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OpenBootTM 2.x Quick Reference

Syntax

Commands are entered at the `ok` prompt and are executed left-to-right after a carriage-return. All commands must be separated by one or more spaces.

Help Commands

TABLE 1-1 Help Commands

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

Restricted Monitor Commands

TABLE 1-2 Restricted Monitor Commands

b [<i>specifiers</i>]	Boot the operating system (same as <code>boot</code> at <code>ok</code> prompt).
c	Resume the execution of a halted program (same as <code>go</code> at <code>ok</code> prompt).
n	Enter the Forth Monitor.

Examining and Creating Device Aliases

TABLE 1-3 Examining and Creating Device Aliases

<code>devalias</code>	Display all current device aliases.
<code>devalias <i>alias</i></code>	Display the device path name corresponding to <i>alias</i> .
<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.

Device Tree Browsing Commands

TABLE 1-4 Device Tree Browsing Commands

<code>.attributes</code>	Display the names and values of the current node's properties.
<code>cd <i>device-path</i></code>	Select the indicated device node, making it the current node.
<code>cd <i>node-name</i></code>	Search for a node with the given name in the subtree below the current node, and select the first such node found.
<code>cd ..</code>	Select the device node that is the parent of the current node.
<code>cd /</code>	Select the root machine node.
<code>device-end</code>	De-select the current device node, leaving no node selected.
<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 known to the system directly beneath a given level in the device hierarchy. (Used by itself, it shows the entire device tree.)
<code>words</code>	Display the names of the current node's methods.

Common Options for the `boot` Command

TABLE 1-5 Common Options for the boot Command

boot [<i>device-specifier</i>] [<i>filename</i>] [<i>options</i>]	
[<i>device-specifier</i>]	The name (full path name or alias) of a device. Examples: cdrom (CD-ROM drive) disk (hard disk) floppy (3-1/2" diskette drive) net (Ethernet) tape (SCSI tape)
[<i>filename</i>]	The name of the program to be booted (for example, <code>stand/diag</code>). <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 <code>boot-file</code> parameter.</i>
[<i>options</i>]	-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>

Diagnostic Test Commands

TABLE 1-6 Diagnostic Test Commands

<code>probe-scsi</code>	Identify devices attached to the built-in SCSI bus.
<code>probe-scsi-all</code> [<i>device-path</i>]	Perform <code>probe-scsi</code> on all SCSI buses installed in the system below the specified node. (If <i>device-path</i> is absent, the root node is used.)
<code>test</code> <i>device-specifier</i>	Execute the specified device's self-test method. For example: <code>test floppy</code> - test the floppy drive, if installed <code>test /memory</code> - test number of megabytes specified in <code>selftest-#megs</code> ; or test all of memory if <code>diag-switch?</code> is true <code>test net</code> - test the network connection
<code>test-all</code> [<i>device-specifier</i>]	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.

System Information Display Commands

TABLE 1-7 System Information Display Commands

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

Emergency Keyboard Commands

TABLE 1-8 Emergency Keyboard Commands

	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.

File Loading Commands

TABLE 1-9 File Loading Commands

boot [specifiers] -h	(-)	Load file from specified source.
byte-load	(adr span -)	Interpret a loaded FCode binary file. span 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>	(adr -)	Load specified file over Ethernet at given address.

TABLE 1-9 File Loading Commands *(continued)*

<code>go</code>	(-)	Begin executing a previously-loaded binary program, or resume executing an interrupted program.
<code>init-program</code>	(-)	Initialize to execute a binary file.
<code>load [specifiers]</code>	(-)	Load data from specified device into memory at the address given by <code>load-base</code> . (See <code>boot</code> format.)
<code>load-base</code>	(- adr)	Address at which <code>load</code> places the data it reads from a device.

SPARC Register Commands

TABLE 1-10 SPARC Register Commands

<code>%f0 through %f31</code>	(- value)	Return the value in the given floating point register.
<code>%fsr</code>	(- value)	Return the value in the given floating point register.
<code>%g0 through %g7</code>	(- value)	Return the value in the given register.
<code>%i0 through %i7</code>	(- value)	Return the value in the given register.
<code>%L0 through %L7</code>	(- value)	Return the value in the given register.
<code>%o0 through %o7</code>	(- value)	Return the value in the given register.
<code>%pc %npc %psr</code>	(- value)	Return the value in the given register.
<code>%y %wim %tbr</code>	(- value)	Return the value in the given register.

