



# OpenBoot 3.x Quick Reference

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# OpenBoot 3.x Quick Reference

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## Syntax

Enter commands at the `ok` prompt. They are executed left-to-right after a carriage-return. Separate all commands by one or more spaces.

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## Numeric Usage and Stack Comments

- Numeric I/O defaults to hexadecimal.
- Switch to decimal with `decimal`, switch to hexadecimal with `hex`.
- Use `10 .d` to see which base is currently active.

A numeric stack is used for all numeric parameters. Typing any integer puts that value on top of the stack. (Previous values are pushed down.) The right-hand item in a set always indicates the topmost stack item.

- The command `."` removes and displays the top stack value.
- The command `.s` non-destructively shows the entire stack contents.

A stack comment such as `(n1 n2 -- n3)` or `(adr len --)` or `(--)` listed after each command name shows the effect on the stack of executing that command. Items *before* the `--` are used by the command and removed from the stack. These items *must*

be present on the stack before the command can properly execute. Items **after** the - are left on the stack after the command completes execution, and are available for use by subsequent commands.

**TABLE 1-1** Numeric Usage and Stack Comments

---

	Alternate stack results. Example: ( input -- adr len false   result true ).
?	Unknown stack items (changed from ???).
???	Unknown stack items.
adr	Memory address (generally a virtual address).
adr16	Memory address, must be 16-bit aligned.
adr32	Memory address, must be 32-bit aligned.
adr64	Memory address, must be 64-bit aligned.
byte bxxx	8-bit value (smallest byte in a 32-bit word).
char	7-bit value (smallest byte), high bit unspecified.
cnt/len/size	Count or length.
flag xxx?	0 = false; any other value = true (usually -1).
long lxxx	32-bit value.
n n1 n2 n3	Normal signed values.
+n u	Unsigned, positive values.
phys	Physical address (actual hardware address).
pstr	Packed string (adr len means unpacked string).
virt	Virtual address (address used by software).
word wxxx	16-bit value.
xt	Execution token.

---

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# Help Commands

**TABLE 1-2** Help Commands

---

<code>help</code>	List main help categories.
<code>help <i>category</i></code>	Show help for all commands in the <i>category</i> . Use only the first word of the category description.
<code>help <i>command</i></code>	Show help for individual <i>command</i> (where available).

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# Device Tree Browsing Commands

**TABLE 1-3** Device Tree Browsing Commands

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<code>.properties</code>	Display the names and values of the current node's properties.
<code>dev <i>node-name</i></code>	Search for a node with the given name in the subtree below the current node, and choose the first such node found.
<code>dev ..</code>	Choose the device node that is the parent of the current node.
<code>dev /</code>	Choose the root machine node.
<code>device-end</code>	Leave the device tree.
<code>ls</code>	Display the names of the current node's children.
<code>pwd</code>	Display the device path name that names the current node.
<code>show-devs [<i>device-path</i>]</code>	Display all the devices directly under the specified device in the device tree; without <i>device-path</i> it shows the entire device tree.
<code>words</code>	Display the names of the current node's methods.

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# Common Options for the boot Command

TABLE 1-4 Common Options for the boot Command

---

boot [device-specifier] [filename] [options]	
[device-specifier]	The name (full path name or alias) of a device. Examples: cdrom (CD-ROM drive) disk (hard disk) net (Ethernet) tape (SCSI tape)
[filename]	The name of the program to be booted (for example, stand/diag). <i>If specified, filename is relative to the root of the selected device and partition. If not, the boot program uses the value of the boot-file or diag-file based on diag-switch? parameter.</i>
[options]	-a - Prompt interactively for the device and name of the boot file. -h - Halt after loading the program. <i>(OS-specific options may differ from system to system.)</i>

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# Emergency Keyboard Commands

TABLE 1-5 Emergency Keyboard Commands

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Hold down keys during power-on sequence.	
Stop	Bypass POST. This command does not depend on security-mode. (Note: some systems bypass POST as a default; in such cases, use Stop-D to start POST.)
Stop-A	Abort.
Stop-D	Enter diagnostic mode (set diag-switch? to true).
Stop-F	Enter Forth on TTYA instead of probing. Use fexit to continue with the initialization sequence. (Useful if hardware is broken.)
Stop-N	Reset NVRAM contents to default values.

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## Diagnostic Test Commands

**TABLE 1-6** Diagnostic Test Commands

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<code>probe-scsi</code>	Identify devices attached to the built-in SCSI bus.
<code>test <i>device-specifier</i></code>	Execute the specified device's self-test method. For example: <code>test floppy</code> - test the floppy drive, if installed <code>test net</code> - test the network connection
<code>test-all [<i>device-specifier</i>]</code>	Test all devices (that have a built-in self-test method) below the specified node. (If <i>device-specifier</i> is absent, the root node is used.)
<code>watch-clock</code>	Test the clock function.
<code>watch-net</code>	Monitor the network connection.

