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AVF Control Number: NIST92DDI510 1 1.11 DATE COMPLETED BEFORE ON-SITE: 92-07-24 AFTER ON-SITE: 92-10-06 **REVISIONS:** 

Ada COMPILER VALIDATION SUMMARY REPORT: Certificate Number: 92080551.11263 DDC-I, Inc. DACS MIPS RISC/os to MIPS R3000 Bare Ada Cross Compiler System, Release 2.1-16 MIPS M/120-5 => Lockheed Sanders STAR MVP R3000/R3010 Board

> Prepared By: Software Standards Validation Group National Computer Systems Laboratory National Institute of Standards and Technology Building 225, Room A266 Gaithersburg, Maryland 20899

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AVF Control Number: NIST92DDI510\_1\_1.11

Certificate Information

The following Ada implementation was tested and determined to pass ACVC 1.11. Testing was completed on August 05, 1992.

Compiler Name and Version:	DACS MIPS RISC/os to MIPS R3000 Bare Ada Cross Compiler System, Release 2.1-16
Host Computer System:	MIPS M/120-5 under RISC/os Version 4.50
Target Computer System:	Lockheed Sanders STAR MVP R3000/R3010 Board (bare machine)

See section 3.1 for any additional information about the testing environment.

As a result of this validation effort, Validation Certificate 920805S1.11263 is awarded to DDC-I, Inc. This certificate expires 2 years after ANSI/MIL-STD-1815B is approved by ANSI.

This report has been reviewed and is approved.

Ada Validation Haci

Chief, Information Systems

Engineering Division (ISED)

Dr. David K. Jefferson

5 Church Thum

Ada Validation Facility Mr. L. Arnold Johnson Manager, Software Standards Validation Group aboratory (CLS)

Computer Systems Laboratory (CLS) National Institute of Standards and Technology Building 225, Room A266 Gaithersburg, MD 20899

Ada Validation Organization Directory Computer & Software Engineering Division Institute for Defense Analyses Alexandria VA 22311

Ada Joint Program Office Dr. John Solomond Director Department of Defense Washington DC 20301

## DECLARATION OF CONFORMANCE

The following declaration of conformance was supplied by the customer.

Customer: DDC-I, Inc.

Certificate Awardee: DDC-I, Inc.

Ada Validation Facility: National Institute of Standards and Technology Computer Systems Laboratory (CSL) Software Validation Group Building 225, Room A266 Gaithersburg, Maryland 20899

ACVC Version: 1.11

Ada Implementation:

Compiler Name and Version: DACS MIPS RISC/os to MIPS R3000 Bare Ada Cross Compiler System, Release 2.1-16

Host Computer System: MIPS M/120-5 under RISC/os Version 4.50

Target Computer System:

Lockheed Sanders STAR MVP R3000/R3010 Board (bare machine)

Declaration:

I the undersigned, declare that I have no knowledge of deliberate deviations from the Ada Language Standard ANSI/MIL-STD-1815A ISO 8652-1987 in the implementation listed above.

Customer Signature

Company DDC-I, Inc. Title: President

aul

Certificate Awardee Signature Company DDC-I, Inc. Title: President

Ung 6 1992 Date

11.96,1992 Date

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## CHAPTER 1

#### INTRODUCTION

The Ada implementation described above was tested according to the Ada Validation Procedures [Pro90] against the Ada Standard [Ada83] using the current Ada Compiler Validation Capability (ACVC). This Validation Summary Report (VSR) gives an account of the testing of this Ada implementation. For any technical terms used in this report, the reader is referred to [Pro90]. A detailed description of the ACVC may be found in the current ACVC User's Guide [UG89].

## 1.1 USE OF THIS VALIDATION SUMMARY REPORT

Consistent with the national laws of the originating country, the Ada Certification Body 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 implementation has no nonconformities to the Ada Standard other than those presented. Copies of this report are available to the public from the AVF which performed this validation or from:

> National Technical Information Service 5285 Port Royal Road Springfield VA 22161

Questions regarding this report or the validation test results should be directed to the AVF which performed this validation or to:

> Ada Validation Organization Computer and Software Engineering Division Institute for Defense Analyses 1801 North Beauregard Street Alexandria VA 22311-1772

### **1.2 REFERENCES**

[Ada83] <u>Reference Manual for the Ada Programming Language</u>, ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987. [Pro90] <u>Ada Compiler Validation Procedures</u>, Version 2.1, Ada Joint Program Office, August 1990.

[UG89] <u>Ada Compiler Validation Capability User's Guide</u>, 21 June 1989.

## 1.3 ACVC TEST CLASSES

Compliance of Ada implementations is tested by means of the ACVC. The ACVC contains a collection of test 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. Class B and class L tests are expected to produce errors at compile time and link time, respectively.

The executable tests are written in a self-checking manner and produce a PASSED, FAILED, or NOT APPLICABLE message indicating the result when they are executed. Three Ada library units, the packages REPORT and SPPRT13, and the procedure CHECK\_FILE are used for this purpose. The package REPORT 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 package SPPRT13 is used by many tests for Chapter 13 of the Ada Standard. 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. If these units are not operating correctly, validation testing is discontinued.

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 all violations of the Ada Standard are detected. Some of the class B tests contain legal Ada code which must not be flagged illegal by the compiler. This behavior is also verified.

Class L tests check that an Ada implementation correctly detects violation of the Ada Standard involving multiple, separately compiled units. Errors are expected at link time, and execution is attempted.

In some tests of the ACVC, certain macro strings have to be replaced by implementation-specific values -- for example, the largest integer. A list of the values used for this implementation is provided in Appendix A. In addition to these anticipated test modifications, additional changes may be required to remove unforeseen conflicts between the tests and implementation-dependent characteristics. The modifications required for this implementation are described in section 2.3. For each Ada implementation, a customized test suite is produced by the AVF. This customization consists of making the modifications described in the preceding paragraph, removing withdrawn tests (see section 2.1) and, possibly some inapplicable tests (see Section 3.2 and [UG89]).

In order to pass an ACVC an Ada implementation must process each test of the customized test suite according to the Ada Standard.

## 1.4 DEFINITION OF TERMS

Ada Compiler The software and any needed hardware that have to be added to a given host and target computer system to allow transformation of Ada programs into executable form and execution thereof.

Ada CompilerThe means for testing compliance of AdaValidationimplementations, Validation consisting of theCapabilitytest suite, the support programs, the ACVC(ACVC)Capability user's guide and the template for<br/>the validation summary (ACVC) report.

Ada An Ada compiler with its host computer system and Implementation its target computer system.

Ada Joint The part of the certification body which provides Program policy and guidance for the Ada certification Office (AJPO) system.

Ada The part of the certification body which carries Validation out the procedures required to establish the Facility (AVF) compliance of an Ada implementation.

Ada The part of the certification body that provides Validation technical guidance for operations of the Ada Organization certification system. (AVO)

Compliance of The ability of the implementation to pass an ACVC an Ada version. Implementation

Computer A functional unit, consisting of one or more System computers and associated software, that uses common storage for all or part of a program and also for all or part of the data necessary for the execution of the program; executes user-written or user-designated programs; performs user-designated data manipulation, including arithmetic operations and logic operations; and that can execute programs that modify themselves during execution. A computer system may be a stand-alone unit or may consist of several inter-connected units.

Conformity Fulfillment by a product, process or service of all requirements specified.

Customer An individual or corporate entity who enters into an agreement with an AVF which specifies the terms and conditions for AVF services (of any kind) to be performed.

- Declaration of A formal statement from a customer assuring that Conformance conformity is realized or attainable on the Ada implementation for which validation status is realized.
- Host Computer A computer system where Ada source programs are System transformed into executable form.
- Inapplicable A test that contains one or more test objectives test found to be irrelevant for the given Ada implementation.
- ISO International Organization for Standardization.

LRM The Ada standard, or Language Reference Manual, published as ANSI/MIL-STD-1815A-1983 and ISO 8652-1987. Citations from the LRM take the form "<section>.<subsection>:<paragraph>."

Operating Software that controls the execution of programs System and that provides services such as resource allocation, scheduling, input/output control, and data management. Usually, operating systems are predominantly software, but partial or complete hardware implementations are possible.

TargetA computer system where the executable form of AdaComputerprograms are executed.SystemSystem

Validated Ada The compiler of a validated Ada implementation. Compiler

Validated Ada An Ada implementation that has been validated Implementation successfully either by AVF testing or by registration [Pro90].

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Validation The process of checking the conformity of an Ada compiler to the Ada programming language and of issuing a certificate for this implementation.

.

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

#### CHAPTER 2

#### IMPLEMENTATION DEPENDENCIES

## 2.1 WITHDRAWN TESTS

Some tests are withdrawn by the AVO from the ACVC because they do not conform to the Ada Standard. The following 95 tests had been withdrawn by the Ada Validation Organization (AVO) at the time of validation testing. The rationale for withdrawing each test is available from either the AVO or the AVF. The publication date for this list of withdrawn tests is 91-08-02.

E28005C	B28006C	C32203A	C34006D	C35508I	C35508J
C35508M	C35508N	C35702A	C35702B	B41308B	C43004A
C45114A	C45346A	C45612A	C45612B	C45612C	C45651A
C46022A	B49008A	B49008B	374006A	C74308A	B83022B
B83022H	B83025B	B83025D	B83026B	C83026A	C83041A
B85001L	C86001F	C94021A	C97116A	C98003B	BA2011A
CB7001A	CB7001B	CB7004A	CC1223A	BC1226A	CC1226B
BC3009B	BD1B02B	BD1B06A	AD1B08A	BD2A02A	CD2A21E
CD2A23E	CD2A32A	CD2A41A	CD2A41E	CD2A87A	CD2B15C
BD3006A	BD4008A	CD4022A	CD4022D	CD4024B	CD4024C
CD4024D	CD4031A	CD4051D	CD5111A	CD7004C	ED70C5D
CD7005E	AD7006A	CD7006E	AD7201A	AD7201E	CD7204B
AD7206A	BD8002A	BD8004C	CD9005A	CD9005B	CDA201E
CE2107I	CE2117A	CE2117B	CE2119B	CE2205B	CE2405A
CE3111C	CE3116A	CE3118A	CE3411B	CE3412B	CE3607B
CE3607C	CE3607D	CE3812A	CE3814A	CE3902B	

#### 2.2 INAPPLICABLE TESTS

A test is inapplicable if it contains test objectives which are irrelevant for a given Ada implementation. The inapplicability criteria for some tests are explained in documents issued by ISO and the AJPO known as Ada Commentaries and commonly referenced in the format AI-ddddd. For this implementation, the following tests were determined to be inapplicable for the reasons indicated; references to Ada Commentaries are included as appropriate.

