252=>0,

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<u>Name and Meaning</u>	<u>Value</u>
An integer literal of value 298 with enough leading zeroes so that it is the size of the maximum line length	253..255=>298)
\$BIG_REAL_LIT A universal real literal of value 690.0 with enough leading zeroes to be the size of the maximum line length.	(1..249=>0, 250..255=>69.0E1)
\$BIG_STRING1 A string literal which when catenated with BIG_STRING2 yields the image of BIG_ID1.	(1..127=>'A')
\$BIG_STRING2 A string literal which when catenated to the end of BIG_STRING1 yields the image of BIG_ID1.	(1..127=>'A', 128=>1)
\$BLANKS A sequence of blanks twenty characters less than the size of the maximum line length.	(1..235=>' ')
\$COUNT_LAST A universal integer literal whose value is TEXT_IO.COUNT'LAST.	2147483647
\$DEFAULT_MEM_SIZE An integer literal whose value is SYSTEM.MEMORY_SIZE.	2147483647
\$DEFAULT_STOR_UNIT An integer literal whose value is SYSTEM.STORAGE_UNIT.	8
\$DEFAULT_SYS_NAME The value of the constant SYSTEM.SYSTEM_NAME.	IBM_370
\$DELTA_DOC A real literal whose value is SYSTEM.FINE_DELTA.	2#1.0#E-31

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<u>Name and Meaning</u>	<u>Value</u>
\$FIELD_LAST A universal integer literal whose value is TEXT_IO.FIELD'LAST.	255
\$FIXED_NAME The name of a predefined fixed-point type other than DURATION.	NO_SUCH_TYPE
\$FLOAT_NAME The name of a predefined floating-point type other than FLOAT, SHORT_FLOAT, or LONG_FLOAT.	NO_SUCH_TYPE
\$GREATER_THAN_DURATION A universal real literal that lies between DURATION'BASE'LAST and DURATION'LAST or any value in the range of DURATION.	100000.0
\$GREATER_THAN_DURATION_BASE_LAST A universal real literal that is greater than DURATION'BASE'LAST.	10000000.0
\$HIGH_PRIORITY An integer literal whose value is the upper bound of the range for the subtype SYSTEM.PRIORITY.	10
\$ILLEGAL_EXTERNAL_FILE_NAME1 An external file name which contains invalid characters.	T??????? LISTING A1
\$ILLEGAL_EXTERNAL_FILE_NAME2 An external file name which is too long.	TOOLONGNAME TOOLONGTYPE TOOLONGMODE
\$INTEGER_FIRST A universal integer literal whose value is INTEGER'FIRST.	-2147483648
\$INTEGER_LAST A universal integer literal whose value is INTEGER'LAST.	2147483647

<u>Name and Meaning</u>	<u>Value</u>
\$INTEGER_LAST_PLUS_1 A universal integer literal whose value is INTEGER'LAST+1.	2147483648
\$LESS_THAN_DURATION A universal real literal that lies between DURATION'BASE'FIRST and DURATION'FIRST or any value in the range of DURATION.	-100000.0
\$LESS_THAN_DURATION_BASE_FIRST A universal real literal that is less than DURATION'BASE'FIRST.	-100000000.0
\$LOW_PRIORITY An integer literal whose value is the lower bound of the range for the subtype SYSTEM.PRIORITY.	1
\$MANTISSA_DOC An integer literal whose value is SYSTEM.MAX_MANTISSA.	31
\$MAX_DIGITS Maximum digits supported for floating-point types.	18
\$MAX_IN_LEN Maximum input line length permitted by the implementation.	255
\$MAX_INT A universal integer literal whose value is SYSTEM.MAX_INT.	2147483647
\$MAX_INT_PLUS_1 A universal integer literal whose value is SYSTEM.MAX_INT+1.	2147483648
\$MAX_LEN_INT_BASED_LITERAL A universal integer based literal whose value is 2#11# with enough leading zeroes in the mantissa to be MAX_IN_LEN long.	(1..2=>'2:', 3..252=>'0', 253..255=>'11:')

