Edge Integration

Station Controller (sc)

User's Guide

May 1, 2019
Version 2.6

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Revision Notes

Versions

Version 2.6 (reflected in version 2.5.0)

- Worked through code and cleaned up so that it would compile with the standard set to gnu18.
- Fixed various minor bugs.

Version 2.5 (reflected in version 2.4.0)

- Added a new function, file_orc(), for reading and returning a specified line within a file.
- For the "open port", more options have been added parity, data bits and stop bits
- Allow variables on the left of the ='s to contain a "-". Ex x="abc-123'; let y[$x] = ….

Version 2.4.7 (reflected in sc version 2.3.18)

- Added MORE_SECS_TMP_VARIABLES pragma, and new syntax for sending secs messages
- (see SECS Pass-Through)
- Added documentation for checksum()
- Added ALGEBRAIC_PRECEDENCE pragma
- Added new function, set_system_options(). Used by the system() and system_shell().
- Added documentation for ftoh() and htof()

Version 2.4.6 (reflected in sc version 2.3.17)

- Added new function is_number()
- Open statement allows for options=<> to be an expression.

V**ersion 2.4.5 (reflected in sc version 2.3.16)**

- Added clarification for evaluating expressions.
- Modified the open command to allow a client connection to be closed by a server
- New option for the hsms protocol to handle client disconnect.

Version 2.4.4 (reflected in sc version 2.3.14)

- New random number function rand() / rand(seed)
- Mod so that you can use strings and constants for labels.

Version 2.4.3 (reflected in sc version 2.3.13)

- New function, is_timer() returns seconds remaining for a timer
- New function, save_tmp_var(), makes tmp variables permanent
- New feature to allow linking 'C' functions with the sc executable

Version 2.4.2

- Added the Boolean Not operator. Uses the "!" character.
- New function, htou(), to convert hex values to unsigned ints.
- Fixed the htoi() function to properly return negative values.

Version 2.4.1

- Added some clarification with "Dynamic SECS Body" section. The "." should not be included in the variable data.

Version 2.4.0

- Added clarifications and various edits submitted by Douglas Kaip... thanks Douglas

Version 2.3.9

- New options to standard protocol, tmp_var=toupper or tmp_var=tolower. Converts tmp variable names to upper or lower case
- New function is_print(), returns true or false if a char is printable
- New function atoi(), returns the numeric value of a char

Version 2.3.8

- New function, mkprint()

Version 2.3.7

- No changes to this document

Version 2.3.6

- Added the crlf option to the commands protocol.

Introduction

The purpose of this document is to show how to create program files using the Edge Integration sc Station Controller. This document explains how the sc functions and the program language syntax along with programming examples.

Getting Started

In this section, we discuss how to install the sc, start the sc, stop the sc, and the sc command line options.

To install the sc, copy the sc executable (sc) to the appropriate directory on your system. Make sure that your $PATH environment variable is properly set.

To start the sc, at the system prompt type sc. You should see a greeting. Hist the *enter* key to get an sc prompt and a list of commands.

```
$ sc –i
```

To terminate the sc, at the sc prompt, type *kill*.

```
$ sc> kill
```

To get a list of the sc options, type *sc -i* at the system prompt.

```
$ sc –h
```

Always put a blank space between the *-option* and the argument.

`$ sc –d 3` not `$ sc –d3`

A typical way of starting sc when being used as an Equipment Interface simulator during Equipment Interface development is:

```
$ sc –i –c "read my_program"
```

Or if the preprocessor directives are used in "my_program" FIXME at the current time my_program must be in the default directory.

```
$ sc –i –c "read –P my_program"
```

The following is a list of the sc command line options:

sc option	Description
`–c` command	Used to specify or execute an sc command when starting the sc. The specified command is any valid sc command.

sc option	Description
	`$ sc -c "read my_program_file"` `$ sc -c "read \"./src/my_program_file\""`
`-d` level	Used to specify the debug or trace level. This is used to debug the sc application and your program file. The level ranges from 0 to 5. The default is 0. which turns off debugging. `$ sc -d 3 -c "read my_program_file"`
`-g`	Used to show the GNU GENERAL PUBLIC LICENSE that this program is licensed under.
`-h`	Used to show the options. `$ sc -h`
`-i`	Runs the sc in interactive mode. The sc prompts for commands. `$ sc -i` Note: While in the interactive mode, if you press a key sc will stop processing input on any open connections until the enter key is pressed. This is usually not an issue unless you are entering a command with a lot of characters. If this is the case consider using cut and paste from a different window.
`-n` name	Assigns the name to the sc. The name is used in log messages. This is useful when running multiple sc's and error messages are sent to a common error file.
`-r`	Displays sc command reference information.
`-s` service	Used to specify an interface file socket, service when starting the sc. This socket is used to communicate with the running sc. This utility sc_talk is used to communicate with the running sc through this socket. (A good convention is to put the socket files in a sockets directory and prefix them with an "`s.`") `$ sc -c "read my_program_file" -s sockets/s.sc_tool`

sc option	Description
`-v`	Used to get the current version of the sc. `$ sc -v`
`-w`	Displays program warranty information. In short, there is **no** warranty of any kind.
`-x my_program_file`	Used to run the program syntax checker. `$ sc -x my_program_file`
`-I` path	Define an include path to search for include files. See (`#include`).
`-D` name	Define a name in a program. See (`#ifdef`). `$ sc -c "read -D DEBUG my_program_file"`
`-D` name = value	Substitute all occurrences of name with value in a program. `$ sc -c "read -D DEBUG -D TOOL=Nova my_program_file"`
`-P`	Enable the preprocessor. By default it is disabled. It is automatically enabled if the -I or -D options are used. `$ sc -c "read -P my_program_file"`

Table 1: Startup Command Line Options

sc Command Line Commands

In this section we discuss the sc commands.

The following sc commands can be entered at the sc prompt:

sc Command	Description
`help`	Used to get a list of all of the commands. `sc> help`
`debug` *`level`*	Used to set the debugging level. The level ranges from 0 (turns debugging off) to 5.

sc Command	Description
	`sc> debug 3`
`dump`	Used to dump variables and other internal information. All variables are dumped. The results are written to a file named "`dump.out`". `sc> dump`
`dump` *`variable`*	Used to dump a variable and other internal information. The specified variable is dumped. The results are written to a file named "`dump.out`". `sc> dump my_program_variable`

`event` *`label`*	Used to cause program execution to "jump" to the specified label in the running program.
	
	`sc> event start_1`
	
	Or in a shorter form:
	
	`sc> e start_1`
	
	In this example the running program will start executing at the label `start_1` defined in the running program.

`event` *`label arguments`*	Used to cause program execution to "jump" to the specified label in the running program and allow the specified arguments to be accessed by the running program.
	
	`sc> event start_1 recipe=bake_me`
	
	Or in a shorter form:
	
	`sc> e start_1 recipe=bake_me`
	
	In this example the running program will start executing at the label `start_1` defined in the running program. The value "`bake_me`" will be assigned to a temporary variable (see the section on temporary variables) with the name of `recipe`.

sc Command	Description
`kill`	Use to terminate the program. `sc> kill`
`list`	Used to dump a listing of the loaded program. The results are written to a file named "`program.list`". `sc> list`
`logging`	Used to view the current level of logging for the running program. A level of 0 (zero) indicates that logging is disabled. `sc> logging`
`logging name value`	Used to change the current level of logging for the "channel" identified with the value of the `name` parameter. `sc> logging host_connection 3` In this example the value of the `name` parameter is "host_connection". If you look in the Examples section you will see an open (see the section on the open statement) statement that has as part of it "name=host_connection". The communication logging for this connection/channel will be modified.
`ping`	Used to determine whether the running program is responsive. `sc> ping`
`read` *`my_program_file`* `load` *`my_program_file`*	Used to read, load, and start executing the specified program file. The `read` and `load` commands are synonymous. `sc> read my_program_file`
`set` *`name value`*	Used to create or assign the global program variable `name` and give it the value specified by `value`. sc> set reset_flag 1 This is equivalent to the statement "`glet reset_flag=1`" in the program itself.

sc Command	Description
`tokens`	Used to dump the program file in internal token form. The results are written to a file named "`program.tokens`". `sc> tokens`
`version`	Used to get the version of the sc that is currently running. `sc> version`

Table 2: sc Command Line Prompt Commands

sc Program

Hello World

In this section we will show how to create and run a simple program. This program will print the message "Hello World".