The following 201 tests have floating-point type declarations requiring more digits than SYSTEM.MAX DICITS:

C24113LY	(14	tests)	C35705LY	(14	tests)
C35706LY	(14	tests)	C35707LY	(14	tests)
C35708LY	(14	tests)	C35802LZ	(15	tests)

2-1

C45241LY	(14	tests)	C45321LY	(14	tests)
C45421LY	(14	tests)	C45521LZ	(15	tests)
C45524LZ	(15	tests)	C45621LZ	(15	tests)
C45641LY	(14	tests)	C46012LZ	(15	tests)

C24113I..K (3 TESTS) use a line length in the input file which exceeds 126 characters.

The following 21 tests check for the predefined type SHORT\_INTEGER; for this implementation, there is no such type:

C35404B	B36105C	C45231B	C45304B	C45411B
C45412B	C45502B	C45503B	C45504B	C45504E
C45611B	C45613B	C45614B	C45631B	C45632B
B52004E	C55B07B	B55B09D	B86001V	C86006D
CD7101E				

The following 20 tests check for the predefined type LONG\_INTEGER; for this implementation, there is no such type:

C35404C	C45231C	C45304C	C45411C	C45412C
C45502C	C45503C	C45504C	C45504F	C45611C
C45613C	C45614C	C45631C	C45632C	B52004D
C55B07A	B55B09C	B86001W	C86006C	CD7101F

C35404D, C45231D, B86001X, C86006E, and CD7101G check for a predefined integer type with a name other than INTEGER, LONG\_INTEGER, or SHORT\_INTEGER; for this implementation, there is no such type.

C35713B, C45423B, B86001T, and C86006H check for the predefined type SHORT FLOAT; for this implementation, there is no such type.

C35713D and B86001Z check for a predefined floating-point type with a name other than FLOAT, LONG\_FLOAT, or SHORT\_FLOAT; for this implementation, there is no such type.

C45531M..P and C45532M..P (8 tests) check fixed-point operations for types that require a SYSTEM.MAX\_MANTISSA of 47 or greater; for this implementation, MAX\_MANTISSA is less than 47.

C45624A..B (2 tests) check that the proper exception is raised if MACHINE\_OVERFLOWS is FALSE for floating point types and the results of various floating-point operations lie outside the range of the base type; for this implementation, MACHINE\_OVERFLOWS is TRUE.

C4A013B contains a static universal real expression that exceeds the range of this implementation's largest floating-point type; this expression is rejected by the compiler.

B86001Y uses the name of a predefined fixed-point type other than

type DURATION; for this implementation, there is no such type.

C96005B uses values of type DURATION's base type that are outside the range of type DURATION; for this implementation, the ranges are the same.

CA2009C and CA2009F check whether a generic unit can be instantiated before its body (and any of its subunits) is compiled; this implementation creates a dependence on generic units as allowed by AI-00408 and AI-00506 such that the compilation of the generic unit bodies makes the instantiating units obsolete. (See section 2.3.)

CD1009C checks whether a length clause can specify a non-default size for a floating-point type; this implementation does not support such sizes.

CD2A84A, CD2A84E, CD2A84I..J (2 tests), and CD2A84O use length clauses to specify non-default sizes for access types; this implementation does not support such sizes.

BD8001A, BD8003A, BD8004A..B (2 tests), and AD8011A use machine code insertions; this implementation provides no package MACHINE\_CODE.

CE2103A, CE2103B, and CE3107A use an illegal file name in an attempt to create a file and expect NAME\_ERROR to be raised; this implementation does not support external files and so raises USE ERROR. (See section 2.3.)

The following 264 tests check operations on sequential, text, and direct access files; this implementation does not support external files:

CE2102AC	(3)	CE2102GH	(2)	CE2102K		CE2102NY	(12)
CE2103CD	(2)	CE2104AD	(4)	CE2105AB	(2)	CE2106AB	(2)
CE2107AH	(8)	CE2107L		CE2108AH	(8)	CE2109AC	(3)
CE2110AD	(4)	CE2111AI	(9)	CE2115AB	(2)	CE2120AB	(2)
CE2201AC	(3)	EE2201DE	(2)	CE2201FN	(9)	CE2203A	
CE2204AD	(4)	CE2205A		CE2206A		CE2208B	
CE2401AC	(3)	EE2401D		CE2401EF	(2)	EE2401G	
CE2401HL	(5)	CE2403A		CE2404AB	(2)	CE2405B	
CE2406A		CE2407AB	(2)	CE2408AB	(2)	CE2409AB	(2)
CE2410AB	(2)	CE2411A		CE3102AC	(3)	CE3102FH	(3)
CE3102JK	(2)	CE3103A		CE3104AC	(3)	CE3106AB	(2)
CE3107B		CE3108AB	(2)	CE3109A		CE3110A	
CE3111AB	(2)	CE3111DE	(2)	CE3112AD	(4)	CE3114AB	(2)
CE3115A		CE3119A		EE3203A		EE3204A	
CE3207A		CE3208A		CE3301A		EE3301B	
CE3302A		CE3304A		CE3305A		CE3401A	
CE3402A		EE3402B		CE3402CD	(2)	CE3403AC	(3)

CE3403EF	(2)	CE3404BD	(3)	CE3405A		EE3405B	
CE3405CD	(2)	CE3406AD	(4)	CE3407AC	(3)	CE3408AC	(3)
CE3409A		CE3409CE	(3)	EE3409F		CE3410A	
CE3410CE	(3)	EE3410F		CE3411A		CE3411C	
CE3412A		EE3412C		CE3413AC	(3)	CE3414A	
CE3602AD	(4)	CE3603A		CE3604AB	(2)	CE3605AE	(5)
CE3606AB	(2)	CE3704AF	(6)	CE3704MO	(3)	CE3705AE	(5)
CE3706D		CE3706FG	(2)	CE3804AP	(16)	CE3805AB	(2)
CE3806AB	(2)	CE3806DE	(2)	CE3806GH	(2)	CE3904AB	(2)
CE3905AC	(3)	CE3905L		CE3906AC	(3)	CE3906EF	(2)

#### 2.3 TEST MODIFICATIONS

Modifications (see section 1.3) were required for 71 tests.

The following tests were split into two or more tests because this implementation did not report the violations of the Ada Standard in the way expected by the original tests.

B22003A	B26001A	B26002A	B26005A	B28003A	B29001A	B33301B
B35101A	B37106A	B37301B	B37302A	B38003A	B38003B	B38009A
B38009B	B55A01A	B61001C	B61001F	B61001H	B61001I	B61001M
B61001R	B61001W	B67001H	B83A07A	B83A07B	B83A07C	ESSEDIC
B83E01D	B83E01E	B85001D	B85008D	B91001A	B91002A	B91002B
B91002C	B91002D	B91002E	B91002F	B91002G	B91002H	B91002I
B91002J	B91002K	B91002L	B95030A	B95061A	B95061F	H95061G
B95077A	B97103E	B97104G	BA1001A	BA1101B	BC1109A	BC1109C
BC1109D	BC1202A	BC1202F	BC1202G	BE2210A	BE2413A	
B95077A BC1109D	BG1202A	B97104G BC1202F	BC1202G	BE2210A	BE2413A	B-1109C

C83030C and C86007A were graded passed by Test Modification as directed by the AVO. These tests were modified by inserting "PRAGMA ELABORATE (REPORT);" before the package declarations at lines 13 and 11, respectively. Without the pragma, the packages may be elaborated prior to package Report's body, and thus the packages' calls to function REPORT.IDENT\_INT at lines 14 and 13, respectively, will raise PROGRAM ERROR.

CA2009C and CA2009F were graded inapplicable by Evaluation Modification as directed by the AVO. These tests contain instantiations of a generic unit prior to the compilation of that unit's body; as allowed by AI-00408 and AI-00506, the compilation of the generic unit bodies makes the compilation unit that contains the instantiations obsolete.

BC3204C and BC3205D were graded passed by Processing Modification as directed by the AVO. These tests check that instantiations of generic units with unconstrained types as generic actual parameters are illegal if the generic bodies contain uses of the types that require a constraint. However, the generic bodies are compiled after the units that contain the instantiations, and this implementation creates a dependence of the instantiating units on the generic units as allowed by AI-00408 and AI-00506 such that the compilation of the generic bodies makes the instantiating units obsolete--no errors are detected. The processing of these tests was modified by re-compiling the obsolete units; all intended errors were then detected by the compiler.

CE2103A, CE2103B, and CE3107A were graded inapplicable by Evaluation Modification as directed by the AVO. The tests abort with an unhandled exception when USE ERROR is raised on the attempt to create an external file. This is acceptable behavior because this implementation does not support external files (cf. AI-00332).

## CHAPTER 3

## PROCESSING INFORMATION

## 3.1 TESTING ENVIRONMENT

The Ada implementation tested in this validation effort is described adequately by the information given in the initial pages of this report.

In addition to the host computer system and the target computer system, there are execution controllers which are a pair of cooperating processes. The Remote Process Administrator (RPA) runs under MIPS RISC/os and is a translator/ downloader. The Remote Process Monitor (RPM) runs on the target MIPS R3000 bare machine (the Lockheed Sanders STAR MVP R3000/R3010 board OR the Integrated Device Technology (IDT) board). The two processes communicate via a RS232 link. The RPM is constantly executing on the target computer waiting for requests from the RPA process on the host computer.

For technical information about this Ada implementation, contact:

Jonathan Schilling DDC-Inter, Inc. New York, NY 10017 Telephone: 212-661-5100 ext. 221 Telefax: 212-661-5472

For sales information about this Ada implementation, contact:

Jennifer Collins DDC-I, Inc. 410 North 44th Street, Suite 320 Phoenix, AZ 85008 Telephone: 602-275-7172 Telefax: 602-275-7502

Testing of this Ada implementation was conducted at the customer's site by a validation team from the AVF.

3.2 SUMMARY OF TEST RESULTS

An Ada Implementation passes a given ACVC version if it processes each test of the customized test suite in accordance with the Ada Programming Language Standard, whether the test is applicable or inapplicable; otherwise, the Ada Implementation fails the ACVC [Pro90]. When the Ada program finishes its execution, it gives control back to the RPM. The RPA then gives control back to the user on the MIPS RISC/os.

Testing was performed using command scripts provided by the customer and reviewed by the validation team. See Appendix B for a complete listing of the processing options for this implementation. In general default options were used except as detailed below. The options invoked explicitly for validation testing during this test were:

For all tests the following explicit option was invoked:

-a which specifies the current library.

In addition to the above, the following explicit option was invoked for the B tests and E tests:

-1 which specifies that a compilation listing be produced.

Test output, compiler and linker listings, and job logs were captured on magnetic tape and archived at the AVF. The listings examined on-site by the validation team were also archived.