TABLE 1-10 SPARC Register Commands (continued)

<code>.registers</code>	(-)	Display values in %f0 through %f31.
<code>.locals</code>	(-)	Display the values in the i, L and o registers.
<code>.psr</code>	(-)	Formatted display of the %psr data.
<code>.registers</code>	(-)	Display values in %g0 through %g7, plus %pc, %npc, %psr, %y, %wim, %tbr.
<code>.window</code>	(window# -)	Display the desired window.
<code>ctrace</code>	(-)	Display the return stack showing C subroutines.
<code>set-pc</code>	(value -)	Set %pc to the given value, and set %npc to (value+4).
<code>to regname</code>	(value -)	Change the value stored in any of the above registers. Use in the form: <i>value to regname</i> .
<code>w</code>	(window# -)	Set the current window for displaying %ix %Lx or %ox.

Breakpoint Commands

TABLE 1-11 Breakpoint Commands

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

TABLE 1-11 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 (see <code>.breakpoint</code>).
<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>	(n -)	Execute <code>go</code> n times.
<code>hop</code>	(-)	(Like the <code>step</code> command.) Treats a subroutine call as a single instruction.
<code>hops</code>	(n -)	Execute <code>hop</code> n 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>	(n -)	Execute <code>step</code> n times.
<code>till</code>	(adr -)	Execute until the given address is encountered. Equivalent to <code>+bp go</code> .

Disassembler Commands

TABLE 1-12 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.

Miscellaneous Operations

TABLE 1-13 Miscellaneous Operations

<code>eject-floppy</code>	<code>(-)</code>	Eject the diskette from the drive.
<code>firmware-version</code>	<code>(- n)</code>	Return major/minor CPU firmware version (that is, 0x00020001 = firmware version 2.1).
<code>ftrace</code>	<code>(-)</code>	Show calling sequence when exception occurred.
<code>get-msecs</code>	<code>(- ms)</code>	Return the approximate current time in milliseconds.
<code>ms</code>	<code>(n -)</code>	Delay for n milliseconds. Resolution is 1 millisecond.
<code>reset</code>	<code>(-)</code>	Reset the entire system (similar to a power cycle).
<code>sync</code>	<code>(-)</code>	Call the operating system to write any pending information to the hard disk. Also boot after syncing file systems.

NVRAM Configuration Parameters

TABLE 1-14 NVRAM Configuration Parameters

<code>auto-boot?</code>	<code>true</code>	If true, boot automatically after power-on or reset.
<code>boot-device</code>	<code>disk</code>	Device from which to boot.
<code>boot-file</code>	<code>empty string</code>	File to boot (an empty string lets secondary booter choose default).
<code>boot-from</code>	<code>vmunix</code>	Boot device and file (1.x only).
<code>boot-from-diag</code>	<code>le(vmunix</code>	Diagnostic boot device and file (1.x only).
<code>diag-device</code>	<code>net</code>	Diagnostic boot source device.
<code>diag-file</code>	<code>empty string</code>	File from which to boot in diagnostic mode.
<code>diag-switch?</code>	<code>false</code>	If true, run in diagnostic mode.
<code>fcode-debug?</code>	<code>false</code>	If true, include name fields for plug-in device FCodes.
<code>hardware-revision</code>	<code>no default</code>	System version information.
<code>input-device</code>	<code>keyboard</code>	Power-on input device (usually keyboard, <code>ttya</code> , or <code>ttyb</code>).
<code>keyboard-click?</code>	<code>false</code>	If true, enable keyboard click.
<code>keymap</code>	<code>no default</code>	Keymap for custom keyboard.
<code>last-hardware-update</code>	<code>no default</code>	System update information.
<code>local-mac-address?</code>	<code>false</code>	If true, network drivers use their own MAC address, not system's.
<code>mfg-switch?</code>	<code>false</code>	If true, repeat system self-tests until interrupted with <code>Stop-A</code> .
<code>nvrामrc</code>	<code>empty</code>	Contents of NVRAMRC.
<code>oem-banner</code>	<code>empty string</code>	Custom OEM banner (enabled by <code>oem-banner? true</code>).

