# GNU Algol 68 Internals

For GCC version 16.0.1 (pre-release)

(GCC)

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# Short Contents

1 Scope Checking . . . . . 1
2 Storage Management . . . . . 3
3 Lowering Declarations . . . . . 5
4 Lowering Assignations . . . . . 9
GNU Free Documentation License . . . . . 11
Index . . . . . 19

# Table of Contents

**1 Scope Checking** . . . . . **1**

**2 Storage Management** . . . . . **3**

2.1 Storage Structure of Objects . . . . . 3
2.2 Copying of Objects . . . . . 3
2.3 The Stack . . . . . 3
2.4 The Heap . . . . . 3

**3 Lowering Declarations** . . . . . **5**

3.1 Identity Declarations . . . . . 5
3.2 Variable Declarations . . . . . 6
3.3 Procedure Identity Declarations . . . . . 6
3.4 Procedure Variable Declarations . . . . . 6
3.5 Operator Brief Declarations . . . . . 6
3.6 Operator Declarations . . . . . 6
3.7 Applied Identifiers . . . . . 7

**4 Lowering Assignations** . . . . . **9**

**GNU Free Documentation License** . . . . . **11**

ADDENDUM: How to use this License for your documents . . . . . 18

**Index** . . . . . **19**

# 1 Scope Checking

Static scope checking: pass. Dynamic scope checking: run-time call.

# 2 Storage Management

This chapter discusses the run-time management of internal objects in Algol 68.

First, a conceptual model is presented that describes the restrictions as mandated by the Report. The storage implied by the lowered GENERIC entities, as described in the previous chapter, shall match the storage of the conceptual model.

## 2.1 Storage Structure of Objects

The internal objects which are the values in an Algol 68 program may consist on a hierarchy of memory locations, which may not be contiguous. This hierarchy of memory locations is the storage structure of the object, and is not concerned by the particular bit-patterns stored.

Simple values.

Names.

Multiple values.

Structured values.

Values of united modes.

## 2.2 Copying of Objects

## 2.3 The Stack

XXX

## 2.4 The Heap

- A value that has rows and gets returned by a procedure shall be allocated on the stack.
- A copy of the right hand side is made before assigning it to the left hand side. This copy is always allocated in the heap, because the scope of the left hand side may be older than the scope of the right hand side. This happens when assigning to a global variable.
- A trimmer of a name. This is because the trimmed multiple may be allocated on the heap, and the trim shall have the same scope than the trimmed multiple.

# 3 Lowering Declarations

This chapter describes the mapping between external objects declared in identity and variable declarations and the internal objects that are the result of lowering the external objects in the parse tree into GENERIC entities.

## 3.1 Identity Declarations

An identity declaration with the form:

```
c part 1 c
amode defining_identifier = unit;
c part 2 c
```

Introduces the identifier `defining_identifier` in the current range and ascribes a copy of the value yielded by `unit` to it. Once established, the relationship between an identifier and the value ascribed to it is constant and it cannot change during the reach of the identifier. The ascribed unit can be any unitary clause, and its elaboration can be arbitrarily complicated. In particular, it is not required to be a compile-time constant. **amode** determines the mode of the value yielded by the unit, and the unit is elaborated in a strong context.

An identity declaration like the above, where **amode** is not a procedure mode (See Section 3.3 [Procedure Identity Declarations], page 6) is lowered into:

- A `VAR_DECL` with name `defining_identifier`, type `CTYPE (amode)` and initial value **amode(skip)** that gets chained into the declarations list of the current block.
- A `DECL_EXPR` that gets prepended in the current statement's list.
- A `MODIFY_EXPR` setting the `VAR_DECL` to a copy of the lowering of `unit`, `a68_low_dup (unit)`.

Schematically:

```
BIND_EXPR (BLOCK (DECLS: ... -> VAR_DECL (defining_identifier, INITIAL=SKIP)))
  STMT_LIST
  |
  +-- DECL_EXPR (defining_identifier)
  |
  |   c part 1 c
  |
  +-- MODIFY_EXPR (defining_identifier, unit)
  |
  |   c part 2 c
  |
```

The reason why the `VAR_DECL` is initialized to **skip** and then set to the initial `unit` specified in the source line is that the Report specifies that Algol 68 identifiers can be used before they are defined provided we are in the right range, but in that case the value ascribed to the identifier is "undefined". Accessing an "undefined" value in traditional Algol 68 implementations would lead to a run-time error (these implementations used a special value to denote undefined, such as `FOOL`) but in GNU Algol 68 the "undefined" value is always **skip** which, if not terribly useful in most cases, is at least well defined in this implementation and doesn't lead to an error.

Identity declarations are the Algol 68 way of defining constants, and one may wonder why we are not using `CONST_DECL` instead of `VAR_DECL`. The reason is that `CONST_DECL` is really only intended for integral values in C enums, and the **amode** in the identity declaration can really be any mode, from simple integers or characters to fairly complicated structured modes, which may involve also rows and united modes. Whether the `VAR_DECL` will lead to allocating storage on the stack depends on the nature of the mode and the way the identifier is used in the program: whether its address is taken, etc.

## 3.2 Variable Declarations

A variable declaration with the form:

**[loc|heap] amode** `defining identifier [:= unit];`

Is in principle equivalent to the identity declaration:

**ref amode** `defining identifier = [loc|heap]` **amode**`;`

In both cases the object ascribed to the defining identifier is of mode **ref amode**. The ascribed object is a name which is created by a generator implied in the actual declarer in the variable declaration case, and an explicit generator in the initialization expression in the identity declaration case.

However, in this compiler these two cases are handled differently in order to reduce the amount of both indirect addressing and of storage:

- The variable declaration **[loc|heap] amode** `foo` lowers into a `VAR_DECL` with type `CTYPE (amode)` provided that the generator is **loc** and that the type contains no rows. Accessing the variable will then involve direct addressing, and when its address is required an `ADDR_EXPR` shall be used.
- The identity declaration **ref amode** `foo =` **loc amode** lowers into a `VAR_DECL` with type `*CTYPE (amode)`. Accessing the variable will then involve indirect addressing: it is effectively a pointer.

This optimization introduces the complication that an expression (the `VAR_DECL`) whose type is TYPE can appear in a place where *TYPE is expected, depending on the context and the r-value and l-value interpretation of the `VAR_DECL`. The function `a68_consolidate_ref` is used in several parts of the lowering pass to guarantee a given name is an address regardless of how it was initialized.

## 3.3 Procedure Identity Declarations

XXX

## 3.4 Procedure Variable Declarations

XXX

## 3.5 Operator Brief Declarations

XXX

## 3.6 Operator Declarations

XXX

## 3.7 Applied Identifiers

XXX

# 4 Lowering Assignations

Scope checking:

- If static scope checking is relevant and OK, then just perform assignation.
- If static scope checking is relevant and not OK, a compile-time error will have already being emitted.
- If static scope checking is not relevant, perform dynamic scope checking: each time a name, a routine or a format of the data structure is assigned, its dynamic scope (scope%_si) is compared with the one of the destination (scope%_d). A run-time error message is provided in case scope%_d < scope%_si.

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