VMS Software

# VSI OpenVMS x86-64 Boot Manager User Guide

**Operating System and Version:** VSI OpenVMS x86-64 V9.2-2 or higher

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# VSI OpenVMS x86-64 Boot Manager User Guide

VMS Software

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# Preface

## 1. About VSI

VMS Software, Inc. (VSI) is an independent software company licensed by Hewlett Packard Enterprise to develop and support the OpenVMS operating system.

## 2. About the Guide

This guide explains how to use the Boot Manager software and covers the following primary topics:

- Booting VSI OpenVMS x86-64 (Using the **BOOT** command)
- The boot process from pre-boot environment through transfer to SYSBOOT
- Boot Manager operation and commands
- Troubleshooting tips

## 3. Intended Audience

This guide is intended for system managers of the VSI OpenVMS operating system.

## 4. Document Structure

This guide is organized as follows:

- *Chapter 1, "Overview"*: Provides an overview of the Boot Manager software.
- *Chapter 2, "The Boot Process"*: Describes the boot process in detail.
- *Chapter 3, "The Boot Manager"*: Gives an overview of the Boot Manager and details the boot modes, messages, and provides a dictionary of commands.
- *Chapter 4, "Pre-Installation, Installation, and Post-Installation"*: Details the system preparation before installation and the post-installation procedures.
- *Chapter 5, "Device Enumeration"*: Describes specific features of the device enumeration process.
- *Chapter 6, "Dump Kernel"*: Describes how to handle system crashes using the dump kernel.
- *Chapter 7, "Troubleshooting"*: Provides information about troubleshooting tools to help you with failures or errors that might occur while using the Boot Manager.

## 5. Related Documents

The following manuals provide additional information:

- The Installation Guide for your version of VSI OpenVMS x86-64 (available at docs.vmssoftware.com [https://docs.vmssoftware.com/]) describes how to install the VSI OpenVMS operating system.

- The *VSI OpenVMS Delta/XDelta Debugger Manual* [https://docs.vmssoftware.com/vsi-openvms-deltaxdelta-debugger-manual/] describes the use of the Delta/XDelta debugger utility.
- The *VSI OpenVMS System Manager's Manual, Volume 1: Essentials* [https://docs.vmssoftware.com/vsi-openvms-system-manager-s-manual-volume-1-essentials/] provides comprehensive information on the conversational boot feature.

## 6. OpenVMS Documentation

The full VSI OpenVMS documentation set can be found on the VMS Software Documentation webpage at https://docs.vmssoftware.com.

## 7. VSI Encourages Your Comments

You may send comments or suggestions regarding this manual or any VSI document by sending electronic mail to the following Internet address: `<docinfo@vmssoftware.com>`. Users who have VSI OpenVMS support contracts through VSI can contact `<support@vmssoftware.com>` for help with this product.

## 8. Conventions

The following conventions may be used in this manual:

| Convention | Meaning |
|---|---|
| **Ctrl/*x*** | A sequence such as **Ctrl/*x*** indicates that you must hold down the key labeled **Ctrl** while you press another key or a pointing device button. |
| **PF1 *x*** | A sequence such as **PF1 *x*** indicates that you must first press and release the key labeled **PF1** and then press and release another key or a pointing device button. |
| . . . | A horizontal ellipsis in examples indicates one of the following possibilities:<br>● Additional optional arguments in a statement have been omitted.<br>● The preceding item or items can be repeated one or more times.<br>● Additional parameters, values, or other information can be entered. |
| .<br>.<br>. | A vertical ellipsis indicates the omission of items from a code example or command format; the items are omitted because they are not important to the topic being discussed. |
| ( ) | In command format descriptions, parentheses indicate that you must enclose the options in parentheses if you choose more than one. |
| [ ] | In command format descriptions, brackets indicate optional choices. You can choose one or more items or no items. Do not type the brackets on the command line. However, you must include the brackets in the syntax for VSI OpenVMS directory specifications and for a substring specification in an assignment statement. |
| \| | In command format descriptions, vertical bars separate choices within brackets or braces. Within brackets, the choices are options; within braces, at least one choice is required. Do not type the vertical bars on the command line. |
| **Bold type** | Bold type represents the name of an argument, an attribute, or a reason. It also represents the introduction of a new term. |

| **Convention** | **Meaning** |
|---|---|
| *Italic type* | Italic type indicates important information, complete titles of manuals, or variables. Variables include information that varies in system output (Internal error *number*), in command lines (**`/PRODUCER=`** ***`name`***), and in command parameters in text (where *dd* represents the predefined code for the device type). |
| UPPERCASE TYPE | Uppercase type indicates the name of a routine, the name of a file, or the abbreviation for a system privilege. |
| `Monospace type` | Monospace type indicates code examples and interactive screen displays.<br><br>In the C programming language, monospace type in text identifies the following elements: keywords, the names of independently compiled external functions and files, syntax summaries, and references to variables or identifiers introduced in an example. |
| **`Bold monospace type`** | Bold monospace type indicates a command or command qualifier. |
| - | A hyphen at the end of a command format description, command line, or code line indicates that the command or statement continues on the following line. |
| Numbers | All numbers in text are assumed to be decimal unless otherwise noted. Nondecimal radixes—binary, octal, or hexadecimal—are explicitly indicated. |

# Chapter 1. Overview

**Important**

Virtual machine (VM) configuration details and specific hypervisors are not covered in this guide. It is assumed that readers are familiar with the operation of their chosen host environment. Refer to the documentation for your platform/hypervisor for more information on how to set up and configure VMs.

## 1.1. The Boot Manager Environment

Two forms of a boot manager will exist on every VSI OpenVMS x86-64 operating system. The platform firmware provides a form of a boot manager that is used to set up various parameters and boot options. This typically consists of a series of menus providing access to system-specific chipset, configuration, and boot option parameters. It is aware of the platform features, but not of the operating system that is being booted. In this document, this is referred to as either setup or the boot manager (of your platform firmware).

The second form of a boot manager is the VSI OpenVMS Boot Manager, which is a stand-alone, native UEFI (Unified Extensible Firmware Interface) application. It manages OpenVMS boot options, but knows very little about the underlying platform setup. In this document, this is referred to as the VSI OpenVMS Boot Manager or simply the Boot Manager.

The VSI OpenVMS Boot Manager identifies and enumerates devices, maps memory, builds critical data structures required to boot VSI OpenVMS, creates the standby dump kernel, loads the MemoryDisk, and ultimately transfers control to the VSI OpenVMS SYSBOOT executable.

UEFI (as opposed to BIOS) has existed since 2005, so the vast majority of today's systems support UEFI. While most systems provide UEFI services, only a few expose the UEFI shell application (hence, they lack command input capability).

If you are unfamiliar with this issue, look at your platform firmware's setup screens and see if you can find any options for enabling UEFI. On some systems, you will need to first disable the Secure Boot feature before UEFI options will be presented. Most hypervisors provide an option for creating UEFI-enabled guests, although some may require installing optional packages to install UEFI. Refer to your hardware/hypervisor documentation for additional recommendations.

If you determine your platform does not provide a UEFI shell, the OpenVMS Boot Manager can be launched from a platform firmware boot option, but it may operate with reduced functionality. Alternately, you may obtain a suitable UEFI shell application from your hypervisor vendor.

**Note**

A platform must support UEFI in order to run VSI OpenVMS. If you cannot get to the UEFI `Shell>` prompt, then you cannot run VSI OpenVMS.

## 1.2. Secure Boot and TPM

Secure Boot is a security feature used by several operating systems. It essentially requires that each UEFI executable be signed by a process managed by Microsoft. Secure Boot must be disabled to run VSI OpenVMS. Any system that does not allow Secure Boot to be disabled cannot run VSI OpenVMS.

Trusted Platform Module (TPM) is another security feature. TPM is intended to detect certain types of platform intrusions. It may not be necessary to disable TPM to run VSI OpenVMS, but there is a possibility that this feature, when enabled, could result in interrupt misbehavior while running VSI OpenVMS.

## 1.3. Supported Installation Methods

Refer to the Installation Guide for your version of VSI OpenVMS x86-64 (available at docs.vmssoftware.com [https://docs.vmssoftware.com/]) for specific installation instructions.

VSI supports three methods for installing VSI OpenVMS x86-64. Each option begins by downloading the OpenVMS installation kit, which is a binary ISO image file, from the online VSI Service Platform [https://sp.vmssoftware.com/].

Once you have obtained a copy of the installation kit, you can:

- attach the kit file as a virtual DVD or an optical disk if installing OpenVMS on a VM.
- create a physical DVD using DVD burner software.
- upload the file to your web server and network boot the installation kit.

Your choice of method depends on your own requirements and how many installations you intend to perform.

**Virtual DVD**

Using a virtual DVD is a simple method if you have a small number of installations, as you can internally share the virtual DVD file location. As the OpenVMS installation kit is provided as a hybrid image that features a boot section in the ISO 9660 format, it can be used as is.

VM users can directly attach the installation kit file to their VM as an optical drive.

**Physical DVD**

If you prefer to use a physical DVD, the installation kit can be burned to a DVD. If you choose to burn a DVD, keep in mind that the file is already an ISO disc image, so it must be burned as-is to the DVD in order to retain the correct boot block and partition table structures. Do not attempt further conversions of the file.

**Note**

Even though VSI OpenVMS has limited USB support, the Boot Manager is fully capable of accessing a USB-based DVD reader. On most VMs, you can define the USB DVD reader as a SATA optical disk. When loading an installation kit, the Boot Manager reads the entire DVD image into memory using UEFI block I/O drivers, thus eliminating the need for VSI OpenVMS runtime drivers during installation.

**Web Server**

The installation kit can be uploaded to your internal web server, allowing it to be accessed and installed by your VM guests.

To boot from a web server, users need to first download a small UEFI (console) utility named VMS_KITBOOT.EFI. The kitboot utility is available from an existing VSI OpenVMS installation.

The utility can be copied to a USB stick or to the EFI partition of a local disk. When executed, the utility will prompt for the IP address of the web server and download the specified kit to the guest. Web server installation is only possible on a network managed by a DHCP server.

These methods are described in greater detail in *Chapter 4, "Pre-Installation, Installation, and Post-Installation"*; the virtual DVD method is also covered in the Installation Guide for your version of VSI OpenVMS x86-64 (available at docs.vmssoftware.com [https://docs.vmssoftware.com/]).