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

oem-banner?	false	If true, use custom OEM banner.
oem-logo	no default	Byte array custom OEM logo (enabled by oem-logo? true). Displayed in hex.
oem-logo?	false	If true, use custom OEM logo (else, use Sun logo).
output-device	screen	Power-on output device (usually screen, ttya, or ttyb).
sbus-probe-list	0123	Which SBus slots are probed and in what order.
screen-#columns	80	Number of on-screen columns (characters/line).
screen-#rows	34	Number of on-screen rows (lines).
scsi-initiator-id	7	SCSI bus address of host adapter, range 0-7.
sd-targets	31204567	Map SCSI disk units (1.x only).
security-#badlogins	no default	Number of incorrect security password attempts.
security-mode	none	Firmware security level (none, command, or full).
security-password	no default	Firmware security password (never displayed). <i>Do not set this directly.</i>
selftest-#megs	1	Megabytes of RAM to test. Ignored if diag-switch? is true.
skip-vme-loopback?	false	If true, POST does not do VMEbus loopback tests.
st-targets	45670123	Map SCSI tape units (1.x only).
sunmon-compat?	false	If true, display Restricted Monitor prompt (>).
testarea	0	One-byte scratch field for NVRAM testing.

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

<code>tpe-link-test?</code>	<code>true</code>	Enable link test for built-in 10baseT Ethernet.
<code>ttya-mode</code>	<code>9600,8,n,1,-</code>	TTYA (baud, #bits, parity, #stop, handshake).
<code>ttyb-mode</code>	<code>9600,8,n,1,-</code>	TTYB (baud, #bits, parity, #stop, handshake).
<code>ttya-ignore-cd</code>	<code>true</code>	If true, OS ignores TTYA carrier-detect.
<code>ttyb-ignore-cd</code>	<code>true</code>	If true, OS ignores TTYB carrier-detect.
<code>ttya-rts-dtr-off</code>	<code>false</code>	If true, OS does not assert DTR and RTS on TTYA.
<code>ttyb-rts-dtr-off</code>	<code>false</code>	If true, OS does not assert DTR and RTS on TTYB.
<code>use-nvramrc?</code>	<code>false</code>	If true, execute commands in NVRAMRC during system start-up.
<code>version2?</code>	<code>true</code>	If true, hybrid (1.x/2.x) PROM comes up in version 2.x.
<code>watchdog-reboot?</code>	<code>false</code>	If true, reboot after watchdog reset.

Viewing and Changing Configuration Parameters

TABLE 1-15 Viewing and Changing Configuration Parameters

<code>printenv</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.

NVRAMRC Editor Commands

TABLE 1-16 NVRAMRC Editor Commands

<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.)
<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. Prompt for confirmation.
<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>nvrn</code>	Execute the contents of the temporary buffer.

TABLE 1-16 NVRAMRC Editor Commands (continued)

<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	Previous Word	Previous Character	Next Character	Next Word	Next Line
Move	<code>^P</code>	<code>esc B</code>	<code>^B</code>	<code>^F</code>	<code>esc F</code>	<code>^N</code>
Delete		<code>^W</code>	<code>Del</code>	<code>^D</code>	<code>esc D</code>	<code>^K</code>
Re-type line				<code>^R</code>		
Show all lines				<code>^L</code>		
Paste after <code>^K</code>				<code>^Y</code>		
Complete command				<code>^-space</code>		
Show all matches				<code>^/ or ^?</code>		