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## Examining and Creating Device Aliases

**TABLE 1-7** Examining and Creating Device Aliases

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<code>devalias</code>	Display all current device aliases.
<code>devalias <i>alias</i></code>	Display the device path name corresponding to alias.
<code>devalias <i>alias device-path</i></code>	Define an alias representing the device path. If an alias with the same name already exists, the new value supersedes the old.

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## System Information Display Commands

**TABLE 1-8** System Information Display Commands

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<code>banner</code>	Display the power-on banner.
<code>.version</code>	Display the version and date of the boot PROM.
<code>.speed</code>	Display CPU and bus speeds.

---

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## File Load & Run Commands

TABLE 1-9 File Load & Run Commands

---

boot [ <i>specifiers</i> ] -h	( -- )	Load file from specified source.
byte-load	( <b>adr xt--</b> )	Interpret a loaded FCode binary file. <b>xt</b> is usually 1.
dl	( -- )	Load a Forth file over a serial line with TIP and interpret. Type: ~C cat <i>filename</i> ^-D
dlbin	( -- )	Load a binary file over a serial line with TIP. Type: ~C cat <i>filename</i>
dload <i>filename</i>	( <b>adr --</b> )	Load specified file over Ethernet to given address.
go	( -- )	Begin executing a previously-loaded binary program, or resume executing an interrupted program.
init-program	( -- )	Initialize to execute a binary file.
load [ <i>specifiers</i> ]	( -- )	Load data from specified device into memory at the address given by load-base. (See boot format.)
load-base	( -- <b>adr</b> )	Address at which load places the data it reads from a device.

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## SPARC™ Register Commands

TABLE 1-10 SPARC Register Commands

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%g0 through %g7	( -- <b>value</b> )	Return the value in the given register.
%i0 through %i7	( -- <b>value</b> )	Return the value in the given register.
%l0 through %l7	( -- <b>value</b> )	Return the value in the given register.
%o0 through %o7	( -- <b>value</b> )	Return the value in the given register.
%pc %npc	( -- <b>value</b> )	Return the value in the given register.

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**TABLE 1-10** SPARC Register Commands (*Continued*)

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<code>.fregisters</code>	( -- )	Display values in %f0 through %f31.
<code>.locals</code>	( -- )	Display the values in the i, l and o registers.
<code>.registers</code>	( -- )	Display values in %g0 through %g7, plus some processor registers.
<code>.window</code>	( <b>window#</b> -- )	Display the desired window.
<code>ctrace</code>	( -- )	Display the return stack showing C subroutines.
<code>set-pc</code>	( <b>value</b> -- )	Set %pc to the given value, and set %npc to (value+4).
<code>to <i>regname</i></code>	( <b>value</b> -- )	Change the value stored in any of the above registers. Use in the form: <i>value</i> to <i>regname</i> .
<code>w</code>	( <b>window#</b> -- )	Set the current window for displaying registers.

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# SPARC V9 Register Commands

TABLE 1-11 SPARC V9 Register Commands

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<code>%fprs</code>	( <code>-- value</code> )	Return the value in the specified register.
<code>%asi</code>		
<code>%pstate</code>		
<code>%tl-c</code>		
<code>%pil</code>		
<code>%tstate</code>		
<code>%tt</code>		
<code>%tba</code>		
<code>%cwp</code>		
<code>%cansave</code>		
<code>%canrestore</code>		
<code>%otherwin</code>		
<code>%wstate</code>		
<code>%cleanwin</code>		
<code>.pstate</code>	( <code>--</code> )	Formatted display of the processor state register.
<code>.ver</code>	( <code>--</code> )	Formatted display of the version register.
<code>.ccr</code>	( <code>--</code> )	Formatted display of the ccr register.
<code>.trap- registers</code>	( <code>--</code> )	Display trap-related registers.

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# Breakpoint Commands

TABLE 1-12 Breakpoint Commands

---

<code>+bp</code>	( <code>adr --</code> )	Add a breakpoint at the given address.
<code>-bp</code>	( <code>adr --</code> )	Remove the breakpoint at the given address.
<code>--bp</code>	( <code>--</code> )	Remove the most-recently-set breakpoint.
<code>.bp</code>	( <code>--</code> )	Display all currently set breakpoints.
<code>.breakpoint</code>	( <code>--</code> )	Perform a specified action when a breakpoint occurs (Example, <code>[''] .registers</code> to <code>.breakpoint</code> )

---

**TABLE 1-12** Breakpoint Commands (*Continued*)

---

<code>.instruction</code>	( -- )	Display the address, opcode for the last-encountered breakpoint.
<code>.step</code>	( -- )	Perform a specified action when a single step occurs.
<code>bpoff</code>	( -- )	Remove all breakpoints.
<code>finish-loop</code>	( -- )	Execute until the end of this loop.
<code>go</code>	( -- )	Continue from a breakpoint. This can be used to go to an arbitrary address by setting up the processor's program counter before issuing <code>go</code> .
<code>gos</code>	( <b>n</b> -- )	Execute <code>go</code> <i>n</i> times.
<code>hop</code>	( -- )	(Like the <code>step</code> command.) Treats a subroutine call as a single instruction.
<code>hops</code>	( <b>n</b> -- )	Execute <code>hop</code> <i>n</i> times.
<code>return</code>	( -- )	Execute until the end of this subroutine.
<code>returnl</code>	( -- )	Execute until the end of this leaf subroutine.
<code>skip</code>	( -- )	Skip (do not execute) the current instruction.
<code>step</code>	( -- )	Single-step one instruction.
<code>steps</code>	( <b>n</b> -- )	Execute <code>step</code> <i>n</i> times.
<code>till</code>	( <b>adr</b> -- )	Execute until the given address is encountered. Equivalent to <code>+bp go</code> .