# Chapter 2. The Boot Process

## 2.1. Basic Boot

1. Start your VM guest.
2. VSI OpenVMS is booted from the UEFI `Shell>` prompt. If you have configured your system's boot options and boot order correctly, the UEFI shell application should start automatically.

   ### Note

   Some hypervisors/platforms may require additional configuration steps to obtain a UEFI shell application. For details, refer to the Installation Guide for your version of VSI OpenVMS x86-64 (available at docs.vmssoftware.com [https://docs.vmssoftware.com/]), as well as your hypervisor documentation.

3. Follow the steps below to boot from UEFI:

| At the UEFI prompt... | ...type this command |
|---|---|
| `Shell>` | **`VMS_BOOTMGR`** |
| `BOOTMGR>` | **`DEVICE`**<br><br>This command will return the list of VSI OpenVMS-bootable devices. |
| `BOOTMGR>` | **`BOOT`** ***`device`***<br><br>This command will cause the specified disk to boot. |

As shown above, from the UEFI `Shell>` prompt, launch the VSI OpenVMS Boot Manager, select your boot source device, and issue the **`BOOT`** command specifying your desired boot device name. If you have previously booted, then your prior **`BOOT`** command will be used by default and you can omit the device name from your **`BOOT`** command. Pay attention to your `Default Boot Command` as shown, to be sure you are booting from the desired device. This is especially important after an installation because you will be booting the target device for the first time, yet the previous boot was from the installation media device or network location.

### Note

On x86-64 systems, the platform firmware boot options simply point to a disk where the OpenVMS Boot Manager resides. Since the OpenVMS Boot Manager can boot any bootable disk, the actual system disk to be booted is selected by the OpenVMS Boot Manager. If the OpenVMS Boot Manager previously booted a different system disk, you need to manually enter the desired **`BOOT`** command (one time) to update the default boot device. Subsequent automatic boots will then work as expected.

Boot flags control various aspects of booting. Boot flags and system roots can be managed by the Boot Manager **`FLAGS`** and **`ROOT`** commands, specified as parameters of the **`BOOT`** command, or specified on the initial command line when you launch the Boot Manager. The existing boot flags are described in *Section 3.3.3, "Boot Flags"*.

For example, to boot from system root `0` and hex flag value `807`, you could take one of the following three approaches:

- Set individual parameters using the Boot Manager **FLAG** and **ROOT** commands, before issuing the **BOOT** command:

  ```
  FLAG 807
  ROOT 0
  BOOT device
  ```

- Issue the following fully-qualified **BOOT** command:

  ```
  BOOT device 0 807
  ```

- Issue the following shell command:

  ```
  Shell> vms_bootmgr device -fl 0 807
  ```

UEFI commands can also be inserted (one per line) into the file STARTUP.NSH if you prefer to always boot the same device.

The Boot Manager **AUTO BOOT** command provides a brief countdown prior to taking an automatic action. This countdown can be adjusted by the command **AUTO *seconds***, where *seconds* is a value between 1 and 30.

**Note**

The boot flags for VSI OpenVMS on x86-64 are significantly different from those on prior architectures. Refer to *Section 3.3, "Boot Modes, Boot Messages, and Boot Flags"* for details, or simply issue the Boot Manager **FLAGS** command to see the flag definitions.

The VSI OpenVMS Boot Manager is independent from the VSI OpenVMS x86-64 operating system version. Any version of Boot Manager should be able to load any instance of VSI OpenVMS x86-64 V9.2-2 (or higher). The features offered by specific Boot Manager versions will continue to develop, but all versions will support essential boot operation.

If you want to run a specific instance of the Boot Manager, you need to first select the UEFI file system device (fs0:, fs1:, etc.) and change directory to where the desired Boot Manager is located before launching VMS_BOOTMGR.EFI. For example:

```
Shell> fs2:
fs2:> cd EFI\VMS
```

If you launch the Boot Manager without first selecting the UEFI file system device and directory, your platform firmware will scan a search path of fs*x*: file system devices and launch the first copy of VMS_BOOTMGR.EFI it locates. Often, platform firmware setup mode allows you to define or constrain this search path so that your desired boot operation is automatic. We will discuss several options for setting up automatic actions in later sections.

## 2.2. Boot Process Overview

VSI OpenVMS x86-64 V9.2 introduced a new boot process, which is also used in VSI OpenVMS x86-64 V9.2-2 or higher. This section contains a brief overview of the components involved in the new process. The next section describes the process in greater detail.

**Secure Boot**

If this feature is present in your platform's firmware, it must be disabled. See *Section 1.2, "Secure Boot and TPM"* for more details.

### Platform Firmware

VSI OpenVMS requires UEFI-based console firmware, as opposed to older legacy BIOS-based consoles.

BIOS (Basic Input/Output System) is an older form of platform firmware based in system flash memory, or ROM. BIOS provides the most essential methods for initializing, loading, and booting an operating system, but it is very limited and its specifications were putting multiple constraints on modern hardware.

In 1999, Intel introduced EFI (Extensible Firmware Interface) which is a set of procedures designed to provide a consistent and feature-rich boot environment. In 2005, EFI was moved to an open-source project (TianoCore) and renamed to UEFI (Unified Extensible Firmware Interface). Practically all systems today provide UEFI. UEFI is also typically installed in flash memory and sometimes as a layer of firmware on top of traditional BIOS. The term "Legacy Boot" refers to booting with traditional BIOS or using a compatibility mode of UEFI which interfaces with BIOS. The VSI OpenVMS Boot Manager makes extensive use of UEFI's more advanced features.

## Note

VSI OpenVMS does not support legacy BIOS mode and cannot be installed on x86-64 systems that do not provide support for UEFI.

### Firmware Shell Utility

Upon initialization, x86-64 systems must be set up to run the UEFI shell application. The UEFI shell can be set up to automatically launch the VSI OpenVMS Boot Manager utility; alternatively, the Boot Manager can be invoked manually from the shell command line. Being able to reach the `Shell>` prompt is a fundamental prerequisite for any system to boot VSI OpenVMS. Quite often, the shell is hidden from users and requires changing some setup parameters. For example, disabling Secure Boot will often enable additional setup menu options for accessing the UEFI shell. If necessary, a shell application can be installed where one is not provided by default.

### VSI OpenVMS Boot Manager

The VSI OpenVMS Boot Manager is bundled into the installation media and will be run from it during the initial installation. After installation, the Boot Manager can be run from any UEFI file system device, as it is not coupled to a specific VSI OpenVMS instance or version. When performing an installation from a web server, the Boot Manager is downloaded separately, prior to downloading the full ISO image. After installation, the Boot Manager is typically, but not necessarily, run from the installed system disk.

The VSI OpenVMS Boot Manager should not be confused with a platform firmware boot manager (typically blue setup screens and menus). The VSI OpenVMS Boot Manager executes after a system or VM has booted and is ready to load VSI OpenVMS. The VSI OpenVMS Boot Manager provides commands for managing boot modes, messages, and devices. Potential boot devices are identified and enumerated using VSI OpenVMS device naming conventions. A **`BOOT`** ***`device`*** command causes the Boot Manager to locate and load the operating system from the specified boot device.

### MemoryDisk

Unlike prior releases of VSI OpenVMS for VAX, Alpha, or IA-64 systems, all of the files that comprise the core VSI OpenVMS kernel are pre-packaged into a logical disk container file, referred to as the MemoryDisk. Whether booting from a local drive or over a network, the MemoryDisk is loaded into memory by the VSI OpenVMS Boot Manager using UEFI physical block I/O drivers. This greatly simplifies and speeds up the boot process while eliminating the need for VSI OpenVMS to provide boot drivers for every supported type of boot device.

During installation, the MemoryDisk will contain the full ISO image, regardless of whether it is downloaded from a web server or loaded from a virtual or physical DVD. After installation, on subsequent boots, the MemoryDisk contains only the minimal kernel files that are required to achieve the ability to switch to runtime drivers.

**Dump Kernel**

During boot, after the Boot Manager loads the MemoryDisk into memory and initiates boot of the primary kernel, the MemoryDisk remains memory-resident. In the event of a primary kernel shutdown or crash, the same MemoryDisk is booted a second time into separate memory space, forming what is known as the dump kernel. The dump kernel is a limited-functionality VSI OpenVMS instance that processes a crash dump using runtime drivers and, upon completion, initiates a system reset. Because the MemoryDisk is already resident in memory, the dump kernel boots nearly instantly and processes the crash data much faster than prior implementations that required primitive device drivers.

**Boot Blocks**

Since the embedded MemoryDisk is a separately bootable entity from the system disk, VSI OpenVMS V9.2-2 (or higher) supports additional *inner boot blocks* around the MemoryDisk itself. The MemoryDisk container file resides within the system disk image, which has its own set of boot blocks. We refer to these as the *outer boot blocks*. When booting a system disk, the outer boot blocks are used to locate the inner boot blocks. For the most part, this added complexity is transparent to the user. Related utilities such as Backup, PCSI, SYSGEN, etc. have been modified to maintain the integrity and security of the embedded MemoryDisk. The use of symlinks allows access to MemoryDisk-resident files from system components.

## 2.3. Boot Process in Greater Detail

The VSI OpenVMS x86-64 boot process is significantly different from the VAX, Alpha, or IA-64 implementations. The VSI OpenVMS Boot Manager leverages many of the advanced capabilities of UEFI to provide a rich pre-boot environment.

The port of VSI OpenVMS to the x86-64 architecture has also provided an opportunity to modernize and improve the efficiency of the boot process.

The many individual files (~180) involved in OS startup are now consolidated into a single MemoryDisk image. Consolidation of these files into a single logical disk container file offers new options for network booting and greatly enhances boot performance and integrity.

Some of the major features of the Boot Manager and new boot process include:

- A graphical user interface (GUI) that supports touchpad, touchscreen, and USB keyboard/mouse (on systems that report mouse events).
- A rich command set for customers, support staff, and developers.
- Functional decoupling of the Boot Manager from the operating system, which means it can boot the system from a different device.

- Enumeration of bootable devices, which uses VSI OpenVMS device naming conventions.[1]
- A single MemoryDisk image file to contain the bootable VSI OpenVMS kernel.
- An ability to download the boot source from a web server.
- A second kernel that can be initialized to handle shutdown and crash dump processing.
- Embedded security features to assure boot process integrity.