Use any text editor and create a file called "`hello`", with the following program statement.

```
print "Hello World"
```

To run the new program, enter the following command:

```
$ sc -c "read hello"
```

Prints the message: `yyyy/mm/dd hh:mm:ss PRINT Hello World`

Program Structure

This section discusses how to layout a program.

A program contains statements.

For example:

```
let a = 1
let a = $a + 1
```

etc.

A program may also contain subprograms. Subprograms are defined with a *begin* and *end* statement. The *begin* may contain a name. A subprogram without a name is called the default subprogram. There can only be one default program.

statements

```
begin # Default subprogram
```

  statements

```
end
begin remote # Remote subprogram
```

  statements

```
end
begin local # Local subprogram
```

  statements

```
end
```

statements

Only one subprogram is active at any time. The set_program statement is used to define the active subprogram. Only those statements within the active program can be executed. All other subprograms are temporarily ignored. However, the statements not part of any subprogram are also active. In the example below, the **bolded** statements are active when the program is first loaded.

statements...

```
set_program local


begin
```

  statements

```
end
```

`begin local`

  statements

`end`

statements

Program Execution

This section discusses how a program's statements are executed.

When a program is first read, execution starts at the beginning. i.e. The first line of the file. Execution continues until any of the following statements are encountered: `begin`, `end`, `label`, `after`, or `break`. This rule holds true whenever the program is executing statements. i.e. If a message is received and being processed the message handler will run until one of the afore mentioned statements has been reached.

When the following program is first read, the only the **bolded** lines are executed. No subprogram is active.

statements...

`# set_program local` Note: This line is commented out.

`begin`

statements

`end`

However, if we remove the comment to end of line character(`#`) the `set_program` statement, execution looks as follows and the active subprogram is local.

statements…

`set_program local`

`begin`

statements

`end`

`begin local`

statements...

`label start`

statements

`end`

The `set_program` statement instructs the sc to:

1. Make the subprogram "`local`" the active program.

2. Start executing the statements after the `begin local` statement. Execution stops when the `label start` statement is encountered.

In order to appreciate this, consider the following example:

You have created an sc program that runs through a state machine. You have the processing for each state located just after a label for that state. Now consider that the state machine still transitions through the same states when the mode is in "`remote`" vs. "`local`", however, the processing performed is different depending on the current value of `mode`. The following code snippet shows an example of what some of the code might look like without the set_program statement.

```
goto newState_$mode
label state_1_local
statements
label state_2_local
statements
label state_n_local
statements
label state_1_remote
statements
label state_2_remote
statements
    .
    .
    .
label state_n_remote
statements
```

Now if the `set_program` statement is used the code might look more like.

```
set_program $mode
begin local
label state_1
```

statements
label state_2
statements
.
.
.
label state_n
statements
end
begin remote
label state_1
statements
label state_2
statements
.
.
.
label state_n
statements
end

This method has the potential for making the code easier to understand.

Handling Event and Reply Messages

This section discusses how events are handled.

Unsolicited events and reply messages are handled by the sc in the same way. Here is how it works:

The sc listens on each opened connection. When a message arrives, the sc knows the protocol to use via the proto syntax of the open statement. The sc creates a message from the event and jumps to a `label` statement with the same name as define by the name parameter in the open statement.

For example:

```
open socket_server name=host_1 proto=hsms ...
open socket_server name=host_2 proto=hsms …

# All communications from the host_1 connection start here
label host_1
let conn = "Host 1"
let sxfy= get_tmp_var(SXFY)
goto $sxfy

# All communications from the host_2 connection start here
label host_2
let conn = "Host 2"
let sxfy= get_tmp_var(SXFY)
goto $sxfy
```

The sc creates temporary variables from the event message that are available to the program (using the `get_tmp_var ()` function). Temporary variable names are created by two rules: name/value pairs and ARGx.

Note: The following only applies when the value of the `proto` option is something other that `hsms` or `secs`.

Name/value pairs are created when the sc sees two items delimited by the "=" sign.

Given an event message with: **color=red**

sc creates the temporary variable `color`.

```
get_tmp_var (color)      # Returns red
```

When the sc sees delimited values, it creates temporary variables starting with `ARG`x, where x starts at 0 and is incremented for each delimited value. A final variable, `NUM_ARG`, is created defining the total number of `ARG` variables.

Given an event message with: **red white blue**

sc creates temporary variables: `ARG0`, `ARG1`, `ARG2`, `NUM_ARG`, and `ARGS`

```
get_tmp_var (ARG0)            # Returns red
get_tmp_var (ARG1)            # Returns white
get_tmp_var (ARG2)            # Returns blue
get_tmp_var (NUM_ARG)         # Returns 3
```

Also, a variable `ARGS` is assigned to the entire message.

```
get_tmp_var (ARGS)            # Returns red white blue
```

and remember

```
get_tmp_var ("")              # Returns all temporary variables
```

Note: This is usually used in a print statement for debugging purposes.

i.e. `print get_tmp_var("")`

Both types of variables may be created from the same message.

Parsing Rules

Messages are parsed into token values using the sc rules for parsing. When a message is tokenized, it is broken down into individual tokens. Tokens are defined as follows:

A *number token* starts with a digit, 0-9, and consists of the digits 0-9, and optionally may contain: "e", "e+", "E-", and "E+", and trailing digits 0-9. The token may not contain any blank spaces.

```
100
1.0e+2
```

A name token consists of alphanumeric characters (A-Z, a-z, 0-9), and the "$", "_", ".", "{", "}", "[", and "]" characters. The token may start with any of the above except the 0-9 digits.

```
num_of_points
point.1.value
value[1]
```

A name token may contain a "-" when referenced within a variable.

```
let x = "abc-123"

let y[$x] = ....
```

Other tokens include:

Token	Description
=	Equal sign
<= >= == !=	Equality signs
()	Open and close parenthesis
+ - * /	Plus, minus, multiplication, and division signs
& |	Bitwise ANDing and ORing signs

All other characters are considered to be delimiters. They are used to delimit tokens, but are discarded and not returned as a token or as part of a token.

Any double or single quoted string becomes a single token.

Note: Within double quotes, you can have `\n`, `\r` and `\xhh` and they will be translated to the appropriate characters. Within single quotes, data is what it is, no conversion.

Program Variables

This section discusses how to define, reference and delete program variables.