---

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## Miscellaneous Operations

**TABLE 1-13** Miscellaneous Operations

<code>eject-floppy</code>	( -- )	Eject the diskette from the drive.
<code>firmware-version</code>	( -- n )	Return major/minor CPU firmware version (that is, 0x00030009 = firmware version 3.9).
<code>ftrace</code>	( -- )	Show calling sequence when exception occurred.
<code>get-msecs</code>	( -- ms )	Return the approximate current time in milliseconds.
<code>ms</code>	( n -- )	Delay for n milliseconds. Resolution is 1 millisecond.
<code>reset-all</code>	( -- )	Reset the entire system (similar to a power cycle).
<code>sync</code>	( -- )	Call the operating system to write any pending information to the hard disk.

---

## NVRAM Configuration Parameters

**TABLE 1-14** NVRAM Configuration Parameters

Parameter Name	Default	Description
<code>auto-boot?</code>	<b>true</b>	If true, boot automatically after power-on or reset.
<code>boot-command</code>	<b>boot</b>	Executed when <code>auto-boot?</code> is true.
<code>boot-device</code>	<b>disk net</b>	Device from which to boot.
<code>boot-file</code>	<b>empty string</b>	File to boot (an empty string lets secondary booter choose default).
<code>diag-device</code>	<b>net</b>	Diagnostic boot source device.
<code>diag-file</code>	<b>empty string</b>	File from which to boot in diagnostic mode.
<code>diag-level</code>	<b>min</b>	Level of diagnostics to run (min or max).
<code>diag-switch?</code>	<b>false</b>	If true, run in diagnostic mode.

**TABLE 1-14** NVRAM Configuration Parameters *(Continued)*

---

<code>fcode-debug?</code>	<b>false</b>	If true, include name fields for plug-in device FCodes.
<code>input-device</code>	<b>keyboard</b>	Power-on input device (usually keyboard, <code>ttya</code> , or <code>ttyb</code> ).
<code>keymap</code>	<b>no default</b>	Keymap for custom keyboard.
<code>nvrामrc</code>	<b>empty string</b>	NVRAM Startup script.
<code>oem-banner</code>	<b>empty string</b>	Custom OEM banner (enabled by <code>oem-banner? true</code> ).
<code>oem-banner?</code>	<b>false</b>	If true, use custom OEM banner.
<code>output-device</code>	<b>screen</b>	Power-on output device (usually <code>screen</code> , <code>ttya</code> , or <code>ttyb</code> ).
<code>sbus-probe-list</code>	<b>01</b>	Which SBus slots are probed and in what order.
<code>scsi-initiator-id</code>	<b>7</b>	SCSI bus address of host adapter, range 0-f.
<code>security-mode</code>	<b>none</b>	Firmware security level ( <code>none</code> , <code>command</code> , or <code>full</code> ).
<code>security-password</code>	<b>no default</b>	Firmware security password (never displayed).
<code>ttya-mode</code>	<b>9600,8,n,1,-</b>	TTYA (baud, #bits, parity, #stop, handshake).
<code>ttyb-mode</code>	<b>9600,8,n,1,-</b>	TTYB (baud, #bits, parity, #stop, handshake).
<code>ttya-ignore-cd</code>	<b>true</b>	If true, OS ignores TTYA carrier-detect.
<code>ttyb-ignore-cd</code>	<b>true</b>	If true, OS ignores TTYB carrier-detect.
<code>ttya-rts-dtr-off</code>	<b>false</b>	If true, OS does not assert DTR and RTS on TTYA.
<code>ttyb-rts-dtr-off</code>	<b>false</b>	If true, OS does not assert DTR and RTS on TTYB.
<code>use-nvrामrc?</code>	<b>false</b>	If true, execute commands in NVRAMRC during system start-up.
<code>watchdog-reboot?</code>	<b>false</b>	If true, reboot after watchdog reset.

---

---

# Viewing and Changing Configuration Parameters

**TABLE 1-15** Viewing and Changing Configuration Parameters

---

<code>password</code>	Set security-password.
<code>printenv [parameter]</code>	Display all current parameters and current default values (numbers are usually shown as decimal values). <code>printenv parameter</code> shows the current value of the named parameter.
<code>setenv parameter value</code>	Set the parameter to the given decimal or text value. (Changes are permanent, but usually only take effect after a reset).
<code>set-default parameter</code>	Reset the value of the named parameter to the factory default.
<code>set-defaults</code>	Reset parameter values to the factory defaults.