## APPENDIX A

## MACRO PARAMETERS

This appendix contains the macro parameters used for customizing the ACVC. The meaning and purpose of these parameters are explained in [UG89]. The parameter values are presented in two tables. The first table lists the values that are defined in terms of the maximum input-line length, which is the value for \$MAX\_IN\_LEN--also listed here. These values are expressed here as Ada string aggregates, where "V" represents the maximum input-line length.

Macro Parameter	Macro Value
\$MAX_IN_LEN	126 Value of V
\$BIG_ID1	(1V-1 => 'A', V => '1')
\$BIG_ID2	(1V-1 => 'A', V => '2')
\$BIG_ID3	(1V/2 => 'A') & '3' & (1V-1-V/2 => 'A')
\$BIG_ID4	(1V/2 => 'A') & '4' & (1V-1-V/2 => 'A')
\$BIG_INT_LIT	(1V-3 => '0') & "298"
\$BIG_REAL_LIT	(1V-5 => '0') & "690.0"
\$BIG_STRING1	'"' & (1V/2 => 'A') & '"'
\$BIG_STRING2	/"' & (1V-1-V/2 => 'A') & '1' & '"'
\$BLANKS	(1V-20 => ' ')
\$MAX_LEN_INT_BASE	D_LITERAL "2:" & (1V-5 => '0') & "11:"
\$MAX_LEN_REAL_BASE	ED_LITERAL "16:" & (1V-7 => '0') & "F.E:"
\$MAX STRING LITERA	AL '"' & (1V-2 => 'A') & '"'

The following table contains the values for the remaining macro parameters.

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Macro Parameter	Macro Value
\$ACC_SIZE	32
\$ALIGNMENT	2
\$COUNT_LAST	2_147_483_647
\$DEFAULT_MEM_SIZE	4*1024*1024*1024
\$DEFAULT_STOR_UNIT	8
\$DEFAULT_SYS_NAME	MIPS
\$DELTA_DOC	1.0/2.0**(system.MAX_MANTISSA)
\$ENTRY_ADDRESS	SYSTEM. MODX
\$ENTRY_ADDRESS1	SYSTEM.TLBL
\$ENTRY_ADDRESS2	SYSTEM.TLBS
\$FIELD_LAST	35
\$FILE_TERMINATOR	
\$FIXED_NAME	NO_SUCH_FIXED_TYPE
\$FLOAT_NAME	NO_SUCH_FLOAT_TYPE
\$FORM_STRING	¥8 ¥8
\$FORM_STRING2	"CANNOT_RESTRICT_FILE_CAPACITY"
\$GREATER_THAN_DURATI	ON 131_071.0
\$GREATER_THAN_DURATI	ON_BASE_LAST 131_072.0
\$GREATER_THAN_FLOAT_	BASE_LAST 2#1.0#E129
\$GREATER_THAN_FLOAT_	SAFE_LARGE 2#0.1111111111111111111111111111
\$GREATER_THAN_SHORT_	FLOAT_SAFE_LARGE 0.0
\$HIGH PRIORITY	255

\$ILLEGAL\_EXTERNAL FILE NAME1 ILLEGAL\_FILE\_NAME 1 \$ILLEGAL EXTERNAL FILE NAME2 ILLEGAL FILE NAME 2 \$INAPPROPRIATE LINE LENGTH -1 **\$INAPPROPRIATE PAGE LENGTH** -1 \$INCLUDE PRAGMA1 PRAGMA INCLUDE("A28006D1.TST") \$INCLUDE PRAGMA2 PRAGMA INCLUDE("B28006F1.TST") **\$INTEGER FIRST** -2147483648 SINTEGER LAST 2147483647 \$INTEGER\_LAST\_PLUS\_1 2\_147\_483\_648 **\$INTERFACE LANGUAGE** ASSEMBLY \$LESS THAN DURATION -131 072.0 \$LESS THAN DURATION BASE FIRST -131 073.0 11 **\$LINE TERMINATOR** \$LOW PRIORITY 0 \$MACHINE CODE STATEMENT NULL; \$MACHINE CODE TYPE NO\_SUCH\_TYPE \$MANTISSA DOC 31 \$MAX DIGITS 15 **\$MAX INT** 2147483647 \$MAX INT PLUS 1 2 147 483 648 \$MIN\_INT -2147483648 **\$NAME** NO SUCH INTEGER TYPE \$NAME LIST MIPS \$NAME SPECIFICATION1 NAME SPEC 1 \$NAME\_SPECIFICATION2 NAME SPEC 2 \$NAME SPECIFICATION3 NAME SPEC 3

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\$NEG_BASED_INT	16#FFFFFFE#
\$NEW_MEM_SIZE	4*1024*1024*1024
\$NEW_STOR_UNIT	8
\$NEW_SYS_NAME	MIPS
<b>\$PAGE_TERMINATOR</b>	
\$RECORD_DEFINITION	NEW INTEGER;
\$RECORD_NAME	NO_SUCH_MACHINE_CODE_TYPE
\$TASK_SIZE	32
\$TASK_STORAGE_SIZE	1024
\$TICK	2.0**(-14)
\$VARIABLE_ADDRESS	16#800E0000# - 2**32
\$VARIABLE_ADDRESS1	16#800F8000# - 2**32
\$VARIABLE_ADDRESS2	16#80100000# - 2**32
\$YOUR_PRAGMA	N_Atest withdrawn

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## APPENDIX B

## COMPILATION SYSTEM OPTIONS

The compiler options of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this appendix are to compiler documentation and not to this report.

# Appendix B Compilation System Options Used

The following pages contain excerpts from the appropriate sections of the DACS Unix to MIPS R3000 Bare Ada Cross Compiler System User's Guide, showing all the compiler and linker options.

When the ACVC tests are compiled, default compiler options are generally used. The only exceptions are:

- for all tests, the -a library-name option, which specifies the current program library to compile into, is used
- for B-tests and certain E-tests, the -l option, which specified that a compilation listing is to be produced, is used

When the ACVC tests are linked, default linker options are generally used. The only exceptions are:

- for all tests, the -a library-name option, which specifies the current program library to link from, is used
- for some tests, the -o "string" option, which specifies override values for stack and heap allocations, is used (this option is only used for those tests that cannot run using the default stack and heap allocations)

# Chapter 4 The Ada Compiler

The Ada Compiler translates Ada source code into MIPS R3000 object code.

Diagnostic messages are produced if any errors in the source code are detected. Warning messages are also produced when appropriate.

Compile, cross-reference, and generated assembly code listings are available upon user request.

The compiler uses a program library during the compilation. An internal representation of the compilation, which includes any dependencies on units already in the program library, is stored in the program library as a result of a successful compilation.

On a successful compilation, the compiler generates assembly code, invokes the Unix assembler as(1) to translate this assembly code into object code, and then stores the object code in the program library. (Optionally, the generated assembly code may also be stored in the library.) The invocation of the Assembler is completely transparent to the user.

## 4.1. The Invocation Command

The Ada Co. npiler is invoked by submitting the following Unix command:

% adamips {option} source-file-name {source-file-name}

## 4.1.1. Parameters and Options

Default values exist for all options as indicated below.

#### source-file-name

This parameter specifies the file containing the source text to be compiled. Any valid Unix file name may be used.

If the file name specified does not have a suffix, then the suffix .ada is assumed.

More than one file name can be specified. Each source-file-name may contain pattern matching characters as defined by the shell (such as "\*" and "?"). The compilation starts with the leftmost file name from the command line, and ends with the rightmost. If any of the file names specified contain matching characters, the matching files are compiled in alphanumeric order. If any file name occurs more than once in this process, then it is compiled

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more than once.

The format of the source text is described in Section 4.2.1.

-L or -l

The user may request a source listing by means of this option. The source listing is written to the list file. Section 4.3.1 contains a description of the source listing.

If the option is not present, no source listing is produced, regardless of any use of pragma LIST in the program or of any diagnostic messages  $p_{12}^{-1}$  and  $p_{12}^{-1}$ 

In addition, this option provides generated assembly listings for each compilation unit in the source file. Section 4.3.3 contains a description of the generated assembly listing.

-1

A cross-reference listing can be requested by the user by means of this option. If it is present and no severe or fatal errors are found during the compilation, the cross-reference listing is written to the list file. The cross-reference listing is described in Section 4.3.1.3.

## -a file-name

This option specifies the current sublibrary and thereby also specifies the current program library, which consists of the current sublibrary through the root sublibrary (see Chapter 2). If the option is omitted, the sublibrary designated by the environment variable ADANIPS\_LIBRARY is used as the current sublibrary.

Section 4.4 describes how the Ada compiler uses the current sublibrary.

-c file-name

This option specifies the configuration file to be used by the compiler in the current compilation.

If the option is omitted, the configuration file designated by the file name \$release/compiler/config is used by default. Section 4.2.2 contains a description of the configuration file.

n
N check\_kind.{check\_kind}

check\_kind ::= index | access | discriminant | length | range | division | overflow | elaboration | storage | all

By default, all run time checks will be generated by the compiler.

When the -n option is specified, all runtime checks will be suppressed.

### The Ada Compiler

When the -N option is used, the checks corresponding to the particular check kinds specified will be omitted. These kinds correspond to the identifiers defined for pragma SUPPRESS [Ada RM 11.7].

Suppression of checks is done in the same manner as for pragma SUPPRESS (see Section F.2).

#### •W

Use of this option directs the compiler to accept an extended set of address clauses for interrupt entries, corresponding to additional interrupts found in the GISA architecture (see Sections F.5 and F.8).

## -S or -s

By default, the source text of the compilation unit is stored in the program library. In case that the source text file contains several compilation units, the source text for each compilation unit is stored in the program library. The source texts stored in the program library can be extracted using the Ada PLU type command (see Chapter 3).

By using the -S or -s option, this saving of the source text will not occur. While this will reduce somewhat the space needed by the program library, it will also prevent automatic recompilation by the Ada Recompiler, and hence is not recommended for normal use.

## -k

When this option is given, the compiler will store the generated assembly source code in the program library, for each compilation unit being compiled. By default this is not done. Note that while the assembly code is stored in the library in a compressed form, it nevertheless takes up a large amount of library space relative to the other information stored in the library for a program unit.

This option does not affect the production of generated assembly listings.

#### •p

When this option is given, the compiler will write a message to the standard output as each pass of the compiler starts to run. This information is not provided by default.

## -d -D limit\_opt [full\_opt

When this option is given, the compiler will generate symbolic debug information for each compilation unit in the source file and store the information in the program library. By default this is not done.

This symbolic debug information is used by the DACS Unix to MIPS R3000 Bare Symbolic Cross Debugging System.