`esc` = Press and release Escape key first

`^` = Press and hold Control key

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)
```

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 1-18 Numeric Usage and Stack Commands

	Alternate stack results. Example: (input - adr len false result true).
?	Unknown stack items (changed from ???).
???	Unknown stack items.

TABLE 1–18 Numeric Usage and Stack Commands *(continued)*

<code>acf</code>	Code field address.
<code>adr</code>	Memory address (generally a virtual address).
<code>adr16</code>	Memory address, must be 16-bit aligned.
<code>adr32</code>	Memory address, must be 32-bit aligned.
<code>adr64</code>	Memory address, must be 64-bit aligned.
<code>byte bxxx</code>	8-bit value (smallest byte in a 32-bit word).
<code>char</code>	7-bit value (smallest byte), high bit unspecified.
<code>cnt/len/size</code>	Count or length.
<code>flag xxx?</code>	0 = false; any other value = true (usually -1).
<code>long Lxxx</code>	32-bit value.
<code>n n1 n2 n3</code>	Normal signed values (32-bit).
<code>+n u</code>	Unsigned, positive values (32-bit).
<code>n[64] or (n.low n.hi)</code>	Extended-precision (64-bit) numbers (2 stack items).
<code>phys</code>	Physical address (actual hardware address).
<code>pstr</code>	Packed string (<code>adr len</code> means unpacked string).
<code>virt</code>	Virtual address (address used by software).
<code>word wxxx</code>	16-bit value (smallest two bytes in a 32-bit word).

Changing the Number Base

TABLE 1-19 Changing the Number Base

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

Basic Number Display

TABLE 1-20 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.

Stack Manipulation Commands

TABLE 1-21 Stack Manipulation Commands

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

TABLE 1-21 Stack Manipulation Commands *(continued)*

<code>nip</code>	($n1\ n2 - n2$)	Discard the second stack item.
<code>over</code>	($n1\ n2 - n1\ n2\ n1$)	Copy the second stack item to the top of the stack.
<code>pick</code>	($??? +n - ???\ n2$)	Copy +n-th stack item (1 <code>pick</code> = <code>over</code>).
<code>r></code>	(- n)	Move a return stack item to the stack. (Use with caution.)
<code>r@</code>	(- n)	Copy the top of the return stack to the stack.
<code>roll</code>	($??? +n - ?$)	Rotate +n stack items (2 <code>roll</code> = <code>rot</code>).
<code>rot</code>	($n1\ n2\ n3 - n2\ n3\ n1$)	Rotate three stack items.
<code>swap</code>	($n1\ n2 - n2\ n1$)	Exchange the top two stack items.
<code>tuck</code>	($n1\ n2 - n2\ n1\ n2$)	Copy the top stack item below the second item.

Arithmetic Functions

TABLE 1-22 Arithmetic Functions

<code>*</code>	($n1\ n2 - n3$)	Multiply $n1 * n2$.
<code>+</code>	($n1\ n2 - n3$)	Add $n1 + n2$.
<code>-</code>	($n1\ n2 - n3$)	Subtract $n1 - n2$.
<code>/</code>	($n1\ n2 - \text{quot}$)	Divide $n1 / n2$; remainder is discarded.
<code><<</code>	($n1 +n - n2$)	Left-shift $n1$ by +n bits.

TABLE 1–22 Arithmetic Functions *(continued)*

>>	(n1 +n - n2)	Right-shift n1 by +n bits.
>>a	(n1 +n - n2)	Arithmetic right-shift n1 by +n bits.
abs	(n - u)	Absolute value.
and	(n1 n2 - n3)	Bitwise logical AND.
bounds	(startadr len - endadr startadr)	Convert startadr len to endadr startadr for do loop.
bljoin	(b.low b2 b3 b.hi - long)	Join four bytes to form a 32-bit longword.
bwjoin	(b.low b.hi - word)	Join two bytes to form a 16-bit word.
lbsplit	(long - b.low b2 b3 b.hi)	Split a 32-bit longword into four bytes.
lwsplit	(long - w.low w.hi)	Split a 32-bit longword into two 16-bit words.
max	(n1 n2 - n3)	n3 is maximum of n1 and n2.
min	(n1 n2 - n3)	n3 is minimum of n1 and n2.
mod	(n1 n2 - rem)	Remainder of n1 / n2.
negate	(n1 - n2)	Change the sign of n1.
not	(n1 - n2)	Bitwise ones complement.
or	(n1 n2 - n3)	Bitwise logical OR.
wbsplit	(word - b.low b.hi)	Split 16-bit word into two bytes.
wljoin	(w.low w.hi - long)	Join two words to form a longword.
xor	(n1 n2 - n3)	Bitwise exclusive OR.

Memory Access Commands

TABLE 1-23 Memory Access Commands

!	(n adr16 -)	Store a 32-bit number at adr16, must be 16-bit aligned.