The program uses variables to store values.

```
let x = 100    # Assigns the variable x to 100
```

Program variables begin with the '`$`' character.

```
let y = $x  #  Assigns the variable y to the value of x, y will
          have a value of 100
```

Program variables can be concatenated. Variables are evaluated from left to right.

```
let first = "John_"
let last = "Smith"
let name = $first$last # The variable name is assigned to
                    "John_Smith"
```

All variables in the sc are internally stored as character strings. The '`[]`' are used to control the order in which variables are evaluated. There are **NO** arrays in the sc programming language, but arrays can

be emulated using the "[]" characters. Program variables within the '[]' are evaluated first, then the entire variable is re-evaluated until all variables have been evaluated.

```
let color[1] = "Red"
let color[2] = "White"
let color[3] = "Blue"
for i=1 to 3
    print $color[$i] # Prints "Red" "White" and "Blue"
next i
```

In the above example three variables are created. The variable names are "color[1]", "color[2]", and "color[3]". The square brackets are part of the name of the variable. The only thing the brackets do is control the order of evaluation. In the case of let color[1] = "Red" there is no evaluation necessary since "color[1]" is the variable name itself. In the case of say let color[$i] = "Red" $i would be evaluated in determining what variable the text string "Red" would be assigned to. If $i were to evaluate to the value "eye" the variable "color[eye]" would be assigned to have a value of "Red". If it did not already exist it would be created. One feature of having arrays simulated as they are is that you can create a variable with a name like color[123456789012345678 9] and not have to worry about some type of array out of bounds error. It is just a text string.

The '{}' work just like the '[]', except they are invisible. They just control the order of evaluation.

```
let color1 = "Red"
let color2 = "White"
let color3 = "Blue
for i=1 to 3
    print $color{$i} # Prints "Red" "White" and "Blue"
next i
```

Note In the above example, you can't have print $color$i. This is because $color$i is expecting two variables to be defined, color, and i. And only i exists. However, even if color existed you still can't have " $color$i " unless you use the {}'s.

Variables referenced but not defined have no value. A blank or empty value is returned and no error is generated.

Nesting and mixing of the '[]'s and '{}'s is allowed.

We can use multiple $'s for indirect variable addressing. When encountered, the right most $variable is evaluated first. See the following example:

```
let x = "Hello"
let y = "x"
```

```
print $$y # prints Hello
```

First the variable `$y` is evaluated to "`x`", and then the variable `$x` is evaluated to "`Hello`".

It is possible to delete variables. In the following example three variables will be created, `color[1]`, `color[2]`, and `color[3]`.

```
let color1 = "Red"
let color2 = "White"
let color3 = "Blue
```

In the case where you desire to delete sc's knowledge of and allocated storage space for a variable you may use the delete command as follows.

```
delete color3 # delete the variable and frees any allocated
          storage space
delete "color*" # this would cause the deletion of all three
            variables
```

Dumping sc Variables

This section discusses how to view variables stored in the sc.

The sc has three kinds of variables: *User*, *Temporary*, and *Internal*.

User variables are those variables created and used by the program. Once created a user variable is available (dependent on scope rules) for the duration program run.

Temporary variables are created by the sc and are available to the program via the `get_tmp_var ()` function. A temporary variable's lifetime is limited. Typically temporary variables are created when the sc receives an event and each subsequent event erases all previously created temporary variables.

Internal variables are created and used by the sc and are not available to the program.

The sc's `dump` command is used to view all sc variables.

Variable Context

This section discusses the context of program variables.

Program variables are initially created using the `let` or `define` assignment statements. If a variable is created with the `define` statement, it cannot be modified later.

Variables have context(scope). Variables created within a `begin / end` pair are only known to the statements within the same begin/end pair. Variables created external to any `begin / end` pair, are global to all statements.

Using Timers

This section discusses how to used timers in the program file.

Timers are used to generate events to the program. There are six (6) timers available for program use.

To start a timer, use the `start_timer` statement.

```
start_timer timer=timer_id seconds=seconds handler=label
```

To stop a timer, use the stop_timer statement.

```
stop_timer timer=timer_id
```

The timer_id identifies the timer. Valid entries are 0 to 5. The seconds are the number of seconds to delay before timing-out and jumping to the label. The label is where execution begins when the timer times-out.

Once a timer expires, it is no longer active, and must be restarted if so desired.

Here is a simple program that prints "`Hello`" every five seconds.

```
start_timer timer=1 seconds=5 handler=timeout1
label timeout1
print "Hello"
start_timer timer=1 seconds=5 handler=timeout1
```

All timers are suspended while the sc is executing statements, and are only evaluated when the sc is idle. Be careful when using `sleep` and looping `goto` statements, since they may keep the sc busy for a long time. However, sc, once it is idle, will eventually process timers even if they are overdue.

The sc uses real time (not idle time) to determine when a timer is due. In the example below, the addition of a 3 second sleep will not effect the "Hello" being printed every 5 seconds.

```
start_timer timer=1 seconds=5 handler=timeout1
sleep 3
label timeout1
print "Hello"
start_timer timer=1 seconds=5 handler=timeout1
sleep 3
```

It is OK to stop a timer that is not currently running.

An optional `msg` parameter is used to define a string. When the timer times-out, the `msg` is evaluated and converted into temporary program variables prior to jumping to the `handler` *label*. These variables can be used in the program following the `handler` label.

```
start_timer timer=timer_id seconds=seconds handler=label msg=msg
```

In the example below: The temporary variable, `status`, is set to "`Error`" if the timer times-out.

```
start_timer timer=1 seconds=5 handler=timeout1 msg="Timeout status=Error"
.
.
.
label timeout1
    print "Status is <" . get_tmp_var(status) . ">" # Prints the value of
                                                    status
```

The advantage to using `start_timer` instead of a sleep statement is that a `sleep` statement causes sc to basically stop functioning for the specified amount of time. In a simple application this may not be a problem, however, in a typical complex application is it not acceptable for sc to stop processing for a while. In this situation timers would be used. Basically a timer with a timeout handler is set up. Like any other statement, after the `start_timer` command is used sc will continue processing until it runs into the next `label` statement. When it hits the next label it will stop processing and wait for the next event. The event may be from an incoming message or it may be do to a timer expiring.

Error Handling

This section discusses how to handle program statement errors.

Most program statements support the error option.

```
error=label
```

The error option must appear at the end of the statement. The label is the program label statement where program execution jumps should the given statement fail.

If a statement fails, any statements following the failed statement are not executed. The following **bolded** statements are executed should `statement_2` fails.

statements...
statement_2... **`error=err`**
statements...
`label err`
  statements...

In the case of sending messages, failures will be generated due to protocol failures. The program will need to handle any return error codes.

The `no_error` option may be appended to any statement. In the event of an error, the error is logged, but execution continues with the subsequent statements. The features allows for statements to fail but to have program flow continue as normal.

```
no_error
```

If a statement fails, statements following the failed statement are executed. The following **bolded** statements are executed should statement_2 fails.

statements...
statement_2... **`no_error`**
statements…

```
label err
  statements…
```

Reference

Program Statements

Program Statement (keyword)	Description

`after` *`label`*	This defines a program label and is synonymous with the `label` keyword. Labels behave in a unique manner in sc programs. Be sure and refer to FIXME for more information. The following two statements product an identical result:
	
	`after loop`
	`label loop`
	
	Note: You may include special characters line the "-" within the label by enclosing the value in single or double quotes.
	
	`label "remote_mode"`

`begin` `begin` *`name`*	Used to define the beginning of a subprogram. The `begin` statement without a specified *name* identifies the beginning of the default

Program Statement (keyword)	Description

	program(FIXME). In the normal case this is not necessary.
	
	`begin sub_program_1`
	`end`

`break`	Use to halt program execution.
	
	`if ((return eq "error)`
	`  print "Error detected"`
	`  break  # Stop, don't continue`
	`else`
	`  .`
	`  .`
	`  .`
	`end_if`
	
	The `break` statement does not cause the sc program to "die". It causes it to stop its current execution an go back to waiting for incoming messages or timer expirations.