If -D full\_opt is specified (which is also the default if just -d is specified), the compiler will generate code with all optimizations enabled. This code will be the same object code as if the option had not been specified at all (though there may be some minor differences in the generated assembly code, due to some extra labels being present). However, this full level of optimization may result in some unreliable symbolic debug information being produced.

If -D limit\_opt is specified, the compiler will suppress those optimizations which might result in unreliable symbolic debug information. These optimizations include code motion across Ada statement boundaries; not storing the values of Ada variables to memory across statement boundaries; and the elimination of unnecessary library package elaboration routines. Users may also wish to specify this option to make the generated machine code more understandable relative to the Ada source code.

The remaining options pertain to the various optimizing components of the compiler. By default, the compiler operates with all optimizations turned on. The principal reason why users might want to turn off some optimizations is covered by the **-D** limit\_opt option described above, and that option should be used accordingly.

The options described below directly turn off particular optimizing components, and should only be used to circumvent the capacity or other problems described below.

-f

This pertains to the "front end" optimizer. This sometimes places capacity limits on the source program (e.g., number of variables in a compilation unit) that are more restrictive than those documented in Section F.13. If a compile produces an error message indicating that one of these limits has been reached, for example

\*\*\* 1562S-0: Optimizer capacity exceeded. Too many names in a basic block.

then use of this option will bypass this optimizer and allow the compilation to finish normally.

-g

This pertains to the "g-code" (intermediate language) optimizer. This optimizer presents no special capacity or other problems, so use of this option is unlikely to be necessary.

-U

This pertains to the "back end" optimizer. This optimizer is the most powerful in the compiler, and accordingly uses a fairly large amount of host resources, in both CPU time and virtual memory. If such resource utilization is causing a problem or is undesired, then this option may be used.

Examples of option usage

- % adamips navigation\_constants
- % adamips -lx event\_scheduler.a
- % adamips -p -a test versions.alb /usr1/source/altitudes\_b

[remainder of chapter deleted]

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## LINKER OPTIONS

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The linker options of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this appendix are to linker documentation and not to this report.

# Chapter 5 The Ada Linker

Before a compiled Ada program can be executed it must be linked into a load module by the Ada Linker.

In its normal and conventional usage, the Ada Linker links a single Ada program.

The Ada Linker also has the capability to link multiple Ada programs into one load module, where the programs will execute concurrently. This capability, which is outside the definition of the Ada language, is called *multiprogramming*, and is further discussed below.

The Ada link, while one command, can be seen as having two parts: an "Ada part" and a "MIPS part".

The Ada part performs the link-time functions that are required by the Ada language. This includes checking the consistency of the library units, and constructing an elaboration order for those library units. Any errors found in this process are reported.

To effect the elaboration order, the Ada link constructs an assembly language "elaboration caller routine" that is assembled and linked into the executable load module. This is a small routine that, during execution, gets control from the Ada runtime executive initiator. It invokes or otherwise marks the elaboration of each Ada library unit in the proper order, then returns control to the runtime executive, which in turn invokes the main program. The action of the elaboration caller routine is transparent to the user.

If no errors are found in the Ada part of the link, the MIPS part of the link takes place. This consists of assembling the elaboration caller routine, then invoking the DACS Unix to MIPS R3000 Bare Cross Linker, linking the program unit object modules (stored in the program library) and the elaboration caller routine together with the necessary parts of the Ada runtime executive (and some other runtime modules needed by the generated code). The output of the full Ada link is an executable load module file.

The invocations of the MIPS Assembler and Linker are transparent to the user. However, options on the Ada link command allow the user to specify additional information to be used in the target link. Through this facility, a wide variety of runtime executive optional features, customizations, and user exit routines may be introduced to guide or alter the execution of the program. These are described in the DACS Unix to MIPS R3000 Bare Ada Run-Time System User's Guide. This facility may also be used to modify or add to the standard DACS Unix to MIPS R3000 Bare Cross Linker control statements that are used in the MIPS part of the link; in this way, target memory may be precisely defined. The control statements involved are described in the DACS Unix to MIPS R3000 Bare Cross Linker Reference Manual.

[portion of chapter deleted]

## 5.1. The Invocation Command

The Ada Linker is invoked by submitting the following Unix command:

**% adamips.link** {option} main-program-name {main\_program\_name}

As part of the "MIPS part" of an Ada link, a temporary subdirectory is created in /tmp (unless the -k or -K option has been used, in which case it is created below the current directory). Use of this subdirectory, the name of which is constructed from the Unix process-id, permits concurrent linking in the same current directory. The subdirectory contains work files only, and it and its contents are deleted at the end of the link.

## 5.1.1. Parameters and Options

Default values exist for all options as indicated below.

main-program-name

If a single program link is being done, main-program-name must specify a main program which is a library unit of the current program library, but not necessarily of the current sublibrary. The library unit must be a parameterless procedure. Note that main-program-name is the identifier of an Ada procedure; it is not a Unix file specification.

When *main-program-name* is used as the file name in Ada link output (for the load module, memory map file, etc.), the file name will be truncated to 29 characters if necessary.

If a multiprogramming link is being done, multiple *main-program-names* are specified, separated by spaces. The first name supplied is the one used for the file name in Ada link output.

The first three of the options below pertain to the "Ada part" of the Ada link. The remaining options pertain to the "MIPS part" of the link.

-l file-name -L

This option specifies whether a log file is to be produced during the linking. By default no log file is produced. If -L is used, a log file named *main-program-name* log is created in the current directory. If -l and a file specification are given, that file is created as the log file. The contents of the log file are described in Section 5.3.

-a file-name

This option specifies the current sublibrary and thereby also the current program library, which consists of the current sublibrary through the root sublibrary (see Chapter 2). If the option is omitted, the sublibrary designated by the environment variable ADAMIPS\_LIBRARY is used as current sublibrary.

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This option specifies that a multiprogramming link be done. By default a single program link is done.

## -o "symbol-name=value{,symbol-name=value}"

This option is used to override certain default values that are used by the Ada runtime executive. If the option is omitted, no overriding takes place

The option specifies a quoted string, containing one or more special symbol assignments that override the default values of these symbols. Numeric values are treated as decimal.

If a multiprogramming link is done, suffixes are used in the special symbol names to indicate which programs the overrides are for.

Since the option value cannot be continued onto a new line, an alternative method is available if a large number of overrides must be specified. This involves creating a file of Assembler preprocessor directives specifying the overrides, and then defining that file with the environment variable adamips rte opts.

The names of these special symbols, their default values, and the runtime behavior that they control, are described in the Ada Run-Time System User's Guide, as are the details of the alternative method.

#### -s file-name

This option specifies the file name of "standard" DACS Unix to MIPS R3000 Bare Cross Linker control statements that are to be used for all links for an installation or project. If the option is omitted, the environment variable adamips\_std\_ctl is assumed to define such a file. If that environment variable is not defined or the specified file does not exist, no standard control statements are used.

-c file-name -C

This option specifies the file name of "user" DACS Unix to MIPS R3000 Bare Cross Linker control statements that are to be used for this particular link. If -C is used, *main-program-name.ctl* is used as a default. If the option is omitted or the specified file does not exist, no user control statements are used.

The files designated by the previous two options are used to form the full input control statement stream to the DACS Unix to MIPS R3000 Bare Cross Linker, in this concatenated order:

"standard" control file (if it exists) <statements generated by the Ada part of the link> "user" control file (if option active and it exists)

The statements generated by the Ada part of the link are usually just object\_file statements for the elaboration caller routine(s) and main program(s).

The Compiler System is delivered with the environment variables described above defined to files that contain default sets of standard control statements. These consist of the minimal relocation statements required by the

DACS Unix to MIPS R3000 Bare Cross Linker, and various other necessary directives.

#### -u directory-list

This option specifies a colon-separated list of directories that contains either user-dependent RTE modules, such as a change to the task scheduler for a particular application, or pragma INTERFACE (ASSEMBLY) bodies for subprograms that are not library units (see Section F.2). Modules in this list's directory(ies) are taken ahead of those in the directories specified by the -t option (see below) and those in the standard RTE directories (including those RTE modules in the predefined library). If the option is omitted, environment variable adamips\_user\_rts is used, if it has been defined.

#### -t directory-list

This option specifies a colon-separated list of directories that contains MIPS-implementation(target)-dependent runtime executive (RTE) modules, such as modules to do character I/O for a particular simulator or microprocessor. Modules in this list's directory(ies) are taken ahead of those in the standard RTE directory. If the option is omitted, environment variable adamips\_target\_rts is used, if it has been defined.

-d

When this option is given, the Ada Linker will produce a symbolic debug information file, containing symbolic debug information for all program units involved in the link that were compiled with the -d or -D options present. By default no such file is produced, even if some of the program units linked were compiled with a debug option.

This symbolic debug information file is used by the DACS Unix to MIPS R3000 Bare Symbolic Cross Debugging System.

The show -invocation\_command command of Ada PLU may be used to determine what options units in the program library were compiled with.

It is important to note that the identical executable load module is produced by the Ada Linker, whether or not this option is used.

## -i

By default, the "diagnostic traces" of the Ada runtime executive are linked in and activated. These traces print out information when unusual conditions occur, such as unhandled exceptions and task deadlock. See the Ada Run-Time System User's Guide for full details.

By using the -i option, these diagnostic traces will not be linked in or activated.

## -T

When this option is present, the "optional traces" of the Ada runtime executive are linked in (but not activated). These traces print out information during normal program execution, to assist in debugging and in better understanding program behavior. See the Ada Run-Time System User's Guide for full details.

By default, the optional traces are not linked in.

### The Ada Linker

### -e "DACS Unix to MIPS R3000 Bare Cross Linker options"

This option specifies a string containing one or more command options to be passed to the execution of the DACS Unix to MIPS R3000 Bare Cross Linker.

-k *number* -K

This option, when used with no *number*, results in the Ada link stopping after the "Ada part" has done all Adarequired checking, and has created a command file (Unix Bourne shell script) (located in the temporary subdirectory) that executes the "MIPS part", but before that file has actually been invoked.

When used with *number* 1, the file is invoked, but stops before the DACS Unix to MIPS R3000 Bare Cross Linker is invoked, leaving the temporary subdirectory and its files in place. When used with *number* 2, it executes the DACS Unix to MIPS R3000 Bare Cross Linker but then stops before the symbolic debug information file is produced.

This option is useful for trouble-shooting, or for giving the user an intervention point for Ada link customizations not covered by any of the available options.