APPENDIX C

<u>Name and Meaning</u>	<u>Value</u>
\$MAX_LEN_REAL_BASED_LITERAL A universal real based literal whose value is 1e:F.E: with enough leading zeroes in the mantissa to be MAX_IN_LEN long.	(1..3=>'16:', 4..251=>'0', 252..255=>'F.E:')
\$MAX_STRING_LITERAL A string literal of size MAX_IN_LEN, including the quote characters.	(1=>'"', 2..254=>'A', 255=>'")
\$MIN_INT A universal integer literal whose value is SYSTEM.MIN_INT.	-2147483648
\$MIN_TASK_SIZE An integer literal whose value is the number of bits required to hold a task object which has no entries, no declarations, and "NULL;" as the only statement in its body.	32
\$NAME A name of a predefined numeric type other than FLOAT, INTEGER, SHORT_FLOAT, SHORT_INTEGER, LONG_FLOAT, or LONG_INTEGER.	SHORT_SHORT_INTEGER
\$NAME_LIST A list of enumeration literals in the type SYSTEM.NAME, separated by commas.	IBM_370
\$NEG_BASED_INT A based integer literal whose highest order nonzero bit falls in the sign bit position of the representation for SYSTEM.MAX_INT.	16#FFFFFFFF#
\$NEW_MEM_SIZE An integer literal whose value is a permitted argument for pragma memory_size, other than \$DEFAULT_MEM_SIZE. If there is no other value, then use \$DEFAULT_MEM_SIZE.	2147483647

<u>Name and Meaning</u>	<u>Value</u>
\$NEW_STOR_UNIT An integer literal whose value is a permitted argument for pragma storage_unit, other than \$DEFAULT_STOR_UNIT. If there is no other permitted value, then use value of SYSTEM.STORAGE_UNIT.	8
\$NEW_SYS_NAME A value of the type SYSTEM.NAME, other than \$DEFAULT_SYS_NAME. If there is only one value of that type, then use that value.	IBM_370
\$TASK_SIZE An integer literal whose value is the number of bits required to hold a task object which has a single entry with one inout parameter.	32
\$TICK A real literal whose value is SYSTEM.TICK.	0.01

APPENDIX DWITHDRAWN TESTS

Some tests are withdrawn from the ACVC because they do not conform to the Ada Standard. The following 36 tests had been withdrawn at the time of validation testing for the reasons indicated. A reference of the form AI-ddddd is to an Ada Commentary.

WITHDRAWN TEST LIST

- o A39005G This test unreasonably expects a component clause to pack an array component into a minimum size (line 30).
- o B97102E This test contains an unintended illegality: a select statement contains a null statement at the place of a selective wait alternative (line 31).
- o BC3009B This test wrongly expects that circular instantiations will be detected in several compilation units even though none of the units is illegal with respect to the units it depends on; by AI-00256, the illegality need not be detected until execution is attempted (line 95).
- o CD2A62D This test wrongly requires that an array object's size be no greater than 10 although its subtype's size was specified to be 40 (line 137).
- o CD2A63A..D, CD2A66A..D, CD2A73A..D, CD2A76A..D [16 tests]

These tests wrongly attempt to check the size of objects of a derived type (for which a 'SIZE length clause is given) by passing them to a derived subprogram (which implicitly converts them to the parent type (Ada standard 3.4:14)). Additionally, they use the 'SIZE length clause and attribute, whose interpretation is considered problematic by the WG9 ARG.

- o CD2A81G, CD2A83G, CD2A84N & M, & CD50110
These tests assume that dependent tasks will terminate while the main program executes a loop that simply tests for task termination; this is not the case, and the main program may loop indefinitely (lines 74, 85, 86 & 96, 86 & 96, and 58, respectively.)
- o CD2B15C & CD7205C
These tests expect that a 'STORAGE_SIZE length clause provides precise control over the number of designated objects in a collection; the Ada standard 13.2:15 allows that such control must not be expected.
- o CD5007B This test wrongly expects an implicitly declared subprogram to be at the address that is specified for an unrelated subprogram (line 303).
- o CD7105A This test requires that successive calls to CALENDAR.CLOCK change by at least SYSTEM.TICK; however, by Commentary AI-00201, it is only the expected frequency of change that must be at least SYSTEM.TICK--particular instances of change may be less (line 29).
- o CD72C3B & CD7204B
These tests use the 'SIZE length clause and attribute, whose interpretation is considered problematic by the WG9 ARG.
- o CD7205D This test checks an invalid test objective: it treats the specification of storage to be reserved for a task's activation as though it were like the specification of storage for a collection.
- o CE2107I This test requires that objects of two similar scalar types be distinguished when read from a file--DATA_ERROR is expected to be raised by an attempt to read one object as of the other type. However, it is not clear exactly how the Ada standard 14.2.4:4 is to be interpreted; thus, this test objective is not considered valid. (line 90)

- o CE3111C This test requires certain behaviour, when two files are associated with the same external file, that is not required by the Ada standard.
- o CE3301A This test contains several calls to END_OF_LINE & END_OF_PAGE that have no parameter: these calls were intended to specify a file, not to refer to STANDARD_INPUT (lines 103, 107, 118, 132, & 136).
- o CE3411B This test requires that a text file's column number be set to COUNT'LAST in order to check that LAYOUT_ERROR is raised by a subsequent PUT operation. But the former operation will generally raise an exception due to a lack of available disk space, and the test would thus encumber validation testing.