`break_loop`	Used to exit a `for` or `while` loop.
	
	`for i = 1 to 10`
	`  if ($i == 5)`
	`  break_loop  # Exit loop and continues`
	`  else`
	`  .`
	`  .`
	`  .`
	`  end_if`
	`next i`
	
	Program execution resumes at the statement immediately following (in this case) the `next i` statement.

`close name=`*`name`*	Used to close a connection. The *`name`* is the name that was used in the open statement.
	
	`open socket_client name=equipment_sock …`
	`close name=equipment_socket`

`close client=`*`client`*	Used to close a connection on a channel that is acting as a server. *`client`* is the fd (file descriptor) of the connected client. FIXME

Program Statement (keyword)	Description
	`close client=$`*`client`*

`continue`	Used to continue execution when executing within a `for` or `while` loop.
	
	`For i = 1 to 10`
	`  if ($x[$i] eq “”)`
	`  continue`
	`  end_if`
	`next i`
	
	This operates in the same manner as most programming languages.

`define` *`var`*
`define` *`var=expr`*
	Used to define a program variable and optionally assign a value to it. `define`d variables are also used with preprocessor directives. Refer to the documentation for `#ifdef` FIXME above.
	
	`define x`
	`define x = 100`
	`define x = 5 * 100`
	
	Note: Once a variable is `define`d, it cannot be modified. For "normal" variable creation refer to `glet` and `let` detailed below.

`define_array` *`var`*`=` *`expr1`*`, `*`expr2`*`, ...`	Used as a method of convenience to create an **emulation** of an array. FIXME The name of the array is *`var`*. Its values are what expr1, expr2, etc. resolve to. The array *`var`* is indexed as follows *`var`*`[x]` where x starts at 1, and continues to increment by 1 for each *`expr`*x provided. The variable *`var`*`[0]` contains the number of elements in the array. Consider the following: `define_array days = Mon, Tue, Wed, Thu, Fri` This would result in 6 variables being created. The variable names would be `days[0]`, `days[1]`, `days[2]`, `days[3]`, `days[4]`, `days[5]`. The values stored in the variables are shown below. The value of the variable named `day[0]` is `5`. The value of the variable named `day[1]` is `Mon`. The value of the variable named `day[2]` is `Tue`. The value of the variable named `day[3]` is `Wed`. The value of the variable named `day[4]` is `Thu`. The value of the variable named `day[5]` is `Fri`.

Program Statement (keyword)	Description
	Remember, in order to get the value of the variable you need to prepend a $ (dollar) sign to the beginning of the variable name. For example the statement: `print $day[3]` would print out `Wed`.

`define_xref var = expr1, expr2, ...`	Used to create a cross reference variable. Multiple instances are used to create a cross reference table. When the *`var`* is index by *`expr1`*, *`expr2`* is returned, and when index by expr2, expr1 is returned.
	
	`define_xref color = red, FF0000`
	`define_xref color = white, FFFFFF`
	`define_xref color = blue, 0000FF`
	
	The variables below are assigned:
	
	The value of `color[red]` is `FF0000`
	The value of `color[FF0000]` is `red`
	The value of `color[white]` is `FFFFFF`
	The value of `color[FFFFFF]` is `white`
	The value of `color[blue]` is `0000FF`
	The value of `color[0000FF]` is `blue`
	
	This is a very handy feature. Say you have an incoming event that has the value `FF0000` in it. In the example above you could print the value of `color[FF0000]` (`$color[FF0000]`) and produce the much more user friendly value of red.

`delete "`*`var`*`"`	Used to delete program variable *`var`* and release any associated storage. This example deletes the program variable `x` and releases associated storage. `delete "x"`
`delete "var*"`	Used to delete **all** program variables that begin with the letters *`var`* and release any associated storage. This example deletes all of the program variables that begin with the characters `data[LOT1]` and releases their associated storage. `delete "data[LOT1]*"`

Program Statement (keyword)	Description
	Note: The asterisk may only appear at the end of the string.

`end`	Used to define the end of a subprogram.
	
	`begin subprogram1`
	`.`
	`.`
	`.`
	`end`

`exit`	Terminates the sc and stops it from running. Equivalent to the 'C' `exit(0).`

for loop construct	Used for looping. The `continue` and `break` commands are supported. There are two forms of the for-next loop construct. They are:
	
	`for x=1 to 10`
	`.`
	`.`
	`.`
	`next x`
	
	and
	
	`let max = 10`
	
	`for x=1 to $max by 2`
	`.`
	`.`
	`.`
	`next x`
	
	Note: The syntax for the `next` statement is `next` *`var`* (in this case `next x`), NOT `next $x`. Also, the for statement could look something like `for x=$start to $end by $step`.

`glet var = expr`	FIXME (verify) Used to assign a global variable a value. A global variable is created outside any subprogram.
	
	`let x = 100`
	
	`begin my_subprogram`
	`# Change the global variable x's value to 200`

Program Statement (keyword)	Description

	`glet x=200`
	`end`
	
	If a `let` was used instead of the `glet`, a new variable `x`, would be created that is only visible while program flow is within `my_subprogram`, and the global variable `x` would be unchanged. As an item of note sc will look 2 places for `x`, first within the context of the section bounded by the `begin-end` pair then outside the context of the the `begin-end` pair, but, not within the context of another `begin-end` pair.

`gosub` *`label`*
`gosub` *`label arg1, arg2, ...`*
	Used to jump to (call) a subroutine. A return statement is expect at the end of the subroutine. When subroutine encounters a `return` statement control flow resumes at the first statement following the `gosub` statement.
	
	`gosub sub_func_1`
	`.`
	`.`
	`.`
	
	`label sub_func_1`
	`.`
	`.`
	`.`
	`return`
	
	Arguments, `arg1`, `arg2`, `etc.` can be passed. Arguments may be passed by value, or by reference. In the following example, arg1 and arg2 are passed by value, while the variable `result` is passed by reference.
	
	`let result = 0 # Initialize the result`
	`let arg1 = 100`
	`let arg2 = 200`
	
	`gosub add_numbers $arg1, $arg2, result`
	`print "The result is ". $result`
	`.`
	`.`
	`.`
	
	`# Assign c the result of $a + $b`
	`label add_numbers a, b, c`
	`let c = $a + $b`
	`return`

Program Statement (keyword)	Description
	Note: The variable `result` must exist prior to the `gosub` statement. FIXME I need an example of using the passed in arguments.

`goto` *`label`*	Use to cause the program execution to start executing the first statement following the label define in the program.
	
	`goto turn_on_blue_light`
	`.`
	`.`
	`.`
	
	`label turn_on_blue_light`
	`.`
	`.`
	`.`
	
	FIXME reference the label explanation section

`Goto with arguments?`	FIXME

if then statement	Used for conditional program flow control.
	
	`if ($x == 100)`
	`.`
	`.`
	`.`
	`end_if`
	
	This reads as, if the value of the variable `x` is equal to `100` then execute the following statements up to the `end_if` statement.

if then else statement	Used for conditional program flow control.
	
	`if ($x <= 100)`
	`.`
	`.`
	`.`
	`else`
	`.`
	`.`
	`.`
	`end_if`
	
	This reads as, if the value of `x` is less than or equal to `100` then execute

Program Statement (keyword)	Description
	the statements between the `if` statement and the `else` statement, otherwise, execute the statements between the `else` statement and the `end_if` statement.

if then else if statement	Used for conditional program flow control.
	