### 2.3.1. MemoryDisk

The most significant change in the boot process is the use of a new "MemoryDisk" boot method.

This small disk image is contained in the file SYS$COMMON:[SYS$LDR]SYS$MD.DSK. During boot, this device is represented as DMM0:; when connected as a logical disk at runtime, it is also represented as LDM1:.

The minimum bootable VSI OpenVMS kernel is presented by approximately 180 files.

On prior architectures, during a network installation, the OS loader (an EFI application) constructed a memory-resident, pseudo system disk containing a set of the essential directories found on a system disk. It then parsed a list of files, downloading and copying each file into its proper directory. The boot process ran from files in this memory-resident disk, eventually reaching a point where it could mount the real system disk and use runtime drivers for ongoing file access. The initial memory-resident disk was then dissolved.

This relatively slow and complex process resulted in an OS loader that needed to understand VSI OpenVMS disk and file structures and was tied to the specific device and version of VSI OpenVMS being booted. It also required special primitive boot drivers for every supported boot device.

The new MemoryDisk boot method eliminates most of this complexity and decouples the OS loader (Boot Manager) from a specific device or instance of x86-64 VSI OpenVMS. Instead of downloading a list of files and constructing a pseudo system disk image in memory at boot time, a single pre-packaged MemoryDisk container file (SYS$MD.DSK) is provided on distribution media (the installation kit) and on every bootable VSI OpenVMS system device.

The MemoryDisk contains all of the files that are required to boot the minimum VSI OpenVMS kernel. The Boot Manager loads the MemoryDisk into memory and transfers control to the secondary bootstrap program (SYSBOOT.EXE). It can do this using the physical block I/O and file I/O drivers provided by UEFI, eliminating the need for VSI OpenVMS boot drivers and knowledge of VSI OpenVMS file systems. All of the files required by the dump kernel also reside in the MemoryDisk, allowing the dump kernel to directly boot from the pre-loaded MemoryDisk.

As the Boot Manager loads the MemoryDisk, it performs several security and integrity checks before transferring control to SYSBOOT.EXE. Errors in these checks are deemed fatal and result in clearing memory and performing a system reset.

An important concept to keep in mind is that the MemoryDisk is a container file that is structured as a bootable system disk, having its own (inner) boot blocks and GUID Partition Table (GPT), but containing only those files which are required by the early boot process; hence, a mini-kernel. When the

[1]Device naming is limited to bootable devices within the scope of UEFI. Some complex storage system devices cannot be enumerated until the OS is running.

system is running, the OS uses symlinks to direct file references to their actual location for any files that reside inside the MemoryDisk.

The contents of the MemoryDisk must be kept up to date. Any changes to these MemoryDisk-resident files through parameter file modifications, PCSI kit or patch installation, and so on, require the operating system to execute a procedure to update the MemoryDisk container. This ensures that the next boot will use the new images. This is handled by system utilities and is largely transparent to end users. The command procedure SYS$UPDATE:SYS$MD.COM handles updating the MemoryDisk container.

## Note

Do not invoke SYS$MD.COM directly unless you are advised to do so by VSI Support, or when required while following documented procedures. For example, if you load a user-written execlet by running SYS$UPDATE:VMS$SYSTEM_IMAGES.COM, you must then invoke SYS$UPDATE:SYS$MD.COM.

## Important

VSI does not recommend changing, moving, or manipulating SYS$MD.DSK or SYS$EFI.SYS (or the underlying EFI partition) in any way. These files are needed to boot the system and are maintained by OpenVMS.

As the MemoryDisk is an actual bootable disk image, it implements its own (inner) boot blocks consisting of a Protective Master Boot Record (PMBR), a GPT, and multiple disk partition table entries (GPTEs).

The MemoryDisk image contains two ODS-5 structured partitions (signatures: X86VMS_SYSDISK_LOW and X86VMS_SYSDISK_HIGH) and one FAT-structured UEFI partition (signature: X86_EFI).

An installed system disk also has its own (outer) boot blocks consisting of GPT structures and three partitions, similar to the MemoryDisk. The outer boot blocks contain a pointer to the MemoryDisk. Therefore, we can boot a system disk, extracting the MemoryDisk from it, or we can directly boot a MemoryDisk. Direct boot of a MemoryDisk is primarily a development feature with some future uses.

During a normal boot from an installed system disk, the Boot Manager uses the outer boot blocks to locate and extract the MemoryDisk (SYS$MD.DSK) from the system disk. The MemoryDisk image is loaded into memory, represented as disk DMM0:, and once the logical disk is connected (as LDA1:), it becomes the system device until the boot process reaches a point where it can mount the full, physical system disk. At that point, DMM0: is set offline but is retained in case the dump kernel needs to boot.

## Note

It should never be necessary to run the **BACKUP** command on the (memory-resident) MemoryDisk as its own device (DMM0: or LDA1:). The MemoryDisk container file is backed up during a normal system backup operation.

## Important

To avoid invalidating the MemoryDisk inner boot blocks, never dismount, disconnect, or remove DMM0: or LDM1:.

During a network installation, the entire installation kit image is downloaded into memory as DMM1: and (using the outer boot blocks) the embedded MemoryDisk DMM0: is extracted from the kit. In this one special case and only for the duration of the installation procedure, we have two memory-resident disk images: the installation kit (DMM1:) and the MemoryDisk contained within the installation kit (DMM0:). Both of these memory-resident disks are serviced by the new MemoryDisk driver: SYS$DMDRIVER.EXE.

## 2.3.2. UEFI Partition

VSI OpenVMS is a three-partition system. Of the three disk partitions, the UEFI FAT-structured partition is the only partition that is recognized as a bootable partition by UEFI. Thus, during pre-boot execution, UEFI only sees this one partition and the files contained therein. This is where the VSI OpenVMS Boot Manager and any other UEFI executables reside. The other two ODS-5 structured partitions (and the files they contain) remain invisible to UEFI.

You can view the UEFI disk device paths using the shell command:

```
Shell> MAP -B
```

The resulting display shows device paths for both file system devices (fs*x*:) and block I/O devices (blk*x*:). File system devices are those which contain a UEFI partition and UEFI executable files. Block I/O devices are everything else. Each fs*x*: device path maps to its underlying blk*x*: device, but the blk*x*: devices are not directly accessible from the UEFI shell.

A bootable VSI OpenVMS disk will have four device mappings associated with it; one file system (fs*x*:) device, where the Boot Manager resides, and three block I/O (blk*x*:) devices, representing the three partitions (one FAT and two ODS-5 partitions). Looking at these device paths, you will note that they contain, among other things, a PCI device path, a storage device type (Sata, Fibre, etc.), and a hard disk identifier (HD1, HD2, CDROM, etc.). The bootable partition will always be shown as HD1. HD2 and HD3 are the ODS-5 partitions where the majority of VSI OpenVMS files reside.

If you want to launch a specific instance of the Boot Manager, then you will need to identify the UEFI fs*x*: device that is assigned to your desired boot disk (as you always had to do in IA-64 systems). You can then switch to that fs*x*: device and to the \EFI\VMS folder where you will find and launch VMS_BOOTMGR.EFI. It is not always easy to sift through the UEFI device paths to locate your desired disk, so it helps to familiarize yourself with device path nomenclature.

For x86-64, the Boot Manager can be run from any fs*x*: disk and boot any other (bootable) fs*x*: disk. Thus, you can simply launch the Boot Manager directly from shell as follows:

```
Shell> fs0:\EFI\VMS\VMS_BOOTMGR.EFI
```

In the above case, UEFI will launch the first instance of VMS_BOOTMGR.EFI it finds as it scans the available fs*x*: device paths. Once running, the Boot Manager will then allow you to identify and boot your system disk using familiar VSI OpenVMS device names. For example:

```
BOOTMGR> BOOT DKA0
```

You can also boot a device by its fs*x*: identifier. For example:

```
BOOTMGR> BOOT fs2
```

When a **BOOT** command has been issued, the Boot Manager locates an extent map contained in the boot blocks of the target disk. The extent map contains the information required to locate and load the MemoryDisk and the secondary bootstrap image SYSBOOT.EXE which resides in one of the ODS partitions.

The Boot Manager loads the MemoryDisk and SYSBOOT.EXE using the UEFI block I/O protocol, the LBA (Logical Block Address, or LBN), and the size specified in the extent map. Since UEFI contains block I/O protocols for every supported type of boot device, we no longer need VMS-specific boot drivers. During early boot, while running memory-resident, SYSBOOT.EXE loads and uses the new VSI OpenVMS MemoryDisk driver (SYS$DMDRIVER). Later, during SYSINIT, device-specific runtime drivers are loaded for access to the full physical system disk.

The UEFI partition is implemented as a logical disk container file named [SYSEXE]SYS$EFI.SYS. This is a full implementation of the UEFI partition; the folders and files are visible from the UEFI shell including \EFI\BOOT, \EFI\VMS, \EFI\UPDATE, and \EFI\TOOLS.

In order to allow the MemoryDisk itself to be a bootable entity, the MemoryDisk container file [SYSEXE]SYS$MD.DSK contains a reduced-functionality UEFI partition implemented as another logical disk container file named: [SYSEXE]MEM$EFI.SYS. Although there are no UEFI utilities in this *boot-only* UEFI partition, its inner boot blocks contain just enough information to locate and load SYSBOOT.EXE when the MemoryDisk is directly booted.

To be technically complete, the installation files and kit must adhere to ISO 9660 structure and boot method. Per ISO specification, yet another copy of the UEFI partition exists as the ISO boot file. Per UEFI specification, the ISO boot file must be a UEFI partition instead of an executable image. Therefore, when an ISO DVD is detected by UEFI firmware, UEFI treats the ISO boot file as a file system partition. Subsequently, if the partition contains a UEFI application named \EFI\BOOT\BOOTX64.EFI, then UEFI firmware automatically launches the application. In our case, this is a copy of the VSI OpenVMS Boot Manager. The net result is that the Boot Manager executes automatically when the installation kit file is assigned to an optical device or an installation kit DVD is inserted into the DVD drive.

Due to the automatic launch feature of optical discs that contain fs*x*:\EFI\BOOT\BOOTX64.EFI, VMS Software strongly suggests that you disconnect these devices after installation to prevent unwanted launching from the write-locked DVD device. After installation, you will want to launch the Boot Manager from fs*x*:\EFI\VMS\VMS_BOOTMGR.EFI on the installed disc.