---

---

# Commands Affecting NVRAMRC

**TABLE 1-16** Commands Affecting NVRAMRC

---

<code>nvalias alias device-path</code>	Store the command " <code>devalias alias device-path</code> " in NVRAMRC. (The alias persists until the <code>nvunalias</code> or <code>set-defaults</code> commands are executed.) Turns on <code>use-nvramrc?</code>
<code>nvedit</code>	Enter the NVRAMRC editor. If data remains in the temporary buffer from a previous <code>nvedit</code> session, resume editing those previous contents. If not, read the contents of NVRAMRC into the temporary buffer and begin editing it.
<code>nvquit</code>	Discard the contents of the temporary buffer, without writing it to NVRAMRC.

---



**TABLE 1-16** Commands Affecting NVRAMRC (*Continued*)

<code>nvrecover</code>	Recover the contents of NVRAMRC if they have been lost as a result of the execution of <code>set-defaults</code> ; then enter the editor as with <code>nvedit</code> . <code>nvrecover</code> fails if <code>nvedit</code> is executed between the time that the NVRAMRC contents were lost and the time that <code>nvrecover</code> is executed.
<code>nvstore</code>	Copy the contents of the temporary buffer to NVRAMRC; discard the contents of the temporary buffer.
<code>nvunalias <i>alias</i></code>	Delete the corresponding alias from NVRAMRC.

## Editor Commands (for Command Lines and NVRAMRC)

**TABLE 1-17** Editor Commands (for Command Lines and NVRAMRC)

	Previous Line	Begin Line	Previous Word	Prev. Char	Next Character	Next Word	End Line	Next Line
Move	<code>^P</code>	<code>^A</code>	<code>escB</code>	<code>^B</code>	<code>^F</code>	<code>escF</code>	<code>^E</code>	<code>^N</code>
Delete		<code>^U</code>	<code>^ W</code>	<code>Del</code>	<code>^D</code>	<code>escD</code>	<code>^K</code>	

Re-type line: `^R`  
 Show all lines: `^L`  
 Paste after: `^K ^Y`  
 Complete command: `^ space`  
 Show all matches: `^/` or `^?}`

`esc` = Press and release Escape key first;  
`^` = Press and hold Control key

---

## Using the NVRAMRC Editor

TABLE 1-18 Using the NVRAMRC Editor

---

```
ok nvedit
:
(use editor commands)
:
^c                               get back to ok prompt
ok nvstore                       save changes
ok setenv use-nvramrc? true enable NVRAMRC
```

---

---

## Stack Manipulation Commands

TABLE 1-19 Stack Manipulation Commands

---

<code>-rot</code>	<code>( n1 n2 n3 -- n3 n1 n2 )</code>	Inversely rotate three stack items.
<code>&gt;r</code>	<code>( n -- )</code>	Move a stack item to the return stack.
<code>?dup</code>	<code>( n -- n n   0 )</code>	Duplicate the top stack item if non-zero.
<code>2drop</code>	<code>( n1 n2 -- )</code>	Remove top two items from the stack.
<code>2dup</code>	<code>( n1 n2 -- n1 n2 n1 n2 )</code>	Duplicate top two stack items.
<code>2over</code>	<code>( n1 n2 n3 n4 -- n1 n2 n3 n4 n1 n2 )</code>	Copy second two stack items.
<code>2swap</code>	<code>( n1 n2 n3 n4 -- n3 n4 n1 n2 )</code>	Exchange top two pairs of stack items.
<code>clear</code>	<code>( ??? -- )</code>	Empty the stack.
<code>depth</code>	<code>( ??? -- ??? +n )</code>	Return the number of items on the stack.

---

**TABLE 1-19** Stack Manipulation Commands (*Continued*)

drop	( n -- )	Remove the top item from the stack.
dup	( n -- n n )	Duplicate the top stack item.
over	( n1 n2 -- n1 n2 n1 )	Copy the second stack item to the top of the stack.
pick	( nu ... n1 n0 u -- nu ... n1 n0 nu )	Copy u-th stack item (1 pick = over).
r>	( -- n )	Move a return stack item to the stack.
r@	( -- n )	Copy the top of the return stack to the stack.
roll	( nu ... n1 n0 u -- nu-1 ... n1 n0 nu )	Rotate u stack items (2 roll = rot).
rot	( n1 n2 n3 -- n2 n3 n1 )	Rotate three stack items.
swap	( n1 n2 -- n2 n1 )	Exchange the top two stack items.
tuck	( n1 n2 -- n2 n1 n2 )	Copy the top stack item below the second item.

---

## Changing the Number Base

TABLE 1-20 Changing the Number Base

---

decimal	( -- )	Set the number base to 10.
d# <i>number</i>	( -- n )	Interpret the next number in decimal; base is unchanged.
hex	( -- )	Set the number base to 16.
h# <i>number</i>	( -- n )	Interpret the next number in hex; base is unchanged.
.d	( n -- )	Display n in decimal without changing base.
.h	( n -- )	Display n in hex without changing base.