	`if (($x == 100) or ($x == 200))`
	`.`
	`.`
	`.`
	`else_if ($x == 300)`
	`.`
	`.`
	`.`
	`else`
	`.`
	`.`
	`.`
	`end_if`
	
	This reads as, if the value of `x` is 100 or 200 then execute the statements between the `if` statement and the `else_if` statement, if the value of x is 300 then execute the statements between the `else_if` statement and the `else` statement, otherwise, execute the statements between the `else` statement and the `end_if` statement.

`label` *`label`*	Define a named point (label) within a program where control flow may be directed; usually as the result of a `goto` or `gosub` statement.
	
	`goto "my first label"`
	`.`
	`.`
	`.`
	`label "my first label"`
	`.`
	`.`
	`.`
	
	Note: If control flow is transferred to the label by a `gosub` statement there needs to be a `return` statement somewhere in the control flow after the label.
	
	FIXME reference the detailed explanation of labels
	l

`label` *`label arg1, arg2, ...`*	Define a named point (label) within a program where control flow may

Program Statement (keyword)	Description

	be directed. It the label is the target of a goto or gosub statement arguments may be passed.
	
	`let result = 0 # Initialize the result`
	`let arg1 = 100`
	`let arg2 = 200`
	
	`gosub add_numbers $arg1, $arg2, result`
	`print "The result is ". $result`
	`.`
	`.`
	`.`
	
	`# Assign c the result of $a + $b`
	`label add_numbers a, b, c`
	`let c = $a + $b`
	`return`
	
	Local variables a and b will be assigned to the values of arg1 and arg2. The variable c is assigned to the reference to result. FIXME what are a and b local to?
	
	Note: If control flow is transferred to the label by a gosub statement there needs to be a return statement somewhere in the control flow after the label.

`let` *`var=expr`*	Used to assign a variable to the value of an expression. If the variable does not already exist, it is created. `let x = 100`

`local_var` *`var`*
`local_var` *`var=expr`*
	Creates / defines a variable local to a label and optionally assigns it to the value of an expression. It only makes sense to use this within a label. By default, the variable is initialized to blank. FIXME (empty string?) In the example below, the variable `i` inside the label and the variable `i` before / outside the label are different:
	
	`let i = 200 # Assign i to a value of 200`
	`gosub do_it`
	`.`
	`.`
	`.`

Program Statement (keyword)	Description

	`label do_it`
	`    local_var i # Define a local variable i`
	`    let i = 300 # Assign the local i to 300`
	`    .`
	`    .`
	`    .`
	
	FIXME can the outside variable be referenced at all in this case?

`open` **`port`** **`device=device`** `name=`*`name`* `proto=`*`proto`* `logfile=`*`logfile`* `logging=`*`logging`* `options=`*`options`*	Open a connection for sending and receiving messages. In this form of the `open` statement `device` needs to be a a system file device such as "`/dev/tty01`" (a serial port). `name` is the name of the connection or channel. This name is use for a couple of things: 1. The value assign to `name` needs to correspond with a `label` in the running program. Whenever a message is received on this connection or channel, program flow will start at the first line after the `label` statement that has the same value as what was entered for the value of the `name` argument. 2. Any time the program needs to use any `send` statements it must use the value of the `name` argument for the connection or channel that the message needs to go out on. `proto` – The protocol to be used. The value of this argument must be one of 4 values: 1. `commands` – sc commands 2. `standard` – Simple text messages 3. `SECS` – Semiconductor Equipment Communication Standard SECSII messages transported over a SECSI layer. 4. `HSMS` - Semiconductor Equipment Communication Standard SECSII messages transported over a HSMS layer `logfile` – This provides the file path for a log file that will be used in writing out logging related messages for this connection.

Program Statement (keyword)	Description
	`logging` – This sets the logging level for this connection. The acceptable values for this argument are as follows: 0 - Turns off logging 1 - Prints out a one line message summary. 2 - Prints out the complete message content (default) 3 – Includes protocol details with the complete messages This argument is optional and defaults to 2 if not specified. `options` - zzzzzzzzzzzzz
`open` **`pipe`** **`device=device`** `name=`*`name`* *`proto=proto`* `logfile=`*`logfile`* `logging=`*`logging`* `options=`*`options`*	Open a connection for sending and receiving messages.
`open` **`socket_client`** `name=`*`name`* **`host=host`** **`service=service`** `proto=`*`proto`* `logfile=`*`logfile`* `logging=`*`logging`* `options=`*`options`*	Open a connection for sending and receiving messages.
`open` **`socket_client`** `name=`*`name`* **`local_name=local_name`** `proto=`*`proto`* `logfile=`*`logfile`* `logging=`*`logging`* `options=`*`options`*	Open a connection for sending and receiving messages.
`open` **`socket_server`** `name=`*`name`* **`host=host`** **`service=service`** `proto=`*`proto`* `logfile=`*`logfile`* `logging=`*`logging`* `options=`*`options`*	Open a connection for sending and receiving messages.
`open` **`socket_server`** `name=`*`name`* **`local_name=local_name`** `proto=`*`proto`* `logfile=`*`logfile`*	Open a connection for sending and receiving messages.

Program Statement (keyword)	Description
`logging=`*`logging`* `options=`*`options`*	
`pragma` *`pragma`*	Pragmas are used to control the operation of sc. Current pragmas include: `LOG_CPU_USAGE` – Logs a cpu usage message when sc runs. Default, no message is logged. `SHOW_NON_PRINTING_CHARS_IN_BRACES` – Prints non-printing characters as {hh}. This applies to the `print` statement and `dump` statement. By default, non-printing characters are printed as \xhh. `NO_BLOCK_ON_SLEEP` – Modifies the `sleep` command so that it will not block sc processing while sleeping. This means that sc uses an internal timer for the "sleep" and does not block. When the timer expires, execution resumes just as before. `NO_SOURCE_CODE_LINE_NUMBERS` – Source code filenames and line numbers are not shown when an error or warning is detected. `ALGEGRAIC_PRECEDENDE` – Enables algebraic precedence when solving equations. `MORE_SECS_TMP_VARIABLES` – Creates `.HEADER`, `.BODY`, and `.SYSTEM_BYTES` temporary variables from received secs messages.
`print` *`string`*	Used to output text. String concatenation may be used in the construction of the *`string`*. `print "The value of i is " . $i . " at the moment."` Notice that the "`.`" outside of the quoted strings is used as a concatenation operator.
`return`	Used to return execution flow to just after the prior `gosub` statement.
`send name=`*`name`* *`message`*	Used to send a message to an opened connection. The name is the name defined in the open statement. The message data is protocol specific. `send name=equipment_connection message`

Program Statement (keyword)	Description
`send name=`*`name`* `options=`*`options`* *`message`*	
`send name=`*`name`* `client=`*`client`* `options=`*`options`* *`message`*	The *`options`* defined in the open command can be temporarily overridden with the values defined by the *`options`* in this format of the send statement. The destination of the message can be to a connected client defined by the client. When you are a "server", "clients" connect to you. But suppose you wanted to send them a message (not a reply). To whom do you send the message? There may be several connected. You first need to get the client's id (`get_client()`). Then you can use that returned name (id value) to send a message. All of this is necessary because you could have multiple clients connected.
`send_ reply name=`*`name message`*	Used to send a reply message. The reply message is sent to the client connected to the connection. The message data is protocol specific. `send_reply name=name message  FIXME ident name`
`set_program` *`name`*	Used to activate a subprogram. The subprogram name becomes the active program. `set_program alternate_main` Note: Use `set_program default` to return to the default program. See the `begin` statement.
`sleep` *`seconds`*	Used to sleep for a specified number of seconds. The sleep is an inline sleep. All sc processing is suspended. This is equivalent to a 'C' sleep(). `sleep 20 # Sleep for 20 seconds` The pragma, "`NO_BLOCK_ON_SLEEP`", can be used to have sc not block or suspend processing while sleeping. FIXME...what does this mean? Refer to sleep down below
`start_timer timer=`*`timer_id`* `seconds=`*`seconds`* `handler=`*`label`*	Used to start a timer. There can be up to 6 timers running at the same time. The *`timer_id`* identifies the timer. The *`seconds`* are the number of seconds (whole seconds) to wait, and the *`label`* is where execution will start when the timer expires. The *`msg`* is converted to a

Program Statement (keyword)	Description

`msg=`*`msg`*	program temporary variable when the timer times-out. FIXME what does this msg look like and how is it used?
	