## 2.3.3. UEFI Folders

There are several folders in the UEFI partition:

**\EFI\BOOT (Default Boot File)**

This folder is used for automatic booting from a disk. The Boot Manager and related files are in this folder. There is also a file named BOOTX64.EFI, which is just a copy of VMS_BOOTMGR.EFI given a special name. When a UEFI boot option that points to a specific disk is defined, UEFI will look for a default boot file, \EFI\BOOT\BOOTX64.EFI, and if found, will execute it.

**\EFI\VMS**

This folder contains the normal OS-specific boot files. In our case, it has all the same Boot Manager files in it, except it does not contain BOOTX64.EFI.

**\EFI\TOOLS**

This folder may contain optional UEFI applications deemed useful for maintenance.

**\EFI\UPDATE**

This folder may contain firmware updates for the system or adapters.

### Note

Users should avoid including additional files in the UEFI folders, except where necessary to perform firmware and adapter updates. Copies of any such files should be kept elsewhere to avoid potential loss should the partition be updated.

### 2.3.4. UEFI Files

The following files may be found in the \EFI\VMS and \EFI\BOOT folders:

**VMS_BOOTMGR.EFI**

This is the VSI OpenVMS Boot Manager executable.

**VMS_KITBOOT.EFI**

This is the utility for downloading VSI OpenVMS from a web server. It is an optional file that is used only for downloading installation kits from a local web server. If this file is renamed or removed, the Boot Manager's **`INSTALL`** command and push button will be disabled.

**VMS_IMG.BMP**

This is a background bitmap used by the Boot Manager when in graphical mode. This image can be customized per instructions in a later section. If this file is renamed or removed, the Boot Manager will fall back to a less graphical mode of operation.

**VMS_ENV.DAT**

This is created by the Boot Manager and contains various application parameters in binary form. The contents can be viewed by the Boot Manager command **`ENV`**. It is updated and saved whenever one of the parameters is changed and the user issues one of the following commands: **`BOOT`**, **`EXIT`**, **`SHELL`**, or **`SAVE`**. If the file is deleted, a new copy will be created when the Boot Manager is next launched.

**VMS_OPT.TXT**

This is an optional file created by the user. It contains a simple list of fully-qualified **`BOOT`** commands. If the file exists, the Boot Manager allows selection of **`BOOT`** commands by line number, i.e., **`BOOT #3`** would execute the **`BOOT`** command from the third line. This is primarily intended for VMS Software internal use.

Additional files may appear as development continues.

### 2.3.5. Locating the MemoryDisk

When the Boot Manager is launched, it scans the system hardware to locate all bootable devices. A bootable device is one that contains a GPT and, minimally, a UEFI partition. If the GPT contains structures indicating the presence of VSI OpenVMS partitions, the volume details (labels, size, etc.) will be displayed as a bootable VSI OpenVMS device by the **`DEVICE`** command. Network devices that support the UNDI (Universal Network Device Interface) protocol are also considered bootable.

When a **`BOOT`** command is issued, the Boot Manager attempts to locate the MemoryDisk inside the boot source device. It does this by scanning the boot block structures for a specific signature. If found, additional extent records in the boot block indicate the LBA (Logical Block Address) and size of the

MemoryDisk. Up to twenty-four extent records can describe the full MemoryDisk image. Because all device access at this early stage uses physical block references, the Boot Manager can use the built-in block I/O drivers provided by UEFI to load the MemoryDisk into system memory. This same method is used regardless of whether we are booting an installed system disk or an installation kit from an optical drive or over a network.

When booting from a virtual or physical device, the boot source device's (outer) boot block contains the location (Logical Block Address) and size of the MemoryDisk and the relative location and size of SYSBOOT.EXE within the MemoryDisk. SYSBOOT.EXE is the initial VSI OpenVMS bootstrap program to be loaded and executed.

When booting the installation kit over a network, the VMS_KITBOOT.EFI utility downloads the entire installation kit image. It then launches the Boot Manager. The Boot Manager, using the outer boot blocks, locates, extracts, validates, and loads the MemoryDisk from within the memory-resident installation kit image and then, using the inner boot blocks, locates, extracts, validates, loads, and executes SYSBOOT.EXE.

Before transferring control to SYSBOOT.EXE, the Boot Manager performs a variety of other tasks required to prepare the system for execution, including allocation and initialization of boot-related data structures, such as the Hardware Restart Parameter Block (HWRPB), enumeration of devices, and establishing the memory maps. It does this for both the primary kernel and the dump kernel.

If a bugcheck occurs at any point after VSI OpenVMS is booted, the dump kernel is already resident in system memory (this includes the MemoryDisk and a separate copy of SYSBOOT.EXE). The crashing primary kernel passes control to the dump kernel, which will rapidly boot, perform its tasks, and reset the system. This independent dump kernel provides for faster crash dump and shutdown processing using runtime device drivers.

The operating system procedures that build and maintain the MemoryDisk must also maintain the inner boot blocks of the MemoryDisk and the outer boot blocks of the system disk's UEFI partition. If system files that reside within the MemoryDisk are updated, by installation of a patch kit for example, the involved utilities will invoke a command procedure (SYS$MD.COM) to create a new MemoryDisk image so that any changes will be preserved for the next system boot. The system files that reside within the MemoryDisk are not files that a user or system manager would typically need to modify unless you need to add customer-developed execlets to be loaded during boot.

# Chapter 3. The Boot Manager

## 3.1. VSI OpenVMS Boot Manager

The VSI OpenVMS x86-64 Boot Manager loads the VSI OpenVMS operating system as a guest operating system on a hypervisor.

The Boot Manager is a UEFI (console firmware) application located on the boot device, installation media, or network distribution site. The actual on-disk file is fs*x*:\EFI\VMS\VMS_BOOTMGR.EFI.

While VSI OpenVMS IA-64 systems used a similar console application named VMS_LOADER.EFI, they are crucially different. The Boot Manager application is also an OS loader, but it specifically serves the x86-64 architecture and has a considerably different functionality. The IA-64 loader image offered very few features. Additional EFI utilities were required to help users identify devices and manage the boot environment. The VSI OpenVMS x86-64 Boot Manager has many built-in features, eliminating the need for additional utilities.

It is important to note that platform firmware often provides its own form of a built-in boot manager, usually presented as a series of simple menus that manage platform setup features and let users define various boot options. Do not confuse these platform-specific setup programs with the VSI OpenVMS Boot Manager. If you are familiar with the Linux boot process, you can consider the VSI OpenVMS Boot Manager to be analagous to the GRUB boot loader utility, but specifically tailored to the needs of VSI OpenVMS.

To boot VSI OpenVMS, the x86-64 system must be set up to launch the UEFI shell application. From the `Shell>` prompt, launch (manually or automatically) the VSI OpenVMS Boot Manager. Although the VSI OpenVMS Boot Manager can run without the UEFI shell, the shell provides local UEFI file services. Without these services, certain functions of the VSI OpenVMS Boot Manager will not be available. Most notably, the enumeration of VSI OpenVMS device names (DKA100:, etc.) is not possible or precise, and the user may need to boot using UEFI file system device names (fs1:, etc.).

## 3.2. Boot Manager Basics

This section describes the operation of the VSI OpenVMS Boot Manager. Most customers will be unlikely to need anything more than the basic features of the Boot Manager. Normally functioning systems can be set up to automatically boot with no interaction with the Boot Manager at all. The more advanced features of the Boot Manager provide functions required to initially establish the desired boot environment, set it up for automatic booting, and diagnose boot problems.

### 3.2.1. Automatic Launching

There are several ways to set up a system to automatically launch the VSI OpenVMS Boot Manager. As a standalone UEFI application, it can be launched from one disk and boot another. This can lead to confusion when several bootable disks are present, so the user needs to be careful about how this is set up.

Most UEFI implementations maintain a path-like list of all file system devices. UEFI can use this path to search for specific files among multiple disks. Such searches begin with fs0: and continue incrementally for the remaining fs*x*: devices.

The subsequent sections describe the two most common methods for setting up automatic launch.

## Using a Startup File

If a file STARTUP.NSH is found on any disk that is contained in UEFI's path, it will be executed by the UEFI shell, after a brief countdown. The STARTUP.NSH file is a simple, optional text file containing UEFI shell commands. You can create this file using the shell **`edit`** command or other method of placing the file in an fs*x*:\EFI folder.

The file should contain one shell command per line. In its simplest form, a single line containing `VMS_BOOTMGR` will launch the VSI OpenVMS Boot Manager, but because no specific fs*x*: device was specified, UEFI will search its path for the first instance of VMS_BOOTMGR.EFI available to it.

Best practice is to always specify the root device, folder, and file on individual lines. For example:

```
fs2:
CD EFI\VMS
VMS_BOOTMGR
```

By specifying the fs*x*: device first, you have identified the root device that UEFI will use. This is important because it helps to locate other files (such as environment variable files).

Any combination of shell commands can be placed in the STARTUP.NSH script. It is often used to configure low-level network and adapter details.

Typically, STARTUP.NSH is found in the fs*x*:\EFI folder. If multiple disks contain STARTUP.NSH files, UEFI will execute the first one it finds. You can place this file on fs0: (making it the first one found), or you can adjust the boot options and boot order in your platform firmware to point to the desired disk. Some systems allow STARTUP.NSH to be located on a network.

## Setting Up Boot Options and Boot Order in the Platform Firmware

This is performed to point to the disk that you wish to automatically boot. Entering the platform boot manager screens typically involves pressing a function key during system power-on or exiting from the `Shell>` prompt. Your boot options are a list of bootable devices that can be edited. The boot order specifies the order in which the boot options are processed.

Typical platform firmware implementations may provide some pre-defined boot options, one of which might be the "Internal UEFI Shell." Often the shell option says it is unsupported, meaning that it is not actually a boot device. You can still use this option if you want the UEFI shell to be launched by default.

You can add new boot options and adjust the boot order as needed to place your desired default device at the top of the list. When adding a new boot option, if you specify only a boot device, UEFI will expect to find the default boot file at fs*x*:\EFI\BOOT\BOOTX64.EFI. It is better to specify the full folder and file (fs*x*:\EFI\VMS\VMS_BOOTMGR.EFI) to avoid ambiguity. Failing to be precise means that if the default boot file is not found, the next boot option will be tried, which is likely to be a different disk.

