

ECE198KL – Spring 2013, Exam 1 – Handout

LC-3 Assembler

The LC-3 Assembler (`lc3as`) assembles the file so it can be run in the simulator.

Command	Description
<code>lc3as yourfile.asm</code>	Creates <code>yourfile.obj</code> , which is the object file that can be loaded into the simulator and <code>yourfile.sym</code> , which is the symbol table.

Errors	Description
<i>file contains only comments</i>	Indicates that there are no assembly instructions in the file, only comments.
<i>no .ORIG or .END directive found</i>	All programs must begin with <code>.ORIG</code> followed by the starting address of the program, and must end with <code>.END</code> .
<i>no .ORIG directive found</i>	All programs must begin with <code>.ORIG</code> followed by the starting address of the program.
<i>multiple .ORIG directives found</i>	Only one <code>.ORIG</code> command is allowed per file.
<i>instruction appears before .ORIG</i>	Instructions must start after the <code>.ORIG</code> directive.
<i>no .END directive found</i>	All programs must end with <code>.END</code> .
<i>label appears before .ORIG</i>	All code must be after the <code>.ORIG</code> directive.
<i>label x has already appeared</i>	Indicates that a second label with the same name has been found.
<i>unknown label x</i>	Indicates that label <code>x</code> is referenced, but does not exist.
<i>label has already appeared</i>	Each label in a program must only be used once. However, it can be referenced multiple times.
<i>illegal operands for x</i>	Indicates that the instruction has invalid operands.
<i>unterminated string</i>	Indicates that a string specified by the <code>.STRINGZ</code> directive was not closed with quotation marks.
<i>contains unrecognizable characters</i>	Indicates the line has characters that the assembler cannot parse.
<i>WARNING: All text after .END ignored</i>	Any instructions after the <code>.END</code> directive are not processed by the assembler.
<i>constant outside of allowed range</i>	All constants are limited by their bitwidth. The valid range is $[-2^{\text{num_bits}-1}, 2^{\text{num_bits}-1} - 1]$.

Note: the assembler will tell the total number of errors found in each pass and the line on which these errors occur. However, the assembler only checks for syntax errors, not whether the code is actually doing what it is supposed to.

LC-3 Simulator

Basic Commands	
Command	Description
lc3sim yourfile.obj	Load your program into the <i>command-line</i> simulator. You can also type <code>lc3sim</code> and use the command “file yourfile.obj” to load the program.
lc3sim-tk yourfile.obj	Load your program into the <i>graphical</i> simulator. You can also type <code>lc3sim-tk</code> and load a file by clicking the “Browse” button at the bottom of the screen.
reset	Reset the LC-3 and reload the last file.
quit	Quit the simulator.
help	Print the help message.

Running the program	
Command	Description
continue	Continues (or starts) execution of the program.
break	Sets a breakpoint. In the graphical version, you can double-click on a memory location to set a breakpoint. The line will turn red when a breakpoint is set.
finish	Execute until the end of the current subroutine.
next	Execute next instruction. If the next instruction is a subroutine (JSR) or TRAP, it will execute the entire subroutine or TRAP.
step	Execute one instruction. If the next instruction is a subroutine (JSR) or TRAP, it will <i>step into</i> the subroutine or TRAP.

Examining Memory and Registers ¹	
Command	Description
list	List instructions at the PC, an address, or label.
dump ...	Dump memory at the PC, and address, or a label.
translate <addr>	Show the value of a label and print the contents.
printregs	Print registers and current instruction.
memory <addr> <val>	Set the value stored at a memory location.
register <reg> <val>	Set a register to a value.
execute <file name>	Execute a script file.