## 5.1.2. Examples

Some examples of single program and multiprogramming links:

% adamips.link flight simulator # single program

% adamips.link -m able baker charlie # multiprogramming

An example of overriding default runtime executive values, in this case the system heap size and main stack size:

% adamips.link -o "rtheapsz1=48\*1024,rtmstacksz1=8000" flight simulator

An example of overriding values when multiprogramming is involved (the system heap size is overridden for each program):

```
% adamips.link -m -o "rtheapsz1=20*1024,rtheapsz2=12*1024,rtheapsz3=50*1024" able baker charlie
```

Now, an example of introducing "user" DACS Unix to MIPS R3000 Bare Cross Linker control statements:

% adamips.link -C test driver

where test\_driver.ctl in the current directory contains

The Ada Linker

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search\_path is /dma/object end object\_file is dmacheck end informational messages are off

Now, an example of the use of user and target RTE directories:

% setenv adamips\_target\_rts "/tektronix/io/test:/tektronix/io"

% adamips.link -u "/sys\_user/test/stor\_mgr" flight\_simulator

Runtime executive modules will be looked for in the directory specified by the -u option, then in the two directories specified by the adamips\_target\_rts environment variable, and lastly in the standard RTE directory.

To revert to referencing only the standard RTE directory:

% unsetenv adamips\_target\_rts

% adamips.link flight\_simulator

[remainder of chapter deleted]

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## APPENDIX C

## APPENDIX F OF THE Ada STANDARD

allowed implementation dependencies correspond The only 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 this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this Appendix are to documentation and compiler not to this report. Implementation-specific portions of the package STANDARD, which are not a part of Appendix F, are:

package STANDARD is

type INTEGER is range -2\_147\_483\_648..2\_147\_483\_647;

- type FLOAT is digits 6 range -2#1.0#E128.. 2#0.111111111111111111#E128;
- type DURATION is delta 2\*\*(-14) range +131\_072.0..131\_071.0;

end STANDARD;

# Appendix C Appendix F of the Ada Reference Manual

This appendix includes in its entirety Appendix F from the DACS Unix to MIPS R3000 Bare Ada Cross Compiler System User's Guide.

Note that the implementation-specific portions of the package STANDARD are included in this appendix, as Section F.1.

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# Appendix F Appendix F of the Ada Reference Manual

This appendix describes all implementation-dependent characteristics of the Ada language as implemented by the DACS Unix to MIPS R3000 Bare Ada Cross Compiler System, including those required in the Appendix F frame of Ada RM.

## F.1. Predefined Types in Package STANDARD

This section describes the implementation-dependent predefined types declared in the predefined package STANDARD [Ada RM Annex C], and the relevant attributes of these types.

F.1.1. Integer Types

One predefined integer type is implemented, INTEGER. It has the following attributes:

INTEGER'FIRST	=	-2_147_483_648
INTEGER'LAST	=	2 147 483 647
INTEGER'SIZE	=	32

No other predefined integer types (such as SHORT\_INTEGER or LONG\_INTEGER) are implemented, as there are no corresponding underlying machine base types.

## F.1.2. Floating Point Types

Two predefined floating point types are implemented, FLOAT and LONG\_FLOAT. They have the following attributes:

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FLOAT DIGITS	=	6
FLOAT'FIRST	3	-2#1.0#E128

F-2		Appendix F of the Ada Reference Manual
FLOATLAST	=	2#0.1111111111111111111#E128
FLOAT MACHINE EMAX		128
FLOAT'MACHINE EMIN	=	-125
FLOAT'MACHINE MANTISSA	=	24

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FLOAT'MACHINE OVERFLOWS	÷	TRUE
FLOAT'MACHINE RADIX	=	2
FLOAT MACHINE ROUNDS	=	TRUE
FLOAT'SAFE EMAX	=	125
FLOAT'SAFE LARGE	=	2#0.11111111111111111111#E125
FLOATSAFE SMALL	**	2#0.1#E-125
FLOAT'SIZE	=	32
LONG FLOAT DIGITS	#	15
LONG FLOAT FIRST	=	-2#1.0#E1024
LONG FLOAT LAST	=	<b>2#0.111111111111111111111111111111111111</b>
LONG FLOAT MACHINE EMAX	=	1024
LONG FLOAT MACHINE EMIN	=	-1021
LONG FLOAT'MACHINE MANTISSA	=	53
LONG FLOAT MACHINE OVERFLOWS	=	TRUE
LONG FLOAT'MACHINE RADIX	=	2
LONG FLOAT'MACHINE ROUNDS	=	TRUE
LONG FLOAT'SAFE EMAX	=	1023
LONG FLOAT'SAFE LARGE		<b>2#0.111111111111111111111111111111111111</b>
LONG FLOAT SAFE SMALL	=	2#0.1#E-1023
LONGFLOATSIZE	=	64
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No other predefined floating point types (such as SHORT FLOAT) are implemented, as there are no corresponding underlying machine base types.

F.1.3. Fixed Point Types

One kind of anonymous predefined fixed point type is implemented, fixed (which is not defined in package STANDARD, but is used here only for reference), as well as the predefined type DURATION.

For objects of fixed types, 32 bits are used for the representation of the object.

For fixed there is a virtual predefined type for each possible value of small [Ada RM 3.5.9]. The possible values of small are the powers of two that are representable by a LONG\_FLOAT value, unless a length clause specifying T'SMALL is given, in which case the specified value is used.

The lower and upper bounds of these types are:

lower bound of fixed types	_ =	-2_147_483_648 * small
upper bound of fixed types	. =	2 147 483 647 * small

A declared fixed point type is represented as that predefined fixed type which has the largest value of small not greater than the declared delta, and which has the smallest range that includes the declared range constraint.

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Any fixed point type T has the following attributes:

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Appendix F of the Ada Reference	e Manu	al an	line polarie pola 2016 e dal 19
T'MACHINE_OVERFLOWS T'MACHINE_ROUNDS	8	TRUE TRUE	́с, ;
Type DURATION		<b>5</b> ,	* <b>1</b> * * *6a
The predefined fixed point type I	DURA	FION has the	following attributes
DURATION'AFT DURATION'DELTA DURATION'FIRST	= }	5 DURATION 131_072.0	SMALL

DURATION FORE	=	
DURATIONLARGE	=	1.31071999938965E05
DURATION'LAST	=	131 071.0
DURATION MANTISSA	=	31 .
DURATION'SAFE_LARGE	=	DURATION LARGE
DURATION'SAFE SMALL	=	DURATION'SMALL
DURATION'SIZE	=	32
DURATION'SMALL	=	$2^{**}(-14) = 6.10351562500000E-05$
,		

## F.2. Predefined Language Pragmas

This section lists all language-defined pragmas and any restrictions on their use and effect as compared to the definitions given in Ada RM.

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## F.2.1. Pragma CONTROLLED

This pragma has no effect, as no automatic storage reclamation is performed before the point allowed by the pragma.

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F.2.2. Pragma ELABCINATE

As in Ada RM.

## F.2.3. Pragma INLINE

This pragma causes inline expansion to be performed, except in the following cases:

- 1. The whole body of the subprogram for which inline expansion is wanted has not been seen. This ensures that recursive procedures cannot be inline expanded.
- 2. The subprogram call appears in an expression on which conformance checks may be applied, i.e., in a subprogram specification, in a discriminant part, or in a formal part of an entry declaration or accept statement.

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- 3. The subprogram is an instantiation of the predefined generic subprograms UNCHECKED CONVERSION or UNCHECKED DEALLOCATION. Calls to such subprograms are expanded inline by the compiler automatically.
- 4. The subprogram is declared in a generic unit. The body of that generic unit is compiled as a secondary unit in the same compilation as a unit containing a call to (an instance of) the subprogram.
- 5. The subprogram is declared by a renaming declaration.

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6. The subprogram is passed as a generic actual parameter.

A warning is given if inline expansion is not achieved.

### F.2.4. Pragma INTERFACE

This pragma is supported for the language names defined by the enumerated type INTERFACE\_LANGUAGE in package SYSTEM.

Language ASSEMBLY

Ada programs may call assembly language subprograms that have been assembled with the Unix assembler as(1). Note that if the host system is DECStation/ULTRIX, assemblies must be done using the -EB option; otherwise, object code will be produced according to the host (little-) endianism.

The compiler generates a call to the name of the subprogram (in all upper case). If a call to a different external name is desired, use pragma INTERFACE\_SPELLING in conjunction with pragma INTERFACE (see Section F.3).

Parameters and results, if any, are passed in the same fashion as for a normal Ada call (see Appendix P).

Assembly subprogram bodies are not elaborated at runtime, and no runtime elaboration check is made when such subprograms are called.

Assembly subprogram bodies may in turn call Ada program units, but must obey all Ada calling and environmental conventions in doing so. Furthermore, Ada dependencies (in the form of context clauses) on the called program units must exist. That is, merely calling Ada program units from an assembly subprogram body will not make those program units visible to the Ada Linker.

A pragma INTERFACE (ASSEMBLY) subprogram may be used as a main program. In this case, the procedure specification for the main program must contain context clauses that will (transitively) name all Ada program units.

If an Ada subprogram declared with pragma INTERFACE (ASSEMBLY) is a library unit, the assembled subprogram body object code module must be put into the program library via the Ada Library Injection Tool (see Chapter 7). The Ada Linker will then automatically include the object code of the body in a link, as it would the object code of a normal Ada body.

If the Ada subprogram is not a library unit, the assembled subprogram body object code module cannot be put into the program library. In this case, the user must direct the Ada Linker to the directory containing the object code module (via the -u option, see Section 5.1), so that the DACS Unix to MIPS R3000 Bare C uses Linker can find it.

#### Languages C, C++, Fortran, and Pascal

It is possible to use pragma INTERFACE to call subprograms written in these other languages supported by MIPS Computer Systems, Inc. derived compilers. (These are the compilers licensed by MIPS for their RISC/os systems, by Digital for their DECStation ULTRIX systems, etc.). This is because the object code format and the compiler protocols [*MIPS Appendix D*] used by the Compiler System are the same as those used in the MIPS-supplied compilers. (Note however that special data mapping is done peculiar to the other languages, e.g. it is the user's responsibility to null-terminate Ada strings when passing them to C, to reconcile Ada versus Fortran array layouts, etc.)

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To do this, compile such subprograms using the normal Unix compile command (cc(1), etc.). Note that if the host system is DECStation/ULTRDX, compiles must be done using the -EB option; otherwise, object code will be produced according to the host (little-) endianism.

Note that C++ is not a valid language name to pragma INTERFACE; use C instead.

#### F.2.5. Pragma LIST

As in Ada RM.

#### F.2.6. Pragma MEMORY SIZE

This pragma has no effect. See pragma SYSTEM'NAME.

#### F.2.7. Pragma OPTIMIZE

This pragma has no effect.

### F.2.8. Pragma PACK

This pragma is accepted for array types whose component type is an integer, enumeration, or fixed point type that may be represented in 32 bits or less. (The pragma is accepted but has no effect for other array types.)