Precise boot options can be entered using the `Boot from a file` function or careful construction of a new boot option entry. Unfortunately, the syntax and functions vary among platforms.

Regardless of which method is used to select a disk and launch the VSI OpenVMS Boot Manager, you can complete the automatic boot by setting up the VSI OpenVMS Boot Manager's auto-action feature. This is done using the following command and then booting the desired device:

```
BOOTMGR> AUTO BOOT
```

The next time the VSI OpenVMS Boot Manager is launched, it will perform a brief countdown, then automatically boot.

You can adjust the boot countdown using the command:

```
BOOTMGR> AUTO n
```

where *n* is a number of seconds from 1 to 30. Note that if you find yourself in a situation where you cannot prevent auto-boot, issue the command:

```
BOOTMGR> EXIT
```

After that, proceed immediately to repeatedly press the key that invokes the setup screen[1] of the platform firmware.

## 3.2.2. Display and Input

Depending on the capabilities of the current system, the Boot Manager will operate in one of the four distinct modes. The Boot Manager evaluates and selects the most capable mode in the following order:

1. **GRAPHICAL_IO Mode**

   The system provides full graphical display features; it supports mouse, touchpad, or touchscreen input. In this mode, the Boot Manager supports push buttons, check buttons, and a graphical background image.

2. **GRAPHICAL Mode**

   The system provides full graphical display features but *does not* support mouse, touchpad, or touchscreen input. In this mode, the Boot Manager supports push buttons, check buttons, and a graphical background image, but the keyboard arrow keys must be used to interact with these graphical controls.

3. **RENDERED_TEXT Mode**

   The system supports simple graphical display features, such as full screen colored text, but without graphical controls or a background image. Input is limited to keyboard only. On systems that normally support the graphical modes, rendered text mode can be intentionally selected by deleting or renaming the background image file (fs*x*:\EFI\VMS\VMS_IMG.BMP).

4. **SERIAL_TEXT Mode**

   The system does not support graphical display features. Input and output will be routed to a physical or virtual serial communication port.

When using the VSI OpenVMS Boot Manager, you can usually connect a remote terminal session to use in parallel with the graphical display. You will need a remote connection anyway for OPA0: interaction when the system boots.

The remote serial connection always uses the architectural COM1 port (port address 0x3F8). Currently, only COM1 is supported. Use any terminal emulator that supports serial port communication, such as PuTTY. You can also set up a console connection via network (TCP port 2023, etc.) or named pipes

[1]This may be **Escape**, **F2**, etc. The specific key depends on your hypervisor.

(i.e., `\\.\pipe\`*`pipe_name`*, typically limited to a common host system unless a proxy server is used).

Unfortunately, the number and variety of utilities and remote access methods, along with specific differences between the various hypervisors, make console port setup exceedingly difficult to describe. Individual users will likely have to experiment and refer to relevant documentation to find what works for them.

Some platform firmware and hypervisors do not support remote connections to the UEFI shell. Others may support output-only (no keyboard input) until VSI OpenVMS is booted. In all cases, the VSI OpenVMS Boot Manager will suspend keyboard input after a **BOOT** command has been issued. This is because the UEFI keyboard drivers terminate once the boot has begun, and keyboard input will not resume until the VSI OpenVMS runtime drivers take over (just in time to support a conversational boot dialog).

When booted, VSI OpenVMS always assumes the use of COM1 for OPA0: interaction, except in specific instances where hardware does not support legacy COM ports.

## 3.2.3. Custom Background Image

On systems that provide a graphical display, the Boot Manager will attempt to load an optional background image file that may be customized by the user. A default background image has been provided by VMS Software.

The background image file must adhere to certain guidelines pertaining to format, dimensions, color depth, location, and name.

The file location and name must be fs*x*:\EFI\VMS\VMS_IMG.BMP. If this file is found and it meets the specified guidelines, it will be used by the Boot Manager.

The background bitmap image must be non-compressed, BMP format, with 24-bit color depth. Image dimensions must be a minimum of 1024 × 768 pixels and, ideally, 1920 × 1080 pixels to support most Full HD resolution monitors. If the image is smaller than the current display, it will be tiled as needed to fill the display. If the image is larger than the current display, it will be cropped. Image scaling and rotation are not supported.

A region in the upper-left corner of the image, measuring 900 × 144 pixels, is reserved for overlaying the various buttons and the VMS Software logo. The user cannot alter the placement or color of the graphical controls, so any custom image should provide adequate contrast in this region to assure that the controls remain visible. Selected controls are highlighted in red, so this too should be considered when selecting a custom image. A VMS Software copyright statement will be overlayed along the lower edge of the image. The text output area will be overlayed on top of the provided image.

If no suitable background image is found, the Boot Manager will fall back to the rendered text mode. In this mode, the full display dimensions will be used for output. If this full-size display mode is desirable, the user may rename or delete the bitmap image file. This effectively prevents the Boot Manager from entering graphical modes.

### Note

For security reasons, the graphical subsystem's frame buffer memory is cleared prior to transferring control to the operating system.

### 3.2.4. Display Within a Window

Some remote server management utilities and hypervisors will run the Boot Manager within a child window that is smaller than the physical monitor. Without having specific interfaces to these various utilities, the Boot Manager is unaware of the size of its containing window and will attempt to size its display according to the physical monitor size. This results in the need to scroll the window to see the complete Boot Manager display.

To improve usability when confined to a child window, do the following:

1. If you are using VirtualBox, the host provides a top menu item (when running) to scale the guest display. Unfortunately, not all hosts provide this feature.

2. Alternatively, to display line numbers along the left side of the text output region, issue the following command:

   ```
   BOOTMGR> LINES
   ```

3. Determine how many lines are visible without having to scroll.

4. Issue the command again with the desired number of lines. For example:

   ```
   BOOTMGR> LINES 34
   ```

This will cause the Boot Manager to recalculate its display height to fit the window. This can also be handy if you would like to shrink the Boot Manager to save screen space. Changes to the display size are preserved in response to a **`BOOT`**, **`EXIT`**, or **`SAVE`** command. If you wish to restore the full display size, issue the **`LINES`** command specifying an excessively large number of lines. The Boot Manager will then determine the maximum number of lines it can use with the current monitor.

Note that the Boot Manager does not currently support display width adjustment.

### 3.2.5. Page Mode and Scrolling

The Boot Manager supports a limited form of text scrolling. The **Page Up/Page Down** keys will redisplay prior pages of text output. The number of pages that can be recalled depends on the density of text on each page, but in typical use, six or more pages can usually be recalled, which is sufficient for most users. Page numbers at the bottom-left corner will indicate which page is currently displayed.

Commands that produce more than a single page of output will automatically pause as each full page has been displayed, and the user may enter **`Q`** to quit the current command output.

Although the Boot Manager is able to automatically control multiple-page output, the **`PAGE`** command can be issued to enter "Page Mode." This will cause the display to pause at the end of each page and wait for the user to press a key to continue. The display will be cleared as each subsequent page is displayed. Page mode greatly improves the display performance when using remote server management utilities, particularly when the display is being sent to a web browser interface. You can disable page mode using the **`NOPAGE`** command.

### 3.2.6. Routing and Logging Boot Manager Output

Occasionally, it is useful to capture boot process output for presentation or problem reporting. End-to-end logging of the boot process can be difficult to accomplish due to the many transitions that occur during the boot process. For example, the graphical or text mode Boot Manager runs within UEFI boot context. It transitions into UEFI Runtime context as it transfers control to VSI OpenVMS.

In UEFI runtime context and beyond, the Boot Manager has no access to UEFI file protocols, thus precluding UEFI file-based logging. When VSI OpenVMS is able to initialize its operator terminal driver, it can commence logging to a VSI OpenVMS file. Seamless logging of output across these complex transitions is best accomplished by routing Boot Manager and operator output to a terminal session where logging of session output is possible.

When booting VSI OpenVMS as a VM guest, the hypervisor will often provide a means of logging a session. You may also define a serial port for your Virtual Machine that can be directed to a TCP port and address. In this case, you can route the output to a terminal emulator to provide both scrolling and logging capability.

The Boot Manager **`COM`** ***`x`*** command, where *x* is the x86-64 architecturally defined COM Port number (1 through 4), will cause Boot Manager output to be echoed to the specified serial port. **`COM 0`** disables this function. You may route output to multiple ports by issuing additional **`COM`** ***`x`*** commands.

COM1 (0x3F8) will become the default port for OPA0: terminal communications once VSI OpenVMS has booted, even if Boot Manager output was disabled via a **`COM 0`** command.

Your selected COM port routing is preserved when you issue a **`BOOT`**, **`EXIT`**, or **`SAVE`** command.

## 3.2.7. Capturing and Projecting Graphical Display Output

A useful Boot Manager feature is graphical screen capture. Pressing function key **F1** at the `BOOTMGR>` prompt or at any `PAGE` prompt will cause the Boot Manager to capture the current screen to a UEFI file.

### Note

Currently, only a single snapshot file is supported. Subsequent captures will overwrite the prior capture unless you copy or rename the previous file, which is saved as a bitmap file named SNAPSHOT.BMP in the root UEFI file system device (fs0:, etc.). Be careful to avoid filling up the UEFI partition with these large bitmap files.

Occasionally, it is useful to project the display to a larger screen for demonstration or training purposes. This can be problematic due to the number of display resolution changes upon transferring control between BIOS, UEFI, Boot Manager, and VSI OpenVMS. Experience has shown that most modern projectors will synchronize to the resolution used by UEFI. This is fine for projecting the initial power-on sequence. Once you launch the Boot Manager, the resolution will almost certainly increase, and some projectors are not able to recognize the change. To accommodate this, we recommend that you avoid enabling output to your projector until you have launched the Boot Manager. This allows the projector to synchronize to the active resolution used by the Boot Manager.

## 3.2.8. Input Devices

### Note

Many hypervisors fail to provide mouse movement notifications while executing in UEFI and Boot Manager context. Keyboard input, initially using UEFI protocols, will be disabled during transition between UEFI and the operating system. Once the operating system is running, it will establish terminal devices as needed. As of the latest VSI OpenVMS x86-64 release, OpenVMS does not yet provide USB keyboard drivers. As such, your locally attached keyboard may not be usable once booted. Instead, user input is expected to occur through a terminal utility.

