

A String Manipulation Package for VHDL

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Summary

One important aspect of VHDL is its ability to abstractly model hardware systems. Such models can be invaluable for hardware/software co-design and large system design. When using abstract models, VHDL users often experience great difficulty in manipulating characters and strings due to a lack of a standard set of string manipulation routines. To ease the development of behavioral models that manipulate strings, a standard string convention and the VHDL string package (VSP) is described.

When employing VHDL for abstract modeling, powerful string support can simplify the code development task and the resulting model. For example, consider the case of performance models of a multiprocessor system and its interconnection network. A convenient way to encode a path through the switching fabric is an address consisting of a string of characters corresponding to the concatenation of the port names of each switch along the path. While modeling the network behavior, a number of string manipulations are required including computing the string lengths, comparing string, searching strings for patterns, and copying strings. Providing standard routines to the system modeler significantly eases the model development time and complexity, as well as increasing interoperability and reuse potential.

VSP includes several routines to support character manipulation, string manipulation, and string search operations. The VSP manipulation routines assume strings are null terminated as with C [1]. A set of character and string test and manipulation routines allow character parsing for applications such as testbench support or the abstract modeling example described above. In addition, VSP provides a powerful string search capability based on regular expressions. A designer can characterize a wide range of pattern types using regular expressions and quickly search strings for pattern matches. The Std_DevelopersKit provides similar functionality for string manipulation and also supports string conversion and file I/O, but does not include the string search and pattern match capabilities of VSP [2].

The character manipulation routines include:

MakeUpper(Character)	Character function	Converts character to upper case
MakeLower(Character)	Character function	Converts character to lower case
IsDigit(Character)	Boolean function	Returns true if character is a digit
IsXDigit(Character)	Boolean function	Returns true if character is a hexadecimal digit
IsAlpha(Character)	Boolean function	Returns true if character is a letter
IsSpace(Character)	Boolean function	Returns true if character is a space
IsUpper(Character)	Boolean function	Returns true if character is upper case
IsLower(Character)	Boolean function	Returns true if character is lower case
CharCmp(Character,Character)	Boolean function	Returns true if characters are same
CharCmpNC(Character,Character)	Boolean function	Case insensitive version of CharCmp()

The string manipulation routines include:

StrLen(String)	Natural function	Returns length of string
StrCmp(String,String)	Integer function	Indicates if strings are identical
StrCmpNC(String,String)	Integer function	Case insensitive version of StrCmp()
StrNCmp(String,String,Integer)	Integer function	Indicates if first N characters of strings are identical
StrNCmpNC(String,String,Integer)	Integer function	Case insensitive version of StrNCmp()
MakeUpper(String)	Procedure	Converts string to all upper case
MakeLower(String)	Procedure	Converts string to all lower case
StrCat(String)	Procedure	Catenates string
StrNCat(String,Integer)	Procedure	Catenates first N characters of string
StrCpy(String,String)	Procedure	Copies first string to second
StrNCpy(String,String,Integer)	Procedure	Copies first N characters of first string to second

The string search routines are:

StrCmpRegex(String,String)	Integer function	Searches string for pattern using regular expression
StrCmpRegexNC(String,String)	Integer function	Case insensitive version of StrCmpRegex()

The string search routines are based upon regular expressions, a powerful means of describing patterns widely used in Unix. The current implementation of VSP supports patterns using several types of wildcards, special characters, beginning/end of line delimiters, and character literals.

Experiments with applying the VSP code to large design problems indicate the code is quite fast and saves significant model development time. VSP can be found via anonymous ftp to [verify.el.wpafb.af.mil](ftp://verify.el.wpafb.af.mil). The package includes a manual which contains additional information including a detailed description of the syntax and semantics of each routine.

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References

- [1] Brian W. Kernighan and Dennis M. Ritchie, *The C Programming Language*, Second Edition, Prentice Hall, 1988.
- [2] VHDL Technology Group, *Std_Developers Kit*.