	`start_timer timer=1 seconds=5 handler=timer_1_timeout`
	`.`
	`.`
	`.`
	
	`label timer_1_timeout`
	`.`
	`.`
	`.`
	
	Note: Valid timer IDs are 0, 1, 2, 3, 4, 5.
	FIXME refer to the detailed explanation of timers

`stop_timer timer=`*`timer_id`*	Used to stop a timer. The *`timer_id`* identifies the timer to stop. No error is produced if timer that is not running is stopped. *stop_timer timer = 1* Note: Valid timer IDs are 0, 1, 2, 3, 4, 5.

`while(`*`expr`*`)`
`.`
`.`
`.`
`end_while`
	Your basic while loop. Executes the commands between the while and the end_while statements as long as the expression(*`expr`*) evaluates to true (non-zero). The while loop construct supports the `continue` and `break` statements.
	
	`let i = 1`
	`while($i <= 100)`
	`  if ($x[$i] eq "")`
	`  continue`
	`  else if ($x[$i] eq "stop")`
	`  break`
	`  else`
	`  print "x[" . $i . "] is " . $x[$i]`
	`  end_if`
	
	`  let i = $i + 1`
	`end_while`

Preprocessor Directives

Preprocessor commands are resolved when the sc program is initially read and loaded. The `#` char must appear in the first column. One of the following sc command line options: `-P`, `-D`, or `-I` must be included.

Preprocessor Directive	Description
`#define` *aname*	Define "*aname*" within the program. See the `#ifdef` description below.

`#define` *aname*`=`*value*	Creates an unchangeable variable with the name of *aname* and assigns it the specified value.
	
	`#define SIRNAME=Jones`
	`print "My last name is " . SIRNAME`
	
	This will print out the following:
	
	"`My last name is Jones`"
	
	Note: It will be printed out without the double quotes. Also, the "`.`" in the `print` statement is a string concatenation operator.

`#include` *filename*	Include another program or parts of a program into the current program. `#include local_values.sc` The location of `local_values.sc` can be defined by the `-I` sc command line option. Note: The file extension specified ("`.sc`") is neither required, nor expected, nor assumed.
`#ifdef` *aname* . . . `#endif`	If "*aname*" has been previously defined then all of the program's statements between the `#ifdef` and the corresponding `#endif` statement are considered part of the program and are executable. "*aname*" may be defined with a `#define` statement as documented above or with the `-D` command line option when sc is started. Refer to table Table 1: Startup Command Line Options on page 9.

Preprocessor Directive	Description

`#ifdef` *aname*
.
.
.
`#else`
.
.
.
`#endif`
	This is an if-then-else form of the `#ifdef` statement documented above.

Table 3: Preprocessor Directives

Comments

Comments are allowed by the methods below.

Comments	Description
`#`	Single line...to end of line
`/*` … `*/`	Block ... everything between the `/*` and the `*/` are considered to be a comment and thus not executable. This comment form may span multiple lines.

Table 4: Comment Characters

Expressions

sc uses infix notation for expression evaluation. This is where the operator is place between 2 operands. In sc, all operators have equal precedence (there is no implied order of precedence). During expression evaluations, expressions are evaluated from right to left.

Always use parentheses for precedence. The table below shows this by example:

Expression to Solve	Result	Implied Parentheses
`5-4+1`	`0 (not 2)`	`5-(4+1)`
`6/2+1`	`2 (not 4)`	`6/(2+1)`

Table 5: Expressions

However, if the `pragma ALGEBRAIC_PRECEDENCE` is defined, expressions are solved using the precedence defined in the table below:

Precedence	Operator	
1	* /	Multiplication and division
2	+ −	Addition and subtraction
3	< <= < <=	Comparisons
4	== !=	Equality and non-Equality
5	&	BitWise AND
6	|	Bitwise OR
7	^	Bitwise exclusive OR
8	and	Logical AND
9	or	Logical OR

Table 6: Precedences

Math Operators

Math operations are used to perform simple arithmetic, add subtract, multiply, and divide. There is no operator precedence during evaluation of equations. All Operators have equal precedence.

Math Operator	Description
+	Addition
−	Subtraction
*	Multiplication
/	Division

Table 7: Math Operators

Unary Operators

Unary operations are used to modify a value prior to evaluation.

Math operator	Description
+	Plus
−	Minus
~	One's complement

Table 8: Unary Operators

Relational Operators

Relational operators are used in expressions (if, else_if). Relational operations return either true or false. True is non-zero, and false is zero.

Numeric

Used with number values

Numeric relational operator	Description
expression1 == expression2	Returns true if expression1 is equal to expression2
expression1 != expression2	Returns true if expression1 is not equal to expression2
expression1 > expression2	Returns true if expression1 is greater than expression2
expression1 < expression2	Returns true if expression1 is less than expression2
expression1 >= expression2	Returns true if expression1 is greater than or equal to expression2
expression1 <= expression2	Returns true if expression1 is less than or equal to expression2

Table 9: Numeric Relational Operators

String conditionals

Used with string variables

String relational operator	Description
string1 `eq` string2	Returns true if string1 is identical to string2
string1 `ne` string2	Returns true if string1 is not identical to string2

Table 10: String conditionals

Boolean Operators

Boolean operators are used to test for either true for false. True is non-zero and false is zero.

Boolean operator	Description
expression1 `and` expression2	Returns true if expression1 and expression2 are true.
expression1 `or` expression2	Returns true if either expression1 or expression2 are true.
`!`expression	Returns true if expression is false, or false if expression is true.

Table 11: Boolean operators

Bitwise Operators

Bitwise operators perform bitwise operations on the arguments.

Bitwise operator	Description
value1 `&` value2	Bitwise and- ing of value1 and value2
value1 `|` value2	Bitwise or- ing of value1 and value2
value1 `^` value2	Bitwise xor- ing of value1 and value2

Table 12: Bitwise operators

Constants

Valid constants for assignment to variables:

Example constants
Integer numbers: 100, 500, -6, etc.
Floating point numbers: 1.2, 5.1, etc.
Strings: "This is a string."
String characters:
\xhh – Hexidecimal value from 00 through FF
\n – new line character
\r – carriage return character

Table 13: Examples of constants

String Concatenation

Strings may be concatenated using the '.' and ':' characters. The '.' appends the strings, while the ':' appends with a single white space between the strings. The following are equivalent.

```
let name = "John" . " " . "Smith"  # Assigns "John Smith" as the value of name
let name = "John" : "Smith"        # Assigns "John Smith" as the value of name
```

Keywords

The following is a list of keywords that are reserved and should not be used in the sc program as variable names, etc. However, they can be used in double quoted strings.