User input on x86-64 systems is typically provided by a locally attached keyboard. This may be a standard keyboard, a USB keyboard, a local or remote serial terminal, or a terminal emulator. Some systems require that the console keyboard be plugged into a specific port in order to recognize it as a boot keyboard. This is particularly true for USB keyboards on systems with firmware that does not yet support USB 3.x speeds. Refer to the documentation for your specific hardware.

Many x86-64 systems, particularly modern middle- to low-end class, do not provide traditional (RS-232/454) serial ports. Vendors tend to get rid of serial ports in home desktop environments and, in many cases, in server/enterprise-grade systems as well.

USB input devices have their own set of issues. USB operation requires an active system timer interrupt and more system resources to be available than required by a simple RS-232 serial port. Developers that need to work in the early boot stages should use traditional serial port input in order to avoid temporary loss of console input during boot.

As the system boots, the various input devices must transition to a runtime driver environment. During this transition, there may be a brief period of time (typically a second or two) when these devices become unavailable. For developers using the XDelta debugger, this problem is avoided by using a traditional serial port keyboard or special serial debug port device instead of the USB keyboard.

The Boot Manager and system firmware support a minimum subset of keyboard functionality as required to boot the system. Special function keys and languages other than English are not currently supported by the Boot Manager. Systems that provide a mouse, touchpad, or touchscreen input device should function as expected, but special features of these devices, such as gesture recognition or specialized buttons, are not supported in the boot environment. Some hypervisors, such as VirtualBox, do not report mouse movement at all in the UEFI environment.

The keyboard **Up** and **Down** arrows operate a command recall buffer. The **Right** and **Left** arrow keys move input focus to the next or previous button in a circular chain of buttons. Whenever the arrow keys highlight a button, the **Escape** or **Enter** keys will activate the highlighted button. If the user presses any key other than the arrow keys, input focus is returned to the Boot Manager command line. The **Page Up** and **Page Down** keys display previous output pages. Pay attention to the page numbers in the lower-left corner of the display. The number of pages that can be redisplayed depends on the density of text in each page, but typically up to six pages of output can be redisplayed.

### 3.2.9. Environment Variables

VSI OpenVMS has traditionally been dependent on UEFI environment variables to control certain aspects of the boot procedures. However, there is some inconsistency among the behaviors of some hypervisors with regards to how they handle UEFI environment variables.

While most hypervisors support interfaces for managing environment variables, some fail to provide persistence of these values across power cycles. Worse yet, some hypervisors fail to provide the fundamental interfaces and also fail to report errors when these standard UEFI features are not available.

In order to address this problem, the Boot Manager maintains an internal structure containing the required variables and attempts to store or retrieve these variables from both environment variable (if present) and a UEFI binary file, fs*x*:\EFI\VMS\VMS_ENV.DAT.

Using a binary file to store environment variables works with the hypervisors that preserve such files across power cycles, although there remain some persistence issues. The VMS_ENV.DAT file should not be edited. Nothing in the file is critical, and the file is deleted if it fails various validity checks.

## 3.3. Boot Modes, Boot Messages, and Boot Flags

There are many optional controls that affect the VSI OpenVMS boot procedures. Control of boot modes and boot messages can be accomplished using boot flags. However, most commonly used features also have Boot Manager commands or buttons that are easier to use than flags. This section describes these modes, messages, and flags, and how they affect the boot procedures.

### 3.3.1. Boot Modes

**AUTO-ACTION**

Most users will choose to set up their systems to boot with little to no interaction. Systems set up to auto-boot are assured the fastest recovery following a change in power state or fatal system event. The Boot Manager command **`[NO]AUTO`** enables or disables a brief countdown before executing the previous default **`BOOT`** command. Refer to *Section 3.5, "Command Dictionary"* for further details.

**BOOTMGR INTERACTION**

The Boot Manager can operate in an interactive mode that is designed to help diagnose boot problems. The Boot Manager command **`[NO]BOOTMGR`** enables or disables the interactive features that provide insight into the earliest UEFI phase of boot.

**XDELTA**

Developers can use the XDelta instruction level debugger in one of two ways. To debug the early boot process, XDelta is linked into SYSBOOT. To debug later phases of operation, XDelta will be loaded by SYSBOOT as a loadable (execlet) image. The Boot Manager command **`[NO]XDELTA`** enables the XDelta debugger that is linked into SYSBOOT. This is most useful to developers working in the early phase of boot where the system is still using physical addressing.

**BREAK**

When used along with the XDELTA or SYSDBG modes, the instruction level debugger will respond to the first breakpoint it encounters, typically a call to INI$BRK() in a code module.

**SYSDBG**

The Boot Manager command **`[NO]SYSDBG`** enables the loadable XDelta execlet debugger. This is most useful to developers working in later phases of boot where the system is using virtual addressing. It is also useful to device driver developers and for those working with other system components.

**SYSBOOT INTERACTION**

The Boot Manager command **`[NO]CONVERSATION`** enables or disables a pause in the boot process at the `SYSBOOT>` prompt. This is also known as a conversational boot. Refer to the relevant section in the *VSI OpenVMS System Manager's Manual, Volume 1: Essentials* [https://docs.vmssoftware.com/vsi-openvms-system-manager-s-manual-volume-1-essentials/#CONV_BOOT_TASKS] for more details.

**VERBOSE**

This mode works in conjunction with the various message-related boot flags. When in VERBOSE mode, VSI OpenVMS system components may produce extended diagnostic information of interest to developers. This extended information is subject to change and does not follow any message formatting rules. Used with certain other flags, the amount of diagnostic data is substantial and may delay booting by many minutes.

### 3.3.2. Boot Messages

In order to manage the number of messages that VSI OpenVMS can produce during boot, the operating system provides a defined subset of boot flags to control messages from specific phases of the boot procedures. The Boot Manager provides commands and buttons to control each of these phase-specific messaging features.

The boot phases having their own boot message flags include: BOOTMGR, SYSBOOT, EXECINIT, SYSINIT, ACPI, HWCONFIG, and DRIVER. Both graphical mode check buttons and commands are provided for each of these flags.

In addition to each phase-specific message flag, the **`[NO]VERBOSE`** command (or its associated push button) controls the extent of message detail.

If the VERBOSE mode flag is *not* set, the phase-specific messages will be properly formatted VSI OpenVMS messages of the form: `%FACILITY-Severity-Mnemonic, Message String`. For example:

```
%SYSBOOT-I-PARAM, Loaded Parameter File
```

These messages are intended to provide basic progress indication and highlight interesting operations.

If the VERBOSE mode flag is set, extended debug information will be provided. These messages are not formalized, and their display depends on specific developers' requirements for extensive troubleshooting.

### 3.3.3. Boot Flags

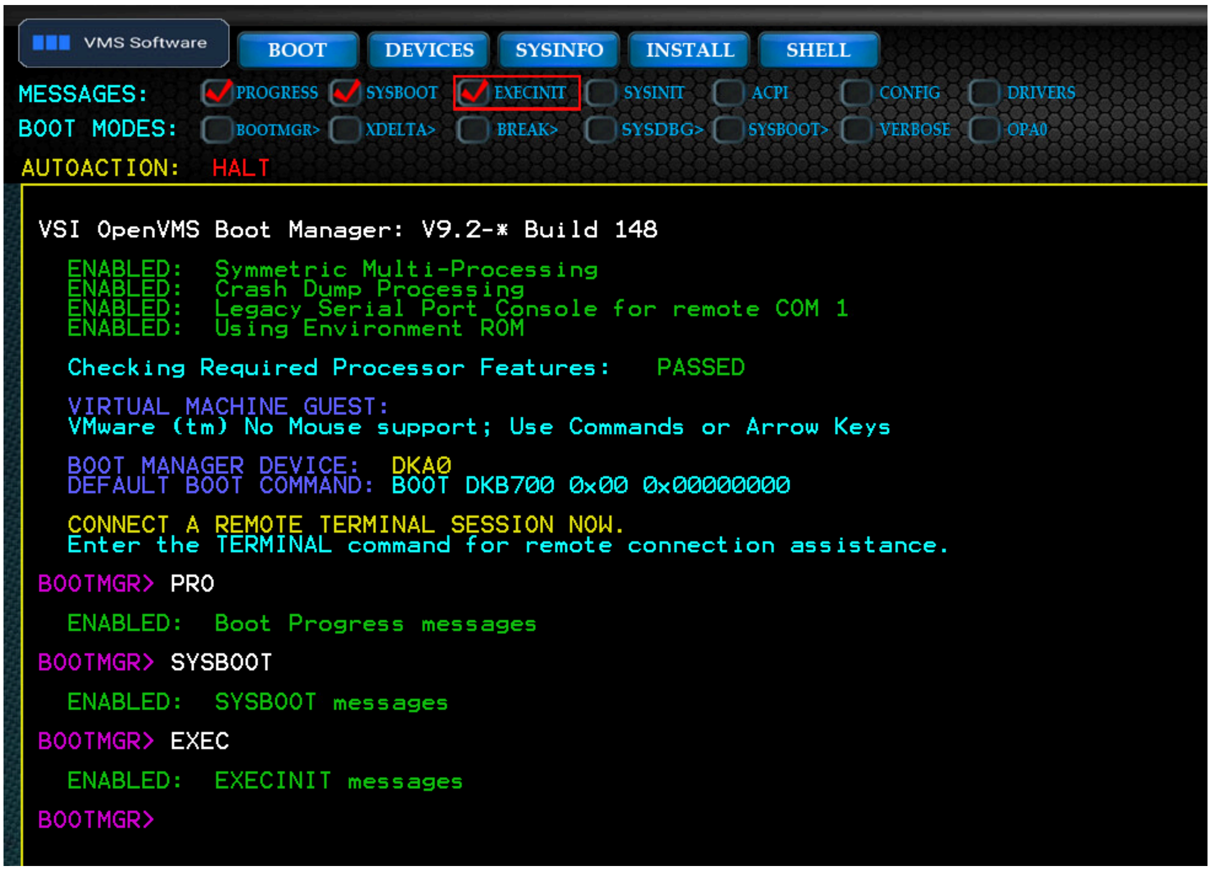
Boot flags are a 32-bit mask of numeric constants that enable or disable specific boot-related features. These features include boot modes, boot messages, and a variety of less common features.