---

---

## Basic Number Display

TABLE 1-21 Basic Number Display

---

.	( n -- )	Display a number in the current base.
.s	( -- )	Display contents of data stack.
showstack	( -- )	Execute .s automatically before each ok prompt.

---

---

## Arithmetic Functions

TABLE 1-22 Arithmetic Functions

---

*	( n1 n2 -- n3 )	Multiply n1 * n2.
+	( n1 n2 -- n3 )	Add n1 + n2.
-	( n1 n2 -- n3 )	Subtract n1 - n2
/	( n1 n2 -- quot )	Divide n1 / n2; remainder is discarded.

---

**TABLE 1-22** Arithmetic Functions (*Continued*)

---

<code>lshift</code>	<code>( n1 +n -- n2 )</code>	Left-shift <code>n1</code> by <code>+n</code> bits.
<code>rshift</code>	<code>( n1 +n -- n2 )</code>	Right-shift <code>n1</code> by <code>+n</code> bits.
<code>&gt;&gt;a</code>	<code>( n1 +n -- n2 )</code>	Arithmetic right-shift <code>n1</code> by <code>+n</code> bits.
<code>abs</code>	<code>( n -- u )</code>	Absolute value.
<code>and</code>	<code>( n1 n2 -- n3 )</code>	Bitwise logical AND.
<code>bounds</code>	<code>( n cnt -- n+cnt n )</code>	Prepare arguments for <code>do</code> or <code>?do</code> loop.
<code>bljoin</code>	<code>( b.low b2 b3 b.hi -- long )</code>	Join four bytes to form a 32-bit value.
<code>bwjoin</code>	<code>( b.low b.hi -- word )</code>	Join two bytes to form a 16-bit value.
<code>lbsplit</code>	<code>( long -- b.low b2 b3 b.hi )</code>	Split a 32-bit value into four bytes.
<code>lwsplit</code>	<code>( long -- w.low w.hi )</code>	Split a 32-bit value into two 16-bit words.
<code>max</code>	<code>( n1 n2 -- n3 )</code>	<code>n3</code> is maximum of <code>n1</code> and <code>n2</code> .
<code>min</code>	<code>( n1 n2 -- n3 )</code>	<code>n3</code> is minimum of <code>n1</code> and <code>n2</code> .
<code>mod</code>	<code>( n1 n2 -- rem )</code>	Remainder of <code>n1 / n2</code> .
<code>negate</code>	<code>( n1 -- n2 )</code>	Change the sign of <code>n1</code> .
<code>invert</code>	<code>( n1 -- n2 )</code>	Bitwise ones complement.
<code>or</code>	<code>( n1 n2 -- n3 )</code>	Bitwise logical OR.
<code>wbsplit</code>	<code>( word -- b.low b.hi )</code>	Split 16-bit value into two bytes.
<code>wljoin</code>	<code>( w.low w.hi -- long )</code>	Join two 16-bit values to form a 32-bit value.
<code>xor</code>	<code>( n1 n2 -- n3 )</code>	Bitwise exclusive OR.

---

---

## Disassembler Commands

TABLE 1-23 Disassembler Commands

---

<code>+dis</code>	<code>( -- )</code>	Continue disassembling where the last disassembly left off.
<code>dis</code>	<code>( adr -- )</code>	Begin disassembling at the given address.

---

---

## Memory Access Commands

TABLE 1-24 Memory Access Commands

---

<code>!</code>	<code>( n adr -- )</code>	Store a number at <code>adr</code> .
<code>+</code>	<code>( n adr -- )</code>	Add <code>n</code> to the number stored at <code>adr</code> .
<code>@</code>	<code>( adr -- n )</code>	Fetch a number from <code>adr</code> .
<code>c!</code>	<code>( n adr -- )</code>	Store low byte of <code>n</code> at <code>adr</code> .
<code>c@</code>	<code>( adr -- byte )</code>	Fetch a byte from <code>adr</code> .
<code>cpeek</code>	<code>( adr -- false   byte true )</code>	Fetch the byte at <code>adr</code> . Return the data and <code>true</code> if the access was successful. Return <code>false</code> if a read access error occurred. (Also <code>lpeek</code> , <code>wpeek</code> .)
<code>cpoke</code>	<code>( byte adr -- okay? )</code>	Store the byte to <code>adr</code> . Return <code>true</code> if the access was successful. Return <code>false</code> if a write access error occurred. (Also <code>lpoke</code> , <code>wpoke</code> .)
<code>comp</code>	<code>( adr1 adr2 len -- n )</code>	Compare two byte arrays, <code>n = 0</code> if arrays are identical, <code>n = 1</code> if first byte that is different is greater in array#1, <code>n = -1</code> otherwise.
<code>dump</code>	<code>( adr len -- )</code>	Display <code>len</code> bytes of memory starting at <code>adr</code> .
<code>fill</code>	<code>( adr size byte -- )</code>	Set <code>size</code> bytes of memory to <code>byte</code> .
<code>l!</code>	<code>( n adr32 -- )</code>	Store a 32-bit number at <code>adr32</code> .