Keywords				
after	else	format	ne	set_program
and	else_if	glet	next	sleep
begin	end	gosub	open	start_timer
break	end_if	goto	or	step
break_loop	end_while	if	pragma	stop_timer
close	eq	import	print	system
continue	error	is_label	proto	then
define	exit	ltoi	return	to
define_array	export	label	send	while
define_xfer	for	let	send_reply	
delete		local_var		

Table 14: Language Reserved Words

Functions

Protocols

Command Protocols

Handling SECS Events

Dynamic SECS Body

SECS Pass-Through

Hints

You can check the version of sc using the Unix "what" or "strings" commands.

```
what sc
strings sc | grep '@(#)'
```

Examples

Using sc as a semiconductor equipment simulator

The following bit of sc code represent a very simplistic equipment simulation. Please refer to the callouts for a more detailed explanation of what is going on.

1. "*host_connection*" is the name of this connection. In environments where multiple connections are required it is used to distinguish between them. The value of name (in this case "*host_connection*") is also the value of a `label` in the program file. Whenever there is input on this channel sc will start processing at the statement immediately following this `label`.
2. The value of `host` can be either an IP address or it can be a host name that can be resolved via the host file or DNS. Since this script example is that of a server (think equipment simulator) the IP address would be the same as the machine that sc is running on. `localhost` (127.0.0.1) can be used instead.
3. The value of `service` represents the port that the connection will use. The value of 5000 is fairly typical.
4. Whenever a message is received on the "`host_connection`" channel/connection sc packages the contents of the message into temporary variables. When using the SECS (`secs`

or `hsms`) protocols there are several temporary variables you can expect to have good data in them. In this case the `SXFY` variable will contain the stream and function of the message just received. For example, if the incoming message was a stream 1 function 13 message the value of the temporary variable `SXFY` would be S1F13.

5. Most semiconductor equipment simulators will be set up in this manner. In simple terms, whenever a message is received the stream and function of the message are retrieved and this dynamic `goto` is executed to direct the simulation to the appropriate message handler. In the situation mentioned above, this line would resolve to a `goto S1F13` which would cause the program to start executing at the line immediately following `label S1F13`.

6. This is a very simple handler to deal with an incoming S1F13 message. It generates the appropriate S1F14 message header and then includes the information specified and sends the reply back on the "`host_connection`" connection. In this example the values of the variables `E5Model` and `E5SoftwareVersion` are retrieved and sent back as part of the response.

7. In this example, this block of code is executed in response to an interactive command line input from the user. This code simulates the start and ending of a job that lasts 10 seconds. In order to execute this code block the user would type `event run_job` or `e run_job` from the command line and press enter. As a result the two S6F11 messages would be sent with a 10 second pause between them. One thing to note in this example is that sc will be asleep for 10 seconds and will not be able to process other messages, an incoming S1F13 for instance, until it wakes up from its sleep and starts processing again. There are methods to deal with this situation in the event this is not acceptable. They are explained elsewhere.

```
let client = -1
let E5Model = "EqModel"
let E5SoftwareVersion = "1.2.14"
let sc_version = get_version()
print "SC Version is <" . $sc_version . ">"

open socket_server name=host_connection 1 proto=hsms logging=2

host=10.100.32.140 2 service=5000 3 options="t3=5 t6=10 t7=10 t8=10
timeout_msg=TIMEOUT"

# All communications from the host start here

label host_connection 1
```

```
    let client = get_client(host_connection)
    let sxfy= get_tmp_var(SXFY) 4
    goto $sxfy 5

# S1F1 - Hello from the host
label S1F1
    send_reply name=host_connection S1F2 0
    <L
        <A $E5Model>
        <A $E5SoftwareVersion>
    >.

# S1F13 - Establish Communications, CommunicationState is
COMMUNICATING
label S1F13 6
    send_reply name=host_connection S1F14 0
    <L
        <B 00>
        <L
            <A $E5Model>
            <A $E5SoftwareVersion>
        >
    >.

# S7F19 - Request PPID List
label S7F19
    send_reply name=host_connection S7F20 0
    <L
        <A '/Test/Recipe001'>
        <A '/Test2/Recipe002'>
        <A 'SZ41T_8a76A'>
        <A 'EMPTY RECIPE'>
    >.


label run_job 7
    # send job started event
    send name=host_connection client=$client S6F11 0 W
    <L
        <U4 23>
        <U4 5458>
```

```
        <L
            <L
                <U4 106>
                <L
                    <A 'CJ001'>
                >
            >
        >
    >.

    sleep 10
    # send job completed event
    send name=host_connection client=$client S6F11 0 W
    <L
        <U4 24>
        <U4 5459>
        <L
            <L
                <U4 106>
                <L
                    <A 'CJ001'>
                >
            >
        >
    >.
```

Using sc as a semiconductor host or Equipment Interface simulator

The following bit of sc code represent a very simplistic equipment simulation. Please refer to the callouts for a more detailed explanation of what is going on.

1. "`tool_connection`" is the name of this connection. In environments where multiple connections are required it is used to distinguish between them. The value of name (in this case "`tool_connection`") is also the value of a label in the script file. Whenever there is input on this channel sc will start the program running at the statement immediately following this label.
2. The value of `host` can be either an IP address or it can be a host name that can be resolved via the host file or DNS. Since this script example is that of a client (think Equipment Interface or host controller simulator) the IP address would be that of the equipment (or emulator/simulator) that you want to communicate with.
3. The value of `service` represents the port that the connection will use. The value of 5000 is fairly typical.

4. Whenever a message is received on the "tool_connection" channel/connection sc packages the contents of the message into temp variables. When using the SECS (secs or hsms) protocols there are several temporary variable syou can expect to have good data in them. In this case the SXFY variable will contain the stream and function of the message just received. For example, if the incoming message was a stream 1 function 13 message the value of the temp variable SXFY would be S1F13.

5. Most semiconductor host controllers or Equipment Interface simulators will be set up in this manner. In simple terms, whenever a message is received the stream and function of the message are retrieved and this dynamic goto is executed to direct the simulation to the appropriate message handler. In the situation mentioned above, this line would resolve to a goto S1F13 which would cause the script to start executing at the line immediately following label S1F13.

6. This is a very simple handler to deal with an incoming S1F13 message. It generates the appropriate S1F14 message header and then sends the reply back on the "tool_connection" connection.

7. These are example of some of the commands you might find in a file that was simulating and Equipment Interface or host.

```
open socket_client name=tool_connection 1 proto=hsms logging=2

host=10.100.32.140 2 service=5000 3 options="t3=5 t6=10 t7=10 t8=10
timeout_msg=TIMEOUT"


label tool_connection 1

    let sxfy = get_tmp_var(SXFY) 4

    goto $sxfy 5

/*
S1F13 - Establish Communications, CommunicationState is COMMUNICATING
This is what the response to an S1F13 is when returned from a "HOST"
*/


label S1F13 6
```

```
    send_reply name=tool_connection S1F14 0
    <L
        <B 00>
        <L
        >
    >.

label est_com 7
    send name=tool_connection S1F13 0 W
    <L>.

label hello 7
    send name=tool_connection S1F1 0 W
    <L>.

label query 7
    send name=tool_connection S1F3 0 W
    <L
FIXME
    >.
label offline 7
    send name=tool_connection S1F15 0 W .

label online 7
    send name=tool_connection S1F17 0 W .
```

Using sc to upload a binary recipe and compare it to a recipe in a file

This example shows how to upload a binary recipe from the tool and then compare it to a recipe file.

```
# Connect to the tool
open socket_client name=tool proto=secs local_name="./sockets/tool"
logging=2 options="baud=9600 t1=2 t2=2 t3=45 rbit=0 retry=3
timeout_msg=T3_TIMEOUT_DETECTED"
# Upload the recipe from the tool
send name=tool S7F5 0 W
<L
```

```
    <A "my_recipe">
>.

# Add all the uploaded bytes together to create one variable with the data
let size = get_tmp_var("S7F6.1.2[0]")
print "size <" . $size . ">"
let recipe = "" # Initialize to blank
for i=1 to $size
    let b = get_tmp_var(S7F6.1.2[$i])
    let bb = itoh($b, "2.2") # Convert the decimal value to hexadecimal
    print "b <" . $b . "> bb <" . $bb . ">"
    let recipe = $recipe . $bb
next I

# Read in the master recipe file (from disk)
import("t.binary_recipe_small", "rb", recipe.old)

# Compare the recipe file with the uploaded recipe
if ($recipe.old eq $recipe)
    print "YES match"
else
    print "NO match"
end_if
```

More sophisticated variable usage

This section will be addressed in a later revision.