The definition of boot flags were changed for VSI OpenVMS x86-64. Many of the earlier flags no longer applied to the x86-64 architecture, or else served functions that were unrelated to booting.

For VSI OpenVMS on x86-64, we have reorganized the flags into three categories:

- Message controls
- Boot mode controls
- Debug and diagnostic controls

**Figure 3.1. Typical Boot Message Control Flags**



```
VSI OpenVMS Boot Manager: V9.2-* Build 148

   ENABLED:  Symmetric Multi-Processing
   ENABLED:  Crash Dump Processing
   ENABLED:  Legacy Serial Port Console for remote COM 1
   ENABLED:  Using Environment ROM

   Checking Required Processor Features:    PASSED

   VIRTUAL MACHINE GUEST:
   VMware (tm) No Mouse support; Use Commands or Arrow Keys

   BOOT MANAGER DEVICE:  DKA0
   DEFAULT BOOT COMMAND: BOOT DKB700 0x00 0x00000000

   CONNECT A REMOTE TERMINAL SESSION NOW.
   Enter the TERMINAL command for remote connection assistance.
BOOTMGR> PRO

   ENABLED:  Boot Progress messages

BOOTMGR> SYSBOOT

   ENABLED:  SYSBOOT messages

BOOTMGR> EXEC

   ENABLED:  EXECINIT messages

BOOTMGR>
```

The Boot Manager presents graphical check buttons for the most commonly used flags and commands to set and clear individual flags by name. Note, however, that most hypervisors do not support mouse movement under UEFI, so if you wish to use the graphical buttons, you will need to press the arrow keys to select a button, then press **Enter** to toggle the state of the button. As an alternative, you can use commands to control the flag states. Refer to *FLAGS and Message Check Buttons* for more information on the **FLAGS** command and message check buttons.

Each boot flag has a corresponding command to set or clear the flag. All such Boot Manager commands can be prefixed with **NO** to clear the flag. For example: **PROGRESS** sets the progress message flag and **NOPROGRESS** clears the flag. Most commands can be abbreviated to a minimum number of unique characters.

A **FLAGS** command is also available for managing the full set of available flags. Entering the **FLAGS** command without an additional value will display and interpret the current boot flag settings, as follows (in graphical modes, a chart of flag bits will also be displayed):

```
BOOTMGR> FLAGS
3 3 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0
1 0 9 8 7 6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1 0
  X             X X X X X X             X X           X
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0


Bit   Hex          Type      Command         Description
<00>(00000001) = BOOTMODE: CONVERSE  Conversational Boot : SYSBOOT>
<01>(00000002) = BOOTMODE: XDELTA    Enable Early XDELTA Debugger
<02>(00000004) = BOOTMODE: BREAK     Take Early XDELTA breakpoint
<03>(00000008) = Reserved
<04>(00000010) = MESSAGES: PROGRESS  Display Boot Progress Messages
<05>(00000020) = MESSAGES: SYSBOOT   Display Detailed SYSBOOT  Messages
```

```
<06>(00000040) = MESSAGES: EXECINIT  Display Detailed EXECINIT Messages
<07>(00000080) = MESSAGES: SYSINIT   Display Detailed SYSINIT  Messages
<08>(00000100) = MESSAGES: DRIVER    Display Device DRIVER Messages
<09:10>        = Reserved
<11>(00000800) = BOOTMODE: SYSDBG    Enable System Execlet XDELTA Debugger
<12>(00001000) = MESSAGES: ACPI      Display ACPI Messages
<13>(00002000) = MESSAGES: CONFIG    Display Hardware Configuration Messages
<14>(00004000) = Reserved
<15>(00008000) = BOOTMODE: HALT      Halt before transfer of control to SYSBOOT
<16>(00010000) = BOOTMODE: NoCommand Dump Kernel runs without a System disk
<17:19>        = Reserved
<20:22>        = Reserved
<23>(00800000) = BOOTMODE: OPA0      Use Guest Console OPA0 Terminal
                                     (rather than serial port).
<24>(01000000) = BOOTMODE: BOOTMGR   Interactive Boot Manager Dialog: BOOTMGR>
<25>(02000000) = DIAG MSG: MEMCHECK  Enable Memory Assignment Diagnostics
<26>(04000000) = DIAG MSG: DEVCHECK  Enable Device Enumeration Diagnostics
<27>(08000000) = DIAG MSG: DEVELOP   Enable Special Functions (subject to change)
<28>(10000000) = DIAG MSG: MDCHECK   Enable Memory Disk Diagnostics
<29>(20000000) = DIAG MSG: CPUCHECK  Enable CPU Startup Diagnostics
<30>(40000000) = Reserved
<31>(80000000) = MESSAGES: VERBOSE   Enable Verbose Messages

  BOOTFLAGS:   0x00000010, DUMPFLAGS: 0x00000000
  MESSAGES:    PROGRESS
  MODES:
```

To set or clear boot flags, the desired hexadecimal value can be provided following the **FLAGS** command. For example, **FLAGS 1070** would set boot flag bits <4>, <5>, <6>, and <12>, enabling general boot PROGRESS messages and additional messages from SYSBOOT, EXEC_INIT, and ACPI facilities.

When setting new flag values, be aware that the value you enter will supersede flags that had been set previously. For this reason, you may want to use the **FLAGS** command first to see the current value, then adjust the value to enable or disable the flag bit(s) you are interested in.

The Boot Manager saves your boot flags value in response to a **BOOT**, **EXIT**, or **SAVE** command. Flag values that were set during a **BOOT** command will also be preserved as the default **BOOT** command string to be used on subsequent boots.

## 3.4. Command Usage

The Boot Manager provides a set of commands that serve the needs of developers and system managers. The subset of these commands that support developers is subject to change, and some of the commands will be disabled in production releases. This version of the Boot Manager User Guide describes all of the commands that are active at the time of writing. Each command description will indicate its intended audience.

### 3.4.1. Command Syntax

Boot Manager commands use a very simple syntax.

A command verb is followed by an optional parameter separated by a space.

Command verbs can be abbreviated to the smallest number of characters required to assure uniqueness. Certain commands having significant effect must be entered in full as a means of verifying user intent.

Commands that set a flag or enable a feature are typically cleared by prefixing the verb **NO** in front of the original command. For example, the **PROGRESS** command enables a flag to produce boot progress messages. The **NOPROGRESS** command clears the flag. In other words, the Boot Manager does not use **SET**, **CLEAR**, **ENABLE**, or **DISABLE** command precursors.

## 3.4.2. Command Recall and Logging

The Boot Manager provides a limited command recall buffer that can be accessed with the **Up** or **Down** arrow keys. The Boot Manager supports a limited form of scrolled output using the **Page Up** and **Page Down** keyboard keys.

It is unusual for the early boot process to produce large amounts of text prior to transfer to VSI OpenVMS, at which point the operator terminal and logging are available. In cases where Boot Manager commands produce more lines of output than will fit on a single screen, the Boot Manager may pause the output as text exceeds each visible display page.

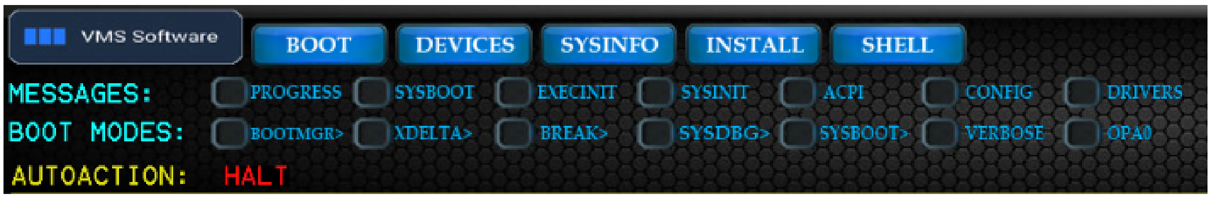
In cases where a permanent log of Boot Manager output is desired, output can be directed to a COM port and terminal emulator. These features are described in their respective command descriptions.

## 3.4.3. Command Push Buttons

When operating in graphical mode, common commands are represented by rows of push buttons (see the figure below). If a pointing device (mouse or touchpad) is active, the push buttons can be activated as you would expect from a GUI-based application.

If no pointing device is active, the push buttons can be selected using the **Right** or **Left** arrow keys. The selected button will be outlined in red. To activate the selected button, press the **Enter** or **Escape** key. If you press any other keys, input focus will return to the command line.

**Figure 3.2. Command Push Buttons**



## 3.5. Command Dictionary

This section describes the commands that are available from the `BOOTMGR>` prompt.

The command descriptions show the full-length command verbs. Most commands can be abbreviated to the shortest number of characters that would uniquely identify them. In certain instances, commands that result in particularly significant operations may not support an abbreviated form.

## AUTOACTION

AUTOACTION — Determines what automatic action occurs when the Boot Manager is launched.

### Syntax

```
AUTOACTION [arg]
```

## Arguments

**HALT**

Remain at the `BOOTMGR>` command prompt.

**BOOT**

Countdown before issuing the previous **`BOOT`** command. Refer to *Section A.1, "DEVICE, AUTOACTION, and CONVERSATION Commands"* for an example of output for the **`AUTOACTION`** command.

***seconds***

Sets a countdown delay between 1 and 30 seconds.

If the boot countdown is interrupted by pressing the **Escape** key, the countdown stops and the `BOOTMGR>` prompt is displayed. Pressing any other key during the countdown skips the remaining countdown and proceeds to boot.

## BOOT

BOOT — Initiates a system boot. Several optional arguments are available.

### Syntax

```
BOOT [device] [root] [flags]
```

### Before You Begin

If you have previously booted the system, a **`BOOT`** command with no additional arguments will attempt to boot the system using the prior **`BOOT`** command string, including device, root, and flags.

If you have not previously booted the system, a **`BOOT`** command with no additional arguments will attempt to boot the system from the device where the Boot Manager resides. In most cases, this will be your default system disk.

Refer to *Section A.4, "Progress Messages on Guest Display After BOOT"* for an example output for an unqualified BOOT command.