+!	(n adr16 -)	Add n to the 32-bit number stored at adr16, must be 16-bit aligned.
@	(adr16 - n)	Fetch a 32-bit number from adr16, must be 16-bit aligned.
c!	(n adr -)	Store low byte of n at adr.
c@	(adr - byte)	Fetch a byte from adr.
cpeek	(adr - false byte true)	Fetch the byte at adr. Return the data and true if the access was successful. Return false if a read access error occurred. (Also lpeek, wpeek.)
cpoke	(byte adr - okay?)	Store the byte to adr. Return true if the access was successful. Return false if a write access error occurred. (Also lpoke, wpoke.)
comp	(adr1 adr2 len - n)	Compare two byte arrays, n = 0 if arrays are identical, n = 1 if first byte that is different is greater in array#1, n = -1 otherwise.
dump	(adr len -)	Display len bytes of memory starting at adr.
fill	(adr size byte -)	Set size bytes of memory to byte.
L!	(n adr32 -)	Store a 32-bit number at adr32.
L@	(adr32 - long)	Fetch a 32-bit number from adr32.
move	(adr1 adr2 u -)	Copy u bytes from adr1 to adr2, handle overlap properly.

TABLE 1–23 Memory Access Commands *(continued)*

w!	(n adr16 -)	Store a 16-bit number at adr16, must be 16-bit aligned.
w@	(adr16 - word)	Fetch a 16-bit number from adr16, must be 16-bit aligned.

Memory Mapping Commands

TABLE 1–24 Memory Mapping Commands

alloc-mem	(size - virt)	Allocate and map size bytes of available memory; return the virtual address. Unmap with free-mem.
cacheable	(space - cache-space)	Modify the address space so that the subsequent address mapping is made cacheable.
free-mem	(virt size -)	Free memory allocated by alloc-mem.
free-virtual	(virt size -)	Undo mappings created with memmap.
map?	(virt -)	Display memory map information for the virtual address.
memmap	(phys space size - virt)	Map a region of physical addresses; return the allocated virtual address. Unmap with free-virtual.
obio	(- space)	Specify the device address space for mapping.
obmem	(- space)	Specify the onboard memory address space for mapping.
pgmap!	(pmentry virt -)	Store a new page map entry for the virtual address.
pgmap?	(virt -)	Display the page map entry (decoded and in English) corresponding to the virtual address.

TABLE 1-24 Memory Mapping Commands *(continued)*

<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 4K).
<code>sbus</code>	<code>(- space)</code>	Specify the SBus address space for mapping.

Defining Words

TABLE 1-25 Defining Words

<code>:</code>	<code>name (-)Usage: (??? - ?)</code>	Start creating a new colon definition.
<code>;</code>	<code>(-)</code>	Finish creating a new colon definition.
<code>buffer: name</code>	<code>(size -)Usage: (- adr64)</code>	Create a named array in temporary storage.
<code>constant name</code>	<code>(n -)Usage: (- n)</code>	Define a constant (for example, 3 constant bar).
<code>create name</code>	<code>(-)Usage: (- adr16)</code>	Generic defining word.
<code>defer name</code>	<code>(-)Usage: (??? - ?)</code>	Define forward reference or execution vector.
<code>does></code>	<code>(- adr16)</code>	Start the run-time clause for defining words.
<code>value name</code>	<code>(n -)Usage: (- n)</code>	Create a changeable, named 32-bit quantity.
<code>variable name</code>	<code>(-)Usage: (- adr16)</code>	Define a variable.

Dictionary Searching Commands

TABLE 1-26 Dictionary Searching Commands

<code>' name</code>	<code>(- acf)</code>	Find the named word in the dictionary. (Returns the code field address. Use outside definitions.)
<code>['] name</code>	<code>(- acf)</code>	Similar to <code>'</code> but is used either inside or outside definitions.
<code>.calls</code>	<code>(acf -)</code>	Display a list of all words that call the word whose compilation address is <code>acf</code> .
<code>\$find</code>	<code>(adr len - adr len false acf 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 thisword</code>	<code>(-)</code>	Decompile the named command.
<code>(see)</code>	<code>(acf -)</code>	Decompile the word indicated by the code field address.