---

**TABLE 1-24** Memory Access Commands *(Continued)*

---

<code>l@</code>	<code>( adr32 -- long )</code>	Fetch a 32-bit number from <code>adr32</code> .
<code>move</code>	<code>( src dst u -- )</code>	Copy <code>u</code> bytes from <code>src</code> to <code>dst</code> , handle overlap properly.
<code>w!</code>	<code>( n adr16 -- )</code>	Store a 16-bit number at <code>adr16</code> , must be 16-bit aligned.
<code>w@</code>	<code>( adr16 -- word )</code>	Fetch a 16-bit number from <code>adr16</code> , must be 16-bit aligned.
<code>x!</code>	<code>( o oaddr -- )</code>	Store a 64-bit number at <code>oaddr</code> , must be 64-bit aligned.
<code>x@</code>	<code>( oaddr -- o )</code>	Fetch a 64-bit number from <code>oaddr</code> , must be 64-bit aligned.

---

---

# Memory Mapping Commands

**TABLE 1-25** Memory Mapping Commands

---

<code>alloc-mem</code>	<code>( size -- virt )</code>	Allocate and map size bytes of available memory; return the virtual address. Unmap with <code>free-mem</code> .
<code>free-mem</code>	<code>( virt size -- )</code>	Free memory allocated by <code>alloc-mem</code> .
<code>free-virtual</code>	<code>( virt size -- )</code>	Undo mappings created with <code>memmap</code> .
<code>map?</code>	<code>( virt -- )</code>	Display memory map information for the virtual address.
<code>memmap</code>	<code>( phys space size -- virt )</code>	Map a region of physical addresses; return the allocated virtual address. Unmap with <code>free-virtual</code> .
<code>obio</code>	<code>( -- space )</code>	Specify the device address space for mapping.
<code>obmem</code>	<code>( -- space )</code>	Specify the onboard memory address space for mapping.
<code>pgmap!</code>	<code>( pmentry virt -- )</code>	Store a new page map entry for the virtual address.
<code>pgmap?</code>	<code>( virt -- )</code>	Display the decoded page map entry corresponding to the virtual address.
<code>pgmap@</code>	<code>( virt -- pmentry )</code>	Return the page map entry for the virtual address.
<code>pagesize</code>	<code>( -- size )</code>	Return the size of a page (often 8K).
<code>sbus</code>	<code>( -- space )</code>	Specify the SBus address space for mapping.

---



---

## Defining Words

TABLE 1-26 Defining Words

---

<code>:</code>	<code>name</code>	<code>( -- )</code> <code>Usage: ( ??? -- ? )</code>	Start creating a new colon definition.
<code>:</code>		<code>( -- )</code>	Finish creating a new colon definition.
<code>buffer:</code>	<code>name</code>	<code>( size -- )</code> <code>Usage: ( -- adr )</code>	Create a named array in temporary storage.
<code>constant</code>	<code>name</code>	<code>( n -- )</code> <code>Usage: ( -- n )</code>	Define a constant (for example, 3 constant bar).
<code>create</code>	<code>name</code>	<code>( -- )</code> <code>Usage: ( -- adr )</code>	Generic defining word.
<code>defer</code>	<code>name</code>	<code>( -- )</code> <code>Usage: ( ??? -- ? )</code>	Define forward reference or execution vector.
<code>value</code>	<code>name</code>	<code>( n -- )</code> <code>Usage: ( -- n )</code>	Create a changeable, named quantity.
<code>variable</code>	<code>name</code>	<code>( -- )</code> <code>Usage: ( -- adr )</code>	Define a variable.

---

---

## Dictionary Searching Commands

TABLE 1-27 Dictionary Searching Commands

---

<code>'</code>	<code>name</code>	<code>( -- xt )</code>	Find the named word in the dictionary. (Returns the execution token. Use outside definitions.)
<code>[']</code>	<code>name</code>	<code>( -- xt )</code>	Similar to <code>'</code> but is used inside definitions.
<code>.</code>	<code>calls</code>	<code>( xt -- )</code>	Display a list of all words that call the word whose execution token is <code>xt</code> .
<code>\$find</code>		<code>( adr len --</code> <code>adr len false</code> <code>  xt n )</code>	Find a word. <code>n = 0</code> if not found, <code>n = 1</code> if immediate, <code>n = -1</code> otherwise.
<code>see</code>	<code>thisword</code>	<code>( -- )</code>	Decompile the named command.

---

**TABLE 1-27** Dictionary Searching Commands (*Continued*)

---

(see)	( <b>xt</b> -- )	Decompile the word indicated by the execution token.
sifting ccc	( -- )	Display names of all dictionary entries containing the sequence of characters. <b>ccc</b> contains no spaces.
words	( -- )	Display visible words in the dictionary.