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The pragma normally has the effect that in allocating storage for an object of the array type, the components of the object are each packed into the next largest 2<sup>a</sup> bits needed to contain a value of the component type. This calculation is done using the *minimal size* for the component type (see Section F.6.1 for the definition of the minimal size of a type).

However, if the array's component type is declared with a size specification length clause, then the components of the object are each packed into exactly the number of bits specified by the length clause. This means that if the specified size is not a power of two, and if the array takes up more than a word of memory, then some components will be allocated across word boundaries. This achieves the maximum storage compaction but makes for less efficient array indexing and other array operations.

Some examples:

type BOOL\_ARR is array (1..32) of BOOLEAN; -- BOOLEAN minimal size is 1 bit pragma PACK (BOOL\_ARR); -- each component packed into 1 bit F-5

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type TINY_INT is range -21; type TINY_APP is array (1, 32) of	•- minimal size is 2 bits
THE THE ARE IS BITBY (1.12) OF	strigter (
pragma PACK (TINT_ARK);	cach component packed into 2 bits
type SMALL_INT is range 063;	minimal size is 6 bits, not a power of two
type SMALL ARR is array (132) of	SMALL INT;
pragma PACK (SMALL_ARR);	thus, each component packed into 8 bits
type SMALL_INT_2 is range 063;	minimal size is 6 bits, but
for SMALL INT 2'SIZE use 6;	this time length clause is used
type SMALL_ARR_2 is array (132)	of SMALL_INT_2;
pragma PACK (SMALL_ARR_2);	thus, each component packed into 6 bits;
	some components cross word boundaries

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Pragma PACK is also accepted for record types but has no effect. Record representation clauses may be used to "pack" components of a record into any desired number of bits; see Section F.6.3.

#### F.2.9. Pragma PAGE

As in Ada RM.

### F.2.10. Pragma PRIORITY

As in Ada RM. See the DACS Univ to MIPS 12500 Bare / da Run-Time System User's Guide for how a default priority may be set.

### F.2.11. Pragma SHARED

This pragma has no effect, in terms of the compiler (and a warning message is issued).

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## F.2.12. Pragma STORAGE\_UNIT

This pragma has no effect. See pragma SYSTEM NAME.

#### F.2.13. Pragma SUPPRESS

Only the "identifier" argument, which identifies the type of check to b omitted, is allowed. The "[ON = >] name" argument, which isolates the check omission to a specific object, type, or subprogram, is not supported.

Pragma SUPPRESS with all checks other than DIVISION\_CHECK results in the corresponding checking code not being generated. The implementation of arithmetic operations is such that, in general, pragma SUPPRESS with DIVISION\_CHECK has no effect. In this case, runtime executive customizations may be used to mask the overflow interrupts that are used to implement these checks (see the DACS Unix to MIPS R3000 Bare Ada Run-Time System User's Guide for details).

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## F.2.14. Pragma SYSTEM NAME

This pragma has no effect. The only possible SYSTEM\_NAME is Mips. The compilation of pragma MEMORY\_SIZE, pragma STORAGE\_UNIT, or this pragma does not cause an implicit recompilation of package SYSTEM.

F.3. Implementation-dependent Pragmas

#### F.3.1. Pragma EXPORT

This pragma is used to define an external name for Ada objects, so that they may be accessed from non-Ada routines. The pragma has the form

pragma EXPORT (object\_name [,external\_name\_string\_literal]);

The pragma must appear immediately after the associated object declaration. If the second argument is omitted, the object name in all upper case is used as the external name. Note that the Unix assembler as(1) is casesensitive; the second argument must be used if the external name is to be other than all upper case.

The associated object must be declared in a library package (or package nested within a library package), and must not be a statically-valued scalar constant (as such constants are not allocated in memory).

Identical external names should not be put out by multiple uses of the pragma (names can always be made unique by use of the second argument).

Objects which are allocated indirectly by the compiler (such as dynamically-sized arrays and renames of dynamically-addressed objects) must be so interpreted by non-Ada routines.

As an example of the use of this pragma, the objects in the following Ada library package

```
package GLOBAL is
ABLE : FLOAT;
pragma EXPORT (ABLE);
Baker : STRING(1..8);
pragma EXPORT (Baker, "Baker");
```

end GLOBAL;

may be accessed in the following assembly language fragment

lw	\$8,ABLE	#	get	valúe	of	AE	BLE
la	\$9,Baker	#	get	addres	S (	of	Bake

## F.3.2. Pragma IMPORT

This pragma is used to associate an Ada object with an object defined and allocated externally to the Ada program. The pragma has the form

pragma IMPORT (object\_name [,external\_name\_string\_literal]);

The pragma must appear immediately after the associated object declaration. If the second argument is omitted, the object name in all upper case is used as the external name. Note that the Unix assembler as(1) is casesensitive; the second argument must be used if the external name is to be other than all upper case.

The associated object must be declared in a library package (or package nested within a library package). The associated object may not have an explicit or implicit initialization.

As an example of the use of this pragma, the objects in the following Ada library package

```
package GLOBAL is
ABLE : FLOAT;
pragma IMPORT (ABLE);
Baker : STRING(1..8);
pragma IMPORT (Baker, "Baker");
```

end GLOBAL;

are actually defined and allocated in the following assembly language fragment

```
.globl ABLE
.lcomm ABLE, 4
.globl Baker
.lcomm Baker, 8
```

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#### F.3.3. Pragma INTERFACE SPELLING

This pragma is used to define the external name of a subprogram written in another language, if that external name is different from the subprogram name (if the names are the same, the pragma is not needed). Note that the Unix assembler as(1) is case-sensitive; this pragma must be used if the external name is to be other than all upper case. The pragma has the form

pragma INTERFACE SPELLING (subprogram\_name, external\_name\_string\_literal);

The pragma should appear after the pragma INTERFACE for the subprogram.

This pragma is useful in cases where the desired external name contains characters that are not valid in Ada identifiers. For example,

procedure Connect\_Bus (SIGNAL : INTEGER); pragma INTERFACE (ASSEMBLY, Connect\_Bus); pragma INTERFACE\_SPELLING (Connect\_Bus, "Connect\_Bus");

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## F.3.4. Pragma SUBPROGRAM SPELLING

This pragma is used to define the external name of an Ada subprogram. Normally such names are compilergenerated, based on the program library unit number. The pragma has the form

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pragma SUBPROGRAM SPELLING (subprogram name [,external name\_string literal]);

The pragma is allowed wherever a pragma INTERFACE would be allowed for the subprogram. If the second argument is omitted, the object name in all upper case is used as the external name. Note that the Unix assembler as(1) is case-sensitive; the second argument must be used if the external name is to be other than all upper case.

This pragma is useful in cases where the subprogram is to be referenced from another language.

## F.4. Implementation-dependent Attributes

### F.4.1. X'PASSED BY REFERENCE

For a prefix X that denotes a formal parameter (of either a subprogram or an entry) or any type, this attribute yields the value TRUE if the formal parameter is (or would be, in the case of a type, assuming a formal parameter of that type) passed by reference; it yields the value FALSE otherwise, that is, when the formal parameter is (would be) passed by copy-in/copy-back [Ada RM 6.2 (6-8)]. The value of this attribute is of the predefined type BOOLEAN.

Examples of the use of this attribute:

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# F.5. Package SYSTEM

The specification of package SYSTEM is:

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package SYSTEM is

type ADDRESS	is new INTEGER;
ADDRESS NULL	: constant ADDRESS := 0:
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TUDA NAME	ic (Hino).
cype where	is (mips);
SYSTEM_NAME	: constant NAME := Mips;
STORAGE UNIT	: constant := 8:
NEMORY SIZE	<pre>constant += 4 # 1024 # 1024 # 1024+</pre>
417 M TH	
HIN_INI	: constant := -2_14/_483_04/-1;
MAX_INT	: constant := 2_147_483_647;
MAX_DIGITS	: constant := 15;
MAX_MANTISSA	: constant := 31;
FINE DELTA	: constant := 1.0 / 2.0 ** MAX MANTISSA.
TICK	• constant •= 1.0 / 2.0 ## 14.
TTCK .	· constant .= 110 / 2.0 14,
	• • • • • • •
subtype PRIORITY	is INTEGER range 0255;
type INTERFACE LANG	UAGE is (Assembly, C, Fortran, Pascal);
-	
these are the m	ssible ADDRESS values for interrupt entries
	t constant = 1 t 3tt2 (NOD is preserved used)
	; Constant := 1 = 2==2; (MOU is reserved Word)
1LOL	: constant := 2 * 2**2;
TLBS	: constant := 3 * 2**2;
Adel	: constant := 4 * 2**2;
Ades	: constant := 5 * 2**2;
186	: constant := 6 * 2**2;
DBE	: constant := 7 * 2**2:
Svs	: constant := 8 # 2**2+
BD	= 0 + 2 + 2
61 61	z = z = z = z = z = z = z = z = z = z =
	: constant := 10 ~ 22;
сро Ос	: constant := 11 = 2**2;
UVT	: constant := 12 = 2*=2;
Reserved13	: constant := 13 # 2**2;
Reserved14	: constant := 14 * 2**2;
Reserved15	: constant ;= 15 * 2**2;
SWO	: constant := 2**0 * 2**8:
SW1	: constant := 2**1 * 2**8
IPO	t = 200000000000000000000000000000000000
10	$\frac{1}{2} = \frac{1}{2} = \frac{1}$
100	$= 2^{-1} +$
1FC 107	: constant := 22 - 210;
IPS .	: constant := 2**3 * 2**10;
IP4	: constant := 2*#4 # 2**10;
195	: constant := 2**5 * 2**10;
these are only m	meaningful for the GISA processor
GISAO	: constant := IPO + 1 + 0:
GISAI	t = 100 to $t = 100 + 1 + 1$
CISA2	= 100 + 100 + 1 + 2
	$\frac{1}{2} = \frac{1}{2} = \frac{1}$
GISAS	: constant := 1PU + 1 + 5;
UISA4	: constant := IFU + 1 + 4;
GISAS	: constant := IPO + 1 + 5;
GISA6	: constant := 1P0.+ 1 + 6;
GISA7	: constant := IPO.+ 1 + 7;
GISA8	: constant := 1P0 + 1 + 8;
GISA9	: constant := $IPO + 1 + 9$
GISA10	+ constant $+$ IPO + 1 + 10+
010A10	= U U U U U U U U U U U U U U U U U U
010410	: constant :* IPU + 1.+ 11;
GISATZ	: constant := IPU + 1 + 12;

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GISA13	:	constant	:=	190	+	1	+	13;
GISA14	:	constant	:=	IFO	٠	1	٠	14;
GISA15	:	constant	:=	IP0	+	1	+	15;
GISA16	:	constant	:=	[P0	٠	1	•	16;
GISA17	:	constant	:=	100	+	1	+	17;
GISA18	:	constant	:=	IP0	+	1	÷	18;
GISA19	:	constant	:=	IP0	+	1	+	19;
GISA20	:	constant	:=	190	+	1	+	20;
GISA21	:	constant	:=	190	+	1	+	21;
GISA22	:	constant	:=	160	+	1	+	22;
GISA23	<u>۰</u> :	constant	:=	190	+	1	+	23;
GISAZ4	:	constant	:=	100	+	1	+	24;
GISA25	:	constant	;=	190	÷	1	÷	25;
GISA26	:	constant	:=	IPO	+	1	÷	25;
GISA27	:	constant	:=	190	+	1	+	27;
GISA28	:	constant	:=	IPO	+	1	+	28;
GISA29	:	constant	;=	190	+	1	+	29;
GISA30	:	constant	:=	IFO	+	1	٠	30;
GISA31	:	constant	:=	IPJ	+	1	÷	31;

end SYSTEM;

Note that since timers are not part of the MIPS R3000 architecture specification, different MIPS R3000 target implementations may contain timers with varying characteristics. This has an effect on the granularity of the CLOCK function in package CALENDAR. The value of the named number TICK above, which represents that granularity, corresponds to the MIPS R3000 target implementation that the DACS Unix to MIPS R3000 Bare Ada Cross Compiler System is validated upon. It also is the most common value for the different MIPS R3000 target implementations that the Compiler System supports; however, for some supported target implementations, it is incorrect.