<code>sifting ccc</code>	<code>(-)</code>	Display names of all dictionary entries containing the sequence of characters. <code>ccc</code> contains no spaces.
<code>words</code>	<code>(-)</code>	Display all visible words in the dictionary.

Dictionary Compilation Commands

TABLE 1-27 Dictionary Compilation Commands

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

Controlling Text Input

TABLE 1-28 Controlling Text Input

(<i>ccc</i>)	(-)	Begin a comment.
\ rest-of-line	(-)	Skip the rest of the line.
ascii <i>ccc</i>	(- char)	Get numerical value of first ASCII character of next word.

TABLE 1-28 Controlling Text Input (continued)

key	(- char)	Read a character from the assigned input device's keyboard.
key?	(- flag)	True if a key has been typed on the input device's keyboard.

Displaying Text Output

TABLE 1-29 Displaying Text Output

<code>\n</code>		Terminate a line on the display and go to the next line.
<code>\c</code>	(- char)	Display the character.
<code>\a</code>	(- n)	Display n characters.

Manipulating Text Strings

TABLE 1-30 Manipulating Text Strings

<code>" ccc"</code>	(- adr len)	Collect an input stream string, either interpreted or compiled. Within the string, use "(00,ff...)" to include arbitrary byte values.
<code>. " ccc"</code>	(-)	Compile a string for later display.
<code>b1</code>	(- char)	ASCII code for the space character; decimal 32.

TABLE 1-30 Manipulating Text Strings (continued)

count	(pstr - adr +n)	Unpack a packed string.
p" ccc"	(- pstr)	Collect a string from the input stream; store as a packed string.

Redirecting I/O

TABLE 1-31 Redirecting I/O

input	(device -)	Select device (ttya, ttyb, keyboard, or " <i>device-specifier</i> ") for subsequent input.
io	(device -)	Select device for subsequent input and output.
output	(device -)	Select device (ttya, ttyb, screen, or " <i>device-specifier</i> ") for subsequent output.

Comparison Commands

TABLE 1-32 Comparison Commands

<	(n1 n2 - flag)	True if n1 < n2.
<=	(n1 n2 - flag)	True if n1 <= n2.
<>	(n1 n2 - flag)	True if n1 <> n2.
=	(n1 n2 - flag)	True if n1 = n2.
>	(n1 n2 - flag)	True if n1 > n2.

TABLE 1-32 Comparison Commands *(continued)*

<code>>=</code>	<code>(n1 n2 - flag)</code>	True if <code>n1 >= n2</code> .
<code>between</code>	<code>(n min max - flag)</code>	True if <code>min <= n <= max</code> .
<code>u<</code>	<code>(u1 u2 - flag)</code>	True if <code>u1 < u2</code> , unsigned.
<code>u<=</code>	<code>(u1 u2 - flag)</code>	True if <code>u1 <= u2</code> , unsigned.
<code>u></code>	<code>(u1 u2 - flag)</code>	True if <code>u1 > u2</code> , unsigned.
<code>u>=</code>	<code>(u1 u2 - flag)</code>	True if <code>u1 >= u2</code> , unsigned.
<code>within</code>	<code>(n min max - flag)</code>	True if <code>min <= n < max</code> .

if-then-else Commands

TABLE 1-33 if-then-else 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...then...else</code> .

begin (Conditional) Loop Commands

TABLE 1-34 begin (Conditional) Loop Commands

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

do (Counted) Loop Commands

TABLE 1-35 do (Counted) Loop Commands

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

case Statement

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

Cache Manipulation Commands

TABLE 1-36 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.

Alternate Address Space Access Commands

TABLE 1-37 Alternate Address Space Access Commands

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

Multiprocessor Commands

TABLE 1-38 Microprocessor Commands

<code>module-info</code>	(-)	Display type and speed of all CPU modules.
<code>switch-cpu</code>	(cpu# -)	Switch to indicated CPU.

Program Execution Control Commands

TABLE 1-39 Program Execution Control Commands

<code>abort</code>	(-)	Abort current execution and interpret keyboard commands.
<code>abort" ccc"</code>	(abort? -)	If flag is true, abort and display message.
<code>eval</code>	(adr len -)	Interpret Forth source from an array.
<code>execute</code>	(acf -)	Execute the word whose code field address 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.