---

---

## Manipulating Text Strings

**TABLE 1-28** Manipulating Text Strings

---

" ccc"	( -- <b>adr len</b> )	Collect an input stream string.
. " ccc"	( -- )	Compile a string for later display.
bl	( -- <b>char</b> )	ASCII code for the space character; decimal 32.
count	( <b>pstr</b> -- <b>adr +n</b> )	Unpack a packed string.
p" ccc"	( -- <b>pstr</b> )	Collect a string from the input stream; store as a packed string.

---

---

# Dictionary Compilation Commands

TABLE 1-29 Dictionary Compilation Commands

---

,	( <b>n</b> -- )	Place a number in the dictionary.
c,	( <b>byte</b> -- )	Place a byte in the dictionary.
w,	( <b>word</b> -- )	Place a 16-bit number in the dictionary.
l,	( <b>long</b> -- )	Place a 32-bit number in the dictionary.
allot	( <b>n</b> -- )	Allocate n bytes in the dictionary.
forget name	( -- )	Remove word from dictionary and all subsequent words.
here	( -- <b>adr</b> )	Address of top of dictionary.
to <i>name</i>	( <b>n</b> -- )	Install a new action in a defer word or value.
patch <i>new-word</i> <i>old-word</i> <i>word-to-patch</i>	( -- )	Replace <i>old-word</i> with <i>new-word</i> in <i>word-to-patch</i> .
(patch)	( <b>new-n</b> <b>old-n</b> <b>xt</b> -- )	Replace <i>old-n</i> with <i>new-n</i> in word indicated by <i>xt</i> .

---

---

# Controlling Text Input

TABLE 1-30 Controlling Text Input

---

( <i>ccc</i> )	( -- )	Begin a comment.
\ rest-of-line	( -- )	Skip the rest of the line.
ascii <i>ccc</i>	( -- <b>char</b> )	Get numerical value of first ASCII character of next word.
key	( -- <b>char</b> )	Read a character from the assigned input device.
key?	( -- <b>flag</b> )	True if a character has been entered from the input device..

---

---

## Displaying Text Output

TABLE 1-31 Displaying Text Output

---

<code>cr</code>	( <code>--</code> )	Terminate a line on the display and go to the next line.
<code>emit</code>	( <code>char --</code> )	Display the character.
<code>type</code>	( <code>adr +n --</code> )	Display <code>n</code> characters.

---

---

## Redirecting I/O

TABLE 1-32 Redirecting I/O

---

<code>input</code>	( <code>dev-spec --</code> )	Select device ( <code>ttya</code> , <code>ttvb</code> , keyboard, or " <code>dev-spec</code> ") for subsequent input.
<code>io</code>	( <code>dev-spec --</code> )	Select device for subsequent input and output.
<code>output</code>	( <code>dev-spec --</code> )	Select device ( <code>ttya</code> , <code>ttvb</code> , screen, or " <code>dev-spec</code> ") for subsequent output.

---

---

## Comparison Commands

TABLE 1-33 Comparison Commands

---

<code>&lt;</code>	( <code>n1 n2 -- flag</code> )	True if <code>n1 &lt; n2</code> .
<code>&lt;=</code>	( <code>n1 n2 -- flag</code> )	True if <code>n1 &lt;= n2</code> .
<code>&lt;&gt;</code>	( <code>n1 n2 -- flag</code> )	True if <code>n1 &lt;&gt; n2</code> .
<code>=</code>	( <code>n1 n2 -- flag</code> )	True if <code>n1 = n2</code> .
<code>&gt;</code>	( <code>n1 n2 -- flag</code> )	True if <code>n1 &gt; n2</code> .
<code>&gt;=</code>	( <code>n1 n2 -- flag</code> )	True if <code>n1 &gt;= n2</code> .
<code>between</code>	( <code>n min max -- flag</code> )	True if <code>min &lt;= n &lt;= max</code> .

---

**TABLE 1-33** Comparison Commands (*Continued*)

---

<code>u&lt;</code>	<code>( u1 u2 -- flag )</code>	True if <code>u1 &lt; u2</code> , unsigned.
<code>u&lt;=</code>	<code>( u1 u2 -- flag )</code>	True if <code>u1 &lt;= u2</code> , unsigned.
<code>u&gt;</code>	<code>( u1 u2 -- flag )</code>	True if <code>u1 &gt; u2</code> , unsigned.
<code>u&gt;=</code>	<code>( u1 u2 -- flag )</code>	True if <code>u1 &gt;= u2</code> , unsigned.
<code>within</code>	<code>( n min max -- flag )</code>	True if <code>min &lt;= n &lt; max</code> .

---

---

## if-else-then Commands

**TABLE 1-34** if-else-then Commands

---

<code>else</code>	<code>( -- )</code>	Execute the following code if <code>if</code> failed.
<code>if</code>	<code>( flag -- )</code>	Execute the following code if <code>flag</code> is true.
<code>then</code>	<code>( -- )</code>	Terminate <code>if...else...then</code> .