Maintenance

This section discusses how to maintain the sc source code.

Debugging sc

All the source code contains DEBUG statements. Debug statements can be added anywhere in the source code. The format of a debug statement is as follows:

```
DEBUG (<level>, DEBUG_HDR, <format>, <args>);
```

<level> - Can be any number, and is controlled by the –d <level> option on the command line.
<format> - Defines the constant portion.

<args> - Defines the arguments.

Each module should also contain:

```
#undef NAME
#define NAME "<function_name)()"
```

Example:

```
static void look(struct buffer *token, struct buffer *name, int *idx1, int *idx2)
{
    char *data = (char *)NULL;
    int i = 0;
    int var = 0;
    int nest = 0;
    int nest_var = 0;

#undef NAME
#define NAME "look()"

    DEBUG (3, DEBUG_HDR, "Look called, token <%s>\n", bufdata(token));
    var = nest = nest_var = 0;
    data = bufdata(token);
    bufcpy(name, "");
    *idx1 = *idx2 = 0;

.............. deleted code ..............

    DEBUG (3, DEBUG_HDR, "Returning name <%s>, idx1 <%d>, idx2 <%d>\n",
    bufdata(name), *idx1, *idx2);

    return;
}
```

Debugging can also be controlled by an sc.debug file. This file contains enteries containing filenames and modules. If the entry is present, debug statements will be printed. If an entry is ommitted, commented-out ("#"), debug statements will not be printed.

```
break.c::cmd_break_loop()
buffer.c::buffree()
buffer.c::bufprefix()
buffer.c::bufncat()
buffer.c::bufcat()
buffer.c::bufcpy()
```

```
buffer.c::bufncpy()
buffer.c::bufnlcpy()
buffer.c::buffilecpyread()
.........
```

The sc.debug file can easily be created using the following script:

```
strings sc.exe | grep ".c::" > sc.debug
```

The sc.debug file and the –d <level> command line option work together. The level is used to further specify which debug statements are printed.

The sc.debug file is optional and my be omitted, thus only the –d <level> will be used to control the printing of debug statements.

Important Concepts You Need to Understand

Arrays

There are no arrays in sc. There is only an emulation of arrays. Consider the following program snippet:

```
let day[1] = "Monday"
let day[2] = "Tuesday"
let day[3] = "Wednesday"
```

The result of executing the above 3 statements is that 3 variables have been created and have been assigned values. (If they already existed, the values of them would be assigned as indicated above.) The variables created would have the names `day[1]`, `day[2]`, `day[3]`. Yes, that is correct, the names of the variables actually have the left square bracket "`[`", the number ("`1`" for example), and the right square bracket "`]`" as part of their names. Let's say we want to print out the values of the variables. You might do it like this:

```
for i = 1 to 3
    print $day[$i]
next i
```

This would result in `Monday`, `Tuesday`, and `Wednesday` being printed out each on their own line. Basically what is happening is that the `$i` is being converted to its value, let's say `1` in this case. Now the `print` statement looks like `print $day[1]`. This now translates into print the value of the variable with the name of `day[1]`. The `$` (dollar) sign tells sc to substitute the variable's value.

Oh, this is so hokey and silly. Not so fast. How about a contrived, but, not too far fetched example. Let's say we are communicating with a machine and it sends an unsigned 16-bit value that conveys important information that the program needs to act on. The machine can send one of 65536 values (0 – 65535). However, through analysis we know that there are only a few values that it will actually send. Here is an example of a way to implement the program.

```
let jump_table[0] = "Turn_on_Green_Light"
let jump_table[32767] = "Turn_on_Blue_Light"
let jump_table[32768] = "Turn_on_Yellow_Light"
let jump_table[65533] = "Turn_on_Red_Light"
let jump_table[65534] = "Help_Me_Mommy"
let jump_table[65535] = "Kill the Witnesses"
```

code to receive message from machine

```
goto $jump_table[$value_from_machine]
```

```
label  Turn_on_Green_Light
```
code to turn on the green light

```
label  Turn_on_Blue_Light
```
code to turn on the blue light

```
label  Turn_on_Yellow_Light
```
code to turn on the yellow light

```
label  Turn_on_Red_Light
```
code to turn on the red light

```
label  Help_Me_Mommy
```
code to … its getting bad

```
label "Kill the Witnesses"
```
use your imagination here

As described above, in the `goto` statement this is what happens. The value of the variable `value_from_machine` (let's say it is 32767) is retrieved thus changing the `goto` statement into:
`goto $jump_table[32767]`

Next the value of the variable `jump_table[32767]` is retrieved changing the `goto` statement into:
`goto  Turn_on_Blue_Light`

At this point the program flow jumps to the label `Turn_on_Blue_Light` and begins executing the statement after the `label`. (As explained in the Labels section below the program will stop executing instructions when it encounter the next label statement, in this case `label Turn_on_Yellow_Light`. The will (normally) go back up and await the next message from the machine.)
So, what did we do? By using an "array" we were able to create a vector table that was able to use the datum from the machine in order to directly access the appropriate response. We did not have to create a "normal" array that would have needed the space for 65536 entries. We only needed 6 "entries."

Since the array concept is only emulated in sc the following is totally okay and does not produce some kind of array boundary issues:

```
let array[12345678909876543 21] = 1
```

Consider also that the array "index" does not have to be a number. This is possibly too:

```
let tasks[Monday] = "Water Plants"
let tasks[Tuesday] = "Wash Clothes"
let day = "Monday"

print "Today's task is " .  $tasks[$day]
```

This would print out "`Today's task is Water Plants`".

One last item of note is yes, a quoted label may contain spaces as in the label statement:

```
label "Kill the Witnesses"
```

Labels

Labels are named locations in a program that may be reached via some statement that can redirect control flow, a `goto` statement for instance. Labels in an sc program are probably different than you may be used to. In an sc program a label that is reached without an explicit directive to go to it will

cause the execution of the sc program to stop. In the normal case, the program does not "die" it just returns to waiting for incoming messages, expired timers, etc. Below is an example, the text in **bold** identifies the program statements that are actually executed:

```
let a = 1
goto add_2_to_a

let b = 2

label add_2_to_a
    a = $a + 2

label add_2_to_b
    b = $b + 2
```

Multi-threading

Sleep(ing)

Timers

sc has 6 timers. The ID for the timers are the numbers 0, 1, 2, 3, 4, 5. A timer expiration will not interrupt the current processing. This means if sc is caught in a "compute bound" loop it might be a while before expired timer handlers are activated. When sc reaches a "quiet" state (usually awaiting a response "message" or an unsolicited "message") it will process any timers that have expired. The "compute bound" condition is pretty rare do to sc being pretty fast, but, it is something to keep in mind if delayed timeout handling is causing issues in your application. As mentioned above, if the `NO_BLOCK_ON_SLEEP pragma` is not used a `sleep` statement will cause sc to not handle any timeout until sc "awakens" from the sleep statement.

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Version 2, June 1991

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