

Data Types

- Every data object in VHDL can hold a value that belongs to a set of values.
- This set of values is specified by using a *type declaration*.
- A *type* is a name that has associated with it a set of values and a set of operations.

Types of Data Types in VHDL

- 1. Scalar types: Values belonging to these types appear in a sequential order.***
- 2. Composite types: These are composed of elements of a single type (an array type) or elements of different types (a record type).***
- 3. Access types: These provide access to objects of a given type (via pointers).***
- 4. File types: These provides access to objects that contain a sequence of values of a given type.***

It is possible to derive restricted types, called subtypes, from other predefined or user-defined types.

Subtypes

- A subtype is a type with a constraint. The constraint specifies the subset of values for the type.
- The type is called the base type of the subtype. An object is said to belong to a subtype if it is of the base type and if it satisfies the constraint.
- Subtype declarations are used to declare subtypes. An object can be declared to either belong to a type or to a subtype.

Subtypes cont..

- The set of operations belonging to a subtype is the same as that associated with its base type. Subtypes are useful for range checking and for imposing additional constraints on types.
- Examples of subtypes are
 - **subtype MY_INTEGER is INTEGER range 48 to 156 ;**
 - **type DIGIT is ('0', '1', '2', '3', '4', '5', '6', '7', '8', '9') ;**
 - **subtype MIDDLE is DIGIT range '3' to '7' ;**

1. Scalar Types

- There are four different kinds of scalar types. These types are

1. enumeration,

Discrete Type

2. integer,

3. physical,

4. floating point.

Numeric
Type

Position
no
Associat
e

- BIT- 0 and 1
- BOOLEAN – True and False
- SEVERITY_LEVEL- NOTE, WARNING, ERROR, FAILURE
- FILE_OPEN_KIND- READ_MODE, WRITE_MODE, APPEND_MODE
- FILE_OPEN_STATUS- OPEN_OK, STATUS_ERROR, NAME_ERROR, MODE_ERROR

Enumeration Types

- An enumeration type declaration defines a type that has a set of user-defined values consisting of identifiers and character literals. Examples are –
- **Type MVL is ('U','0','1','Z');**
- **type MICRO_OP is (LOAD, STORE, ADD, SUB, MUL, DIV);**
- **subtype ARITH_OP is MICRO_OP range ADD to DIV;**

Enumeration Types cont..

- Examples of objects defined for these types are
- **signal CONTROL_A: MVL;**
- MVL is an enumeration type that has the set of ordered values, 'U', '0', '1', and 'Z'.
- The values of an enumeration type are called enumeration literals. For example, consider the following enumeration type declaration.
- **type CAR_STATE is (STOP, SLOW, MEDIUM, FAST);**

Integer Types

- An integer type defines a type whose set of values fall within a specified integer range. Examples of integer type declarations are
- **type INDEX is range 0 to 15;**
- **type WORD_LENGTH is range 31 downto 0;**
- **subtype DATA_WORD is WORD_LENGTH range 15 downto 0;**

Integer Types cont..

- Some object declarations using these types are
- **constant MUX_ADDRESS: INDEX := 5;**
- **signal DATA_BUS: DATA_WORD;**
- Values belonging to an integer type are called *integer literals*. *Examples of integer literals are*
- 56349 6E2 0 98_71_28
- INTEGER is the only predefined integer type of the language. The range of the

Floating Point Types

- A floating point type has a set of values in a given range of real numbers. Examples of floating point type declarations are
 - **type TTL_VOLTAGE is range -5.5 to -1.4;**
 - **type REAL_DATA is range 0.0 to 31.9;**
- An example of an object declaration is
 - **variable LENGTH: REAL_DATA range 0.0 to 15.9;**

Floating Point Types cont..

- *Floating -point literals are values of a floating point type. Examples of floating point literals are*
- 16.26 0.0 0.002
3_1.4_2
- The only predefined floating point type is REAL.

Physical Types

- A physical type contains values that represent measurement of some physical quantity, like time, length, voltage, and current. Values of this type are expressed as integer multiples of a base unit. An example of a physical type declaration is

type CURRENT is range 0 to 1 E9

units

| | |
|--------------------|----------------------------|
| nA; | -- (base unit) nano-ampere |
| uA = 1000 nA; | -- micro-ampere |
| mA = 1000 μ A; | --milli-ampere |
| Amp = 1000 mA; | -- ampere |