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,
2. integer,
3. physical,
4. floating point.

Position no Associate

Discrete Type

Numeric Type

- 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, STATTUS_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 μA;	--milli-ampere
Amp = 1000 mA;	-- ampere