### Optional Arguments

**BOOT [*device*]**

The first optional argument is a VSI OpenVMS device name that you wish to boot from. Unlike prior versions of VSI OpenVMS, the Boot Manager can be run from one device and boot a different device. You no longer need to figure out which UEFI file system device (fs*x*:) equates to your boot device. The Boot Manager will do this for you. For example:

```
BOOTMGR> BOOT DKA100:
```

#### Note

Mapping of VSI OpenVMS to UEFI file system devices requires support of the UEFI shell protocol. In some rare cases, this protocol is not available in platform firmware. In this case, you can use the UEFI file system device name (fs0:, etc.) in the **`BOOT`** command.

You must choose one of the bootable devices listed by the **DEVICE** command. The listed devices are those that have passed a series of tests to determine that they contain bootable VSI OpenVMS images. Specifying the trailing colon is optional. Note that the scope of devices that the Boot Manager sees during initialization is limited to those for which UEFI drivers are available. Complex storage systems do not always expose their devices to UEFI for booting. Most often, the listed devices will include the system boot device. Once VSI OpenVMS has booted, it gains additional capability for detecting devices and, in some rare cases, the VSI OpenVMS device names may differ from the name that was used during boot.

**BOOT [*device*] [*root*]**

The second optional argument is a system root to boot from. You can set the default system root using the **ROOT** command, or you can specify it as the second argument in a fully-qualified **BOOT** command. For example:

```
BOOTMGR> BOOT DKA0 0 10
```

This command boots `DKA0` using Root `0` with boot flag (hex) `10`; it sets bit <4>, which is the PROGRESS message flag.

**BOOT [*device*] [*root*] [*flags*]**

The third optional argument is a hexadecimal value representing boot flags. Refer to the description of *FLAGS and Message Check Buttons* for more details. Boot flags may also be passed into the Boot Manager when it is launched from the UEFI shell prompt. If you specify flags at the UEFI shell prompt, prefix the flags with **-fl** as you would on earlier versions of VSI OpenVMS. For example:

```
Shell> vms_bootmgr DKA0 -fl 0,807
```

The above command boots device `DKA0` using system root `0` and boot flags `0x807`.

You do not need the **-fl** prefix or comma when entering a **BOOT** command at the `BOOTMGR>` prompt. The equivalent command line would be as follows:

```
BOOTMGR> BOOT DKA0 0 807
```

## Note

The VSI OpenVMS x86-64 boot flag definitions are different from prior versions of VSI OpenVMS. Refer to the *FLAGS and Message Check Buttons* command description for details.

## BOOT OPTIONS LIST

As an alternative to entering **BOOT** command arguments, you can also boot from a pre-defined list of boot options. These are *not* the same as UEFI boot option variables. UEFI boot option variables get you to the Boot Manager, *not* to a VSI OpenVMS boot device.

To use a predefined list of **BOOT** commands, you must first create the list in the same folder where the VMS Boot Manager is launched from, typically fsx:\EFI\VMS. The list is a simple text file that can be created by the UEFI editor or copied to the system using FTP or another mechanism to get the file into the EFI partition.

Refer to the *OPTIONS* command for details on creating the options list.

If the Boot Manager finds the options list, the **`OPTIONS`** command with no arguments will enumerate and display the list.

To select a listed option, enter **`BOOT #`** followed by the option number in the boot options list.

This feature is intended to simplify the task of booting many system configurations for test purposes, but it may be useful for other reasons too.

**AUTOACTION BOOT | HALT | *seconds***

If you have previously set AUTOACTION to BOOT, the Boot Manager will provide a countdown prior to launching the default **`BOOT`** command (prior successful **`BOOT`** command). Pressing the **Escape** key during this countdown period will abort the countdown and present the `BOOTMGR>` command prompt. Pressing any other key during this countdown skips the remaining count and commences with booting.

Refer to the *AUTOACTION* command description for more details.

## CLS and CLEAR

CLS and CLEAR — Each of these commands clears the current graphical or rendered-text mode display.

### Syntax

```
CLS
```

```
CLEAR
```

## COMPORT

COMPORT — The **`COMPORT`** command used with no argument will display the currently active serial COM port numbers (0 through 4).

### Syntax

```
COMPORT [arg]
```

Specifying **`COM 0`** will disable all serial port output. Specifying a value of 1 through 4 will enable COM1 through COM4 output respectively. More than a single port can be enabled. These are the x86-64 architecturally defined serial ports.

If the Boot Manager detects a terminal connection, it will assign it to COM1 (port address 0x3F8). Specifying a COM port causes the Boot Manager output to be directed to that serial port. If no **`COM`** command is issued, VSI OpenVMS will still support terminal connections. Only the Boot Manager output will be excluded from the serial port device.

## CONVERSE

CONVERSE or CONVERSATION — Enables a pause in the boot process at the `SYSBOOT>` prompt. This is also known as a *Conversational Boot*. Refer to the relevant section in the *VSI OpenVMS System*

*Manager's Manual, Volume 1: Essentials* [https://docs.vmssoftware.com/vsi-openvms-system-manager-s-manual-volume-1-essentials/#CONV_BOOT_TASKS] for more details. **NOCONVERSE** disables conversational boot. The **[NO]SYSPROMPT** command is a synonym for this command function.

### Syntax

```
CONVERSE
```

```
NOCONVERSE
```

Refer to *Section A.1, "DEVICE, AUTOACTION, and CONVERSATION Commands"* for an example of output for the **CONVERSE** command. See also *Section A.2, "Conversational Boot"* for an example of output for a conversational boot.

## DEMO

DEMO — Takes on various functions as needed. Typically, this is used to demonstrate some feature of the Boot Manager for other developers to evaluate.

### Syntax

```
DEMO
```

## DEVCHECK (Diagnostic Feature)

DEVCHECK — Executes a PCI-E bus scan and enables extended diagnostics regarding device discovery and assignment of VSI OpenVMS device names. This is a one-shot command which does not require a **NODEVCHECK** command.

### Syntax

```
DEVCHECK
```

## DEVELOPER (Development Feature)

DEVELOPER — The command is reserved for Boot Manager development use. Its function is subject to change.

### Syntax

```
DEVELOPER
```

## DEVICE

DEVICE — Presents a list of qualified VSI OpenVMS boot devices. The bootable devices are enumerated with VSI OpenVMS device names. The listed devices are those which have passed a series of tests to determine that they contain bootable VSI OpenVMS images.

### Syntax

```
DEVICE [ BOOT | FS | NET | USB | PCI | CTRL | SER | APIC | CPU | LIST]
```

## List of tests

1. Does the device contain a GPT?
2. Does the device contain a properly configured set of three VSI OpenVMS partitions?
3. Is there a UEFI partition among this set?
4. Does the UEFI partition contain VMS_BOOTMGR.EFI?
5. Do the partitions satisfy security checks?

### Note

The scope of devices that the Boot Manager sees during initialization is limited to those for which UEFI drivers are available. Complex storage systems do not always expose their devices to UEFI for booting. Most often, the listed devices will include the system boot device. Note, however, that as VSI OpenVMS boots, it gains additional capability for detecting and enumerating devices. As a result, in some rare cases, the VSI OpenVMS device names may differ from the name that was used during boot.

An optional argument can be provided to the **`DEVICE`** command to filter the type of devices shown.

### Note

The **`DEVICE CPU`** option executes a hardware compatibility test to verify that the system has the necessary features to run VSI OpenVMS. It then continues to decode the CPU ID instruction to list the full feature set of the CPU.

## Arguments

**BOOT [Default]**

Shows bootable VSI OpenVMS devices which have VSI OpenVMS device names assigned. Refer to *Section A.1, "DEVICE, AUTOACTION, and CONVERSATION Commands"* for an example of output for the **`DEVICE`** command.

**FS**

Shows file system devices which have fs*x*: names, whether bootable or not.

**NET**

Shows network devices. Those that support the UNDI Protocol are considered bootable.

**USB**

Shows USB devices.

**PCI**

Shows PCI devices.

The **`DEVICE PCI`** command displays the result of PCI and PCI-E bus scans. Details of each device discovered are displayed. Where possible, vendor and device ID are decoded and a one-line description is displayed.

The vendor and device IDs are used for searching an internal database of known vendors and devices. If a match is found, the database information is displayed. If the vendor or device is unrecognized, the Boot Manager will list it as a *Curious Device* and any embedded identification strings in the device's configuration structures will be displayed.

#### Note

Identification or failure to identify any given device does *not* imply that a VSI OpenVMS device driver exists for the device or that the device is unsupported.

Similar behavior applies to the **`DEVICE USB`** command.

**CTRL**

Shows controller devices.

**SER**

Shows serial port devices.

**APIC**

Shows Advanced Programmable Interrupt Controllers.

**CPU**

Decodes the CPU ID instruction and runs the hardware compatibility test.

**LIST**

Shows greater details of all configured devices.

## DUMPFLAGS

DUMPFLAGS — Similar to boot flags, this set of flags is passed to the dump kernel when it boots. This is to allow developers some further control over dump kernel boot behavior. Not all flags apply to dump kernel operation.

### Syntax

```
DUMPFLAGS
```

## ENV

ENV — Displays a list of currently defined VSI OpenVMS environment variables. If the optional argument is `SAVE`, the current set of values is saved to non-volatile storage and will be restored the next time the Boot Manager is run. If the optional argument is `DELETE`, the environment variables will be deleted and their variables will take default values.

### Syntax

```
ENV [SAVE | DELETE]
```

Environment variables which have changed are automatically saved whenever a **BOOT**, **EXIT**, or **SHELL** command is issued.

#### Important

UEFI environment variable storage is used whenever possible. However, some VMs fail to provide persistence of variables across power cycles. The Boot Manager attempts to store its set of environment variables in both the UEFI non-volatile storage and a file in the UEFI partition named VMS_ENV.DAT. This file is in binary form with security features. If the user attempts to edit the file, it will be deleted by the Boot Manager and a new file will be created. Note too that this creates a requirement for the boot device to be writable. During installations, the environment variables will not be stored.

## EXIT

EXIT — The **EXIT** command exits the Boot Manager and returns to the UEFI shell prompt.

### Syntax

```
EXIT
```

## FLAGS and Message Check Buttons

FLAGS — Displays the current set of boot flags. Boot flags are manipulated through commands and, if in graphical mode, buttons. The optional argument is a set of boot flags specified as a hexadecimal value up to 32-bits wide.

### Syntax

```
FLAGS [arg]
```

Boot flags can also be specified on the UEFI command line when the Boot Manager is launched. For example:

```
Shell> vms_bootmgr DKA0 -fl 2,1
```