For more details on timers and the different MIPS R3000 target implementations, see the DACS Unix to MIPS R3000 Bare Ada Run-Time System User's Guide.

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F.6.	Type Representa	tion Clauses	Ē.	•.		•	•	

The three kinds of type representation clauses - length clauses, enumeration representation clauses, and record representation clauses - are all allowed and supported by the compiler. This section describes any restrictions placed upon use of these clauses.

Change of representation [Ada RM 13.6] is allowed and supported by the compiler. Any of these clauses may be specified for derived types, to the extent permitted by Ada RM.

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F.6.1. Length Clauses	tana Nasaran Lat		, <del>-</del> , · · · , · · ·

The compiler accepts all four kinds of length clauses.

Size specification: T'SIZE

The size specification for a type T is accepted in the following cases.

If T is a discrete type then the specified size must be greater than or equal to the *minimal size* of the type, which is the number of bits needed to represent a value of the type, and must be less than or equal to the size of the underlying predefined integer type.

The calculation of the minimal size for a type is done not only in the context of length clauses, but also in the

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context of pragma PACK, record representation clauses, the TSIZE attribute, and unchecked conversion. The definition presented here applies to all these contexts.

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The minimal size for a type is the minimum number of bits required to represent all possible values of the type. When the minimal size is calculated for discrete types, the range is extended to include zero if necessary. That is, both signed and unsigned representations are taken into account, but not biased representations. Also, for unsigned representations, the component subtype must belong to the predefined integer base type normally associated with that many bits.

Some examples:

type SHALL\_INT is range -2..1; for SHALL\_INT'SIZE use 2; -- OK, signed representation, needs minimum 2 bits type U\_SHALL\_INT is range 0..3; for U\_SHALL\_INT'SIZE use 2; -- OK, unsigned representation, needs minimum 2 bits type B\_SHALL\_INT is range 7..10; for B\_SHALL\_INT'SIZE use 2; -- illegul, would be biased representation for B\_SHALL\_INT'SIZE use 2; -- OK, the extended 0..10 range needs minimum 4 bits

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type U\_BIG\_INT is range 0..2\*\*32-1; for U\_BIG\_INT/SIZE use 32; -- illegal, range outside of 32-bit INTEGER predefined type

If T is a fixed point type then the specified size must be greater than or equal to the minimal size of the type, and less than or equal to the size of the underlying predefined fixed point type. The same definition of minimal size applies as for discrete types.

If T is a floating point type, an access type or a task type, the specified size must be equal to the number of bits normally used to represent values of the type (32 or 64 for floating point types, 32 for access and task types).

If T is an array type the size of the array must be static and the specified size must be equal to the minimal number of bits needed to represent a value of the type. This calculation takes into account whether or not the array type is declared with pragma PACK.

If T is a record type the specified size must be equal to the minimal number of bits needed to represent a value of the type. This calculation takes into account whether or not the record type is declared with a record representation clause.

The effect of a size specification length clause for a type depends on the context the type is used in.

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The allocation of objects of a type is unaffected by a length clause for the type. Objects of a type are allocated to one or more storage units of memory. The allocation of components in an array type is also unaffected by a length clause for the component type (unless the array type is declared with pragma PACK); components are allocated to one or more storage units. The allocation of components in a record type is always unaffected by a length clause for any component types; components are allocated to one or more storage units, unless a record representation clause is declared, in which case components are allocated according to the specified component clauses.

There are two important contexts where it is necessary to use a length clause to achieve a certain representation. One is with pragma PACK, when component allocations of a non-power-of-two bit size are desired (see Section F.2.8). The other is with unchecked conversion, where a length clause on a type can make that type's size equal to another type's, and thus allowed the unchecked conversion to take place (see Section F.9).

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## Specification of collection size: T'STORAGE\_SIZE

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This value controls the size of the collection (implemented as a local heap) generated for the given access type. It must be in the range of the predefined type NATURAL. Space for the collection is deallocated when the scope of the access type is left.

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See the DACS Unix to MIPS R3000 Bare Ada Run-Time System User's Guide for full details on how the storage in collections is managed.

Specification of storage for a task activatioa: TSTORAGE SIZE

This value controls the size of the stack allocated for the given task. It must be in the range of the predefined type NATURAL.

It is also possible to specify, at link time, a default size for all task stacks, that is used if no length clause is present. See the DACS Unix to MIPS R3000 Bare Ada Run-Time System User's Guide for full details, and for a general description of how task stacks, and other storage associated with tasks, are allocated.

Specification of a small for a fixed point type: T'SMALL

Any real value (less than the specified delta of the fixed point type) may be used.

#### F.6.2. Enumeration Representation Clauses

Enumeration representation clauses may only specify representations in the range of the predefined\_type INTEGER.

When enumeration representation clauses are present, the representation values (and not the logical values) are used for size and allocation purposes. Thus, for example,

```
type ENUM is (ABLE, BAKER, CHARLIE);
for ENUM use (ABLE => 1, BAKER => 4, CHARLIE => 9);
for ENUM'SIZE use 2; -- illegal, 1..9 range needs minimum 4 bits
for ENUM'SIZE use 4; -- OK
type ARR is array (ENUM) of INTEGER; -- will occupy 9 storage units, not 3
```

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Enumeration representation clauses often lead to less efficient attribute and indexing operations, as noted in [Ada RM 13.3 (6)].

## F.6.3. Record Representation Clauses

Alignment clauses are allowed.

The permitted values are 1, 2, and 4. However, if the type is used as the component type of an array type, then the only permitted value is 1.

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In terms of allowable component clauses, record components fall into three classes, depending on their type:

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integer, enumeration, and fixed point types whose minimal size (see Section F.6.1) is less than 32 bits;

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- statically-bounded array types declared with pragma PACK, and record types declared with a record representation clause;
- all others.

Components of the "less-than-32-bit integer/enumeration/fixed" class may be given a component clause that specifies a storage place at any bit offset, and for any number of bits, as long as the storage place is greater than or equal to the minimal size of the component type, and less than or equal to 32 bits. Furthermore, if the storage place is less than 32 bits, the component may cross a word boundary.

Components of the "packed array/record rep clause" class may be given a component clause that specifies a storage place at any bit offset, if the size of the array or record is less than a word, or at a word offset otherwise. The size of the storage place must be the same as the minimal size of the array or record type. Note that the component clause for an array or record component type cannot specify a representation different from that of the component's type.

Components of the "all others" class may only be given component clauses that specify a storage place at a word offset, and for exactly the number of bits normally allocated for objects of the underlying base type.

If a component clause is used for a discriminant, that discriminant must be the only discriminant of the record type.

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An example of the rule regarding array and record component types:

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```
type SMALL_INT is range 0..15;
type INNER_REC is record
  A : SMALL_INT;
  B : SMALL_INT;
end record;
type BOOL_ARR is array (1..8) of BOOLEAN;
type REC ILLEGAL is record
   IR : INNER_REC;
                      •
   BA : BOOL ARR;
end record;
for REC_ILLEGAL use record
                          -- illegal, not enough storage space
   IR at 0 range 0..7;
   BA at 0 range 8..15;
                         -- illegal, not enough storage space
end record;
type INNER_REC_R is new INNER_REC;
for INNER_REC_R use record
   A at 0 range 0..3;
   B at 0 range 4...7;
end record;
type BOOL_ARR_P is new BOOL_ARR;
pragma PACK (BOOL_ARR_P);
type REC_LEGAL is record
   IR : INNER_REC_R;
   BA : BOOL_ARR_P;
end record;
for REC_LEGAL use record
                           -- OK, now that component type is packed
   IR at 0 range 0..7;
   BA at 0 range 8..15; -- OK, now that component type has rep. clause
end record;
```

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Component clauses do not have to be in storage order, and there may be gaps in storage between component clauses. No other components are allocated in such gaps.

Components that do not have component clauses are allocated in storage places beginning at the next word boundary following the storage place of the last component in the record that has a component clause.

Records with component clauses cannot exceed 1K words (32K bits) in size.

The ordering of bits within storage units is defined to be big-er.dian. That is, bit 0 is the most significant bit and bit 31 is the least significant bit. Note that this convention differs from the one used in [MIPS p. 2-6] for bit-ordering.

F.7. Implementation-dependent Names for Implementation-dependent Components

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## F.8. Address Clauses

Address clauses are allowed for variables (objects that are not constants), and for interrupt entries. Address clauses are not allowed for constant objects, or for subprogram, package, or task units. 

Address clauses occurring within generic units are always allowed at that point, but are not allowed when the units are instantiated if they do not conform to the implementation restrictions described here. (Note that the effect of such address clauses may depend on the context in which they are instantiated; for example, whether multiple address clauses specifying the same address are erroneous may depend on whether they are instantiated into library packages or subprograms.)

#### F.S.1. Address Clauses for Variables

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Address clauses for variables must be static expressions of type ADDRESS in package SYSTEM.

It is the user's responsibility to reserve space at link time for the object. See the DACS Unix to MIPS R3000 Bare Cross Linker Reference Manual for the means to do this. Note that to conform with Compiler System assumptions, space so reserved should begin and end on 16-byte storage boundaries, even if the variable itself is not allocated on a 16-byte storage boundary. Also note that any bit-addressed object (a packed array or a record with a representation clause) must be allocated on a fullword (4-byte) boundary.

Because the value of a variable with an address clause must also be stored in memory, rather than kept in a register, compilations of source units containing references to address clause variables are done with less optimizations than normal. The compiler issues a warning message when this happens. The user may want to isolate such references into small, separately compiled units, to limit the effect of this consequence. æ

Type ADDRESS is a 32-bit signed integer. Thus, addresses in the memory range 16#8000 0000#..16#FFFF FFFF# (i.e., the upper half of target memory) must be supplied as negative numbers, since the positive (unsigned) interpretations of those addresses are greater than ADDRESS'LAST. Furthermore, addresses in this range must be declared as named numbers, with the named number (rather than a negative numeric literal) being used in the address clause. The hexadecimal address can be retained in the named number declaration, and user computation of the negative equivalent avoided, by use of the technique illustrated in the following example:

X : INTEGER; for X use at 16#7FFF FFFF#; -- legal Y : INTEGER: for Y use at 16#FFFF FFFF#; -- illegal ADDR\_HIGH : constant := 16#FFFF\_FFFF# - 2\*\*32; Y : INTEGER; for Y use at ADDR\_HIGH; -- legal, equivalent to unsigned 16#FFFF\_FFFF#

### F.8.2. Address Clauses for Interrupt Entries

Address clauses for interrupt entries do not use target addresses but rather, the values in the target Cause register that correspond to particular interrupts. For convenience these values are defined as named numbers in package SYSTEM, corresponding to the mnemonics used in [MIPS pp. 5-4, 5-5]. Note that if the -w compile option is on, indicating that the target is the Westinghouse GISA architecture, an additional set of interrupt values is available (see Sections 4.1.1 and F.5).

The following restrictions apply to interrupt entries. An interrupt entry must not have formal parameters. Direct calls to an interrupt entry are not allowed. An accept statement for an interrupt entry must not be part of a selective wait, i.e., must not be part of a select statement. If any exception can be raised from within the accept statement for an interrupt entry, the accept statement must include an exception handler.

When the accept statement is encountered, the task is suspended. If the specified interrupt occurs, execution of the accept statement begins. When control reaches end of the accept statement, the special interrupt entry processing ends, and the task continues normal execution. Control must again return to the point where the accept statement is encountered in order for the task to be suspended again, awaiting the interrupt.

There are many more details of how interrupt entries interact with the target machine state and with the Runtime Executive. For these details, see the DACS Unix to MIPS R3000 Bare Ada Run-Time System User's Guide.

#### F.9. Unchecked Conversion

Unchecked type conversions are allowed and supported by the compiler.

Unchecked conversion is only allowed between types that have the same size. In this context, the size of a type is the *minimal size* (see Section F.6.1), unless the type has been declared with a size specification length clause, in which case the size so specified is the size of the type.

In addition, if UNCHECKED\_CONVERSION is instantiated with an array type, that array type must be statically constrained.

In general, unchecked conversion operates on the data for a value, and not on type descriptors or other compiler-generated entities.

For values of scalar types, array types, and record types, the data is that normally expected for the object. Note that objects of record types may be represented in two ways that might not be anticipated: there are compilergenerated extra components representing array type descriptors for each component that is a discriminantdependent array, and all dynamically-size array components (whether discriminant-dependent or not) are represented indirectly in the record object, with the actual array data in the system heap.

For values of an access type, the data is the address of the designated object; thus, unchecked conversion may be done in either direction between access types and type SYSTEM.ADDRESS (which is derived from type INTEGER). (The only exception is that access objects of unconstrained access types which designate unconstrained array types cannot reliably be used in unchecked conversions.) The named number SYSTEM.ADDRESS\_NULL supplies the type ADDRESS equivalent of the access type literal null. Note however that due to compiler assumptions about the machine alignment properties of objects, unchecked conversions from SYSTEM.ADDRESS to access objects must be done on 4-byte (word) aligned addresses only.

For values of a task type, the data is the address of the task's Task Control Block (see the DACS Unix to MIPS R3000 Bare Ada Run-Time System User's Guide).

For unchecked conversions involving types with a size less than a full word of memory, and different representational adjustment within the word (scalar types are right-adjusted within a word, while composite types are leftadjusted within a word), the compiler will correctly readjust the data as part of the conversion operation.

Some examples to illustrate all of this:

type BOOL\_ARR is array(1..32) of BOOLEAN; pragma PACK (BOOL\_ARR);

F-18	1 Line 200 Company Appendix F of the Ada Reference Manual
	function UC is new UNCHECKED_CONVERSION (BOOL_ARR, INTEGER); OK, both have size 32
	type BITS_8 is array(18) of BOOLEAN; pragma PACK (BITS_8);
	function UC is new UNCHECKED_CONVERSION (BITS_8, INTEGER); illegal, sizes are 8 and 32
	type SMALL_INT is range -128127; function UC is new UNCHECKED_CONVERSION (BITS_8, SMALL_INT);OK, both have size 8
	type BYTE is range 0255; function UC is new UNCHECKED_CONVERSION*(BITS_8, BYTE);OK, both have size 8
	type BIG_BOOLEAN is new BOOLEAN; for BIG_BOOLEAN'SIZE use 8; function UC is new UNCHECKED_CONVERSION (BITS_8, BIG_BOOLEAN);OK, both have size 8
	SM : SMALL_INT; actual data is rightmost byte in object's word BI : BITS_8; actual data is leftmost byte in object's word
	$s = 10^{\circ}$ (BI): setupi data is moved from leftmost to rightmost but as part of conversion

Calls to instantiations of UNCHECKED CONVERSION are always generated as inline calls by the compiler.

The instantiation of UNCHECKED CONVERSION as a library unit is not allowed. Instantiations of UNCHECKED CONVERSION may not be used as generic actual parameters.

## F.10. Other Chapter 13 Areas

### F.10.1. Change of Representation

Change of representation is allowed and supported by the compiler.

#### F.10.2. Representation Attributes

All representation attributes [Ada RM 13.7.2, 13.7.3] are allowed and supported by the compiler.

For certain usages of the X'ADDRESS attribute, the resulting address is ill-defined. These usages are: the address of a constant scalar object with a static initial value (which is not located in memory), the address of a loop parameter (which is not located in memory), and the address of an inlined subprogram (which is not uniquely located in memory). In all such cases the value SYSTEM.ADDRESS\_NULL is returned by the attribute, and a warning message is issued by the compiler.

When the X'ADDRESS attribute is used for a package, the resulting address of that of the machine code associated with the package specification.

The X'SIZE attribute, when applied to a type, returns the *minimal size* for that type. See Section F.6.1 for a full definition of this size. However, if the type is declared with a size specification length clause, then the size so specified is returned by the attribute.

Since objects may be allocated in more space than the minimum required for a type (see Section F.6.1), but not less, the relationship O'SIZE > = T'SIZE is always true, where O is an object of type T.

## F.10.3. Machine Code Insertions

Machine code insertions are not allowed by the compiler. Note that pragma INTERFACE (ASSEMBLY) may be used as a (non-inline) alternative to machine code insertions.

#### F.10.4. Unchecked Deallocation

Unchecked storage deallocation is allowed and supported by the compiler.

Calls to instantiations of UNCHECKED\_DEALLOCATION are always generated as inline calls by the compiler.

The instantiation of UNCHECKED\_DEALLOCATION as a library unit is not allowed. Instantiations of UNCHECKED\_DEALLOCATION may not be used as generic actual parameters.

#### F.11. Input-Output

The predefined library generic packages and packages SEQUENTIAL IO, DIRECT IO, and TEXT IO are supplied. However, file input-output is not supported except for the standard input and output files. Any attempt to create or open a file will result in USE\_ERROR being raised.

TEXT\_IO operations to the standard input and output files are implemented as input from or output to some visible device for a given MIPS R3000 target implementation. Depending on the implementation, this may be a console, a workstation disk drive, simulator files, etc. See the DACS Unix to MIPS R3000 Bare Ada Run-Jime System User's Guide for more details. Note that by default, the standard input file is empty.

The range of the type COUNT defined in TEXT\_IO and DIRECT\_IO is 0. SYSTEM.MAX\_INT.

The predefined library package LOW\_LEVEL\_IO is empty.

In addition to the predefined library units, a package STRING\_OUTPUT is also included in the predefined library. This package supplies a very small subset of TEXT\_IO operations to the device connected to the standard output file. (It does not use the actual standard output file object of TEXT\_IO, so TEXT\_IO state functions such as COL, LINE, and PAGE are unaffected by use of this package).

The specification of STRING\_OUTPUT is:

```
package STRING_OUTPUT is
procedure PUT (ITEM : in STRING);
procedure PUT_LINE (ITEM : in STRING);
procedure NEW_LINE;
end STRING_OUTPUT;
```

By using the 'IMAGE attribute function for integer and enumeration types, a fair amount of output can be done using this package instead of TEXT\_IO. The advantage of this is that STRING\_OUTPUT is smaller than TEXT\_IO in terms of object code size, and laster in terms of execution speed.

Use of TEXT\_IO in multiprogramming situations (see Chapter 5) may result in unexpected exceptions being

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raised, due to the shared unit semantics of multiprogramming. In such cases STRING\_OUTPUT may be used instead.

F.12. Compiler System Capacity Limitations

The following capacity limitations apply to Ada programs in the Compiler System:

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- the names of all identifiers, including compilation units, may not exceed the number of characters specified by the INPUT\_LINELENGTH component in the compiler configuration file (see Section 4.2.2);
- a sublibrary can contain at most 4096 compilation units (library units or subunits). A program library can contain at most eight levels of sublibraries, but there is no limit to the number of sublibraries at each level. An Ada program can contain at most 32768 compilation units.

The above limitations are all diagnosed by the compiler. Most may be circumvented straightforwardly by using separate compilation facilities.

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## F.13. Implementation-dependent Predefined Library Units

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In addition to the predefined library units required by [Ada RM Annex C], the predefined library in the Compiler System is delivered with several other library units that application developers may be interested in. These are:

• package STRING\_OUTPUT, described in Section F.11 above

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- a number of packages constituting the Application Runtime Interfaces, which allow for applications to access or control runtime executive functions in ways that are in addition to, or an alternate to, standard Ada language features. These are described in the DACS Unix to MIPS R3000 Bare Ada Run-Time System User's Guide.
- generic package GENERIC MATH FUNCTIONS. This is a public domain math package, taken from the Ada Software Repository, based on the algorithms of Cody and Waite. It supplies a set of elementary mathematics functions. The source for both the specification and the body of the package can be extracted from the predefined library through the Ada PLU type command.

In addition to these units, there are also a number of units in the predefined library that are used as part of the runtime system itself. These are "called" by the code generated by the compiler, and are not intended for direct use by application developers.