---

---

## begin (Conditional) Loop Commands

**TABLE 1-35** begin (Conditional) Loop Commands

---

<code>again</code>	<code>( -- )</code>	End a <code>begin...again</code> infinite loop.
<code>begin</code>	<code>( -- )</code>	Begin a <code>begin...while...repeat</code> , <code>begin...until</code> , or <code>begin...again</code> loop.
<code>repeat</code>	<code>( -- )</code>	End a <code>begin...while...repeat</code> loop.
<code>until</code>	<code>( flag -- )</code>	Continue executing a <code>begin...until</code> loop until <code>flag</code> is true.
<code>while</code>	<code>( flag -- )</code>	Continue executing a <code>begin...while...repeat</code> loop while <code>flag</code> is true.

---

---

## do (Counted) Loop Commands

TABLE 1-36 do (Counted) Loop Commands

---

<code>+loop</code>	<code>( n -- )</code>	End a <code>do...+loop</code> construct; add <code>n</code> to loop index and return to <code>do</code> (if <code>n &lt; 0</code> , index goes from start to end inclusive).
<code>?do</code>	<code>( end start -- )</code>	Begin <code>?do...loop</code> to be executed 0 or more times. Index goes from start to end-1 inclusive. If <code>end = start</code> , loop is not executed.
<code>do</code>	<code>( end start -- )</code>	Begin a <code>do...loop</code> . Index goes from start to end-1 inclusive. Example: 10 0 do i . loop (prints 0 1 2...d e f).
<code>i</code>	<code>( -- n )</code>	Loop index.
<code>j</code>	<code>( -- n )</code>	Loop index for next enclosing loop.
<code>leave</code>	<code>( -- )</code>	Exit from <code>do...loop</code> .
<code>loop</code>	<code>( -- )</code>	End of <code>do...loop</code> .

---

---

## case Statement

```
( value )
case
2 of ." it was two" endof
0 of ." it was zero" endof
." it was " dup . (optional default clause)
endcase
```

---

## Program Execution Control Commands

TABLE 1-37 Program Execution Control Commands

---

<code>abort</code>	<code>( -- )</code>	Abort current execution and interpret keyboard commands.
<code>abort" ccc"</code>	<code>( abort? -- )</code>	If flag is true, abort and display message.
<code>eval</code>	<code>( adr len -- )</code>	Interpret Forth source from an array.
<code>execute</code>	<code>( xt -- )</code>	Execute the word whose execution token is on the stack.
<code>exit</code>	<code>( -- )</code>	Return from the current word. (Cannot be used in counted loops.)
<code>quit</code>	<code>( -- )</code>	Same as <code>abort</code> , but leave stack intact.

---

---

## Alternate Address Space Access Commands

TABLE 1-38 Alternate Address Space Access Commands

---

<code>spacec!</code>	<code>( byte adr asi -- )</code>	Store the byte at <code>asi</code> and address.
<code>spacec@</code>	<code>( adr asi -- byte )</code>	Fetch the byte from <code>asi</code> and address.
<code>spaced!</code>	<code>( n1 n2 adr asi -- )</code>	Store the two values at <code>asi</code> and address. Order is implementation-dependent.
<code>spaced@</code>	<code>( adr asi -- n1 n2 )</code>	Fetch the two values from <code>asi</code> and address. Order is implementation-dependent.
<code>space1!</code>	<code>( long adr asi -- )</code>	Store the 32-bit word at <code>asi</code> and address.
<code>space1@</code>	<code>( adr asi -- long )</code>	Fetch the 32-bit word from <code>asi</code> and address.
<code>spacew!</code>	<code>( word adr asi -- )</code>	Store the 16-bit word at <code>asi</code> and address.
<code>spacew@</code>	<code>( adr asi -- word )</code>	Fetch the 16-bit word from <code>asi</code> and address.
<code>spacex!</code>	<code>( x adr asi -- )</code>	Store the 64-bit word at <code>asi</code> and address.
<code>spacex@</code>	<code>( adr asi -- x )</code>	Fetch the 64-bit word from <code>asi</code> and address.

---

---

## Cache Manipulation Commands

TABLE 1-39 Cache Manipulation Commands

---

<code>clear-cache</code>	( -- )	Invalidate all cache entries.
<code>cache-off</code>	( -- )	Disable the cache.
<code>cache-on</code>	( -- )	Enable the cache.
<code>flush-cache</code>	( -- )	Write back any pending data from the cache.

---

---

## Multiprocessor Command

TABLE 1-40 Multiprocessor Command

---

<code>switch-cpu</code>	( <code>cpu#</code> -- )	Switch to indicated CPU.
-------------------------	--------------------------	--------------------------

---

---

## Program Execution Control Commands

TABLE 1-41 Program Execution Control Commands

---

<code>abort</code>	( -- )	Abort current execution and interpret keyboard commands.
<code>abort" ccc"</code>	( <code>abort?</code> -- )	If flag is true, abort and display message.
<code>eval</code>	( <code>adr len</code> -- )	Interpret Forth source from an array.
<code>execute</code>	( <code>xt</code> -- )	Execute the word whose execution token is on the stack.
<code>exit</code>	( -- )	Return from the current word. (Cannot be used in counted loops.)
<code>quit</code>	( -- )	Same as <code>abort</code> , but leave stack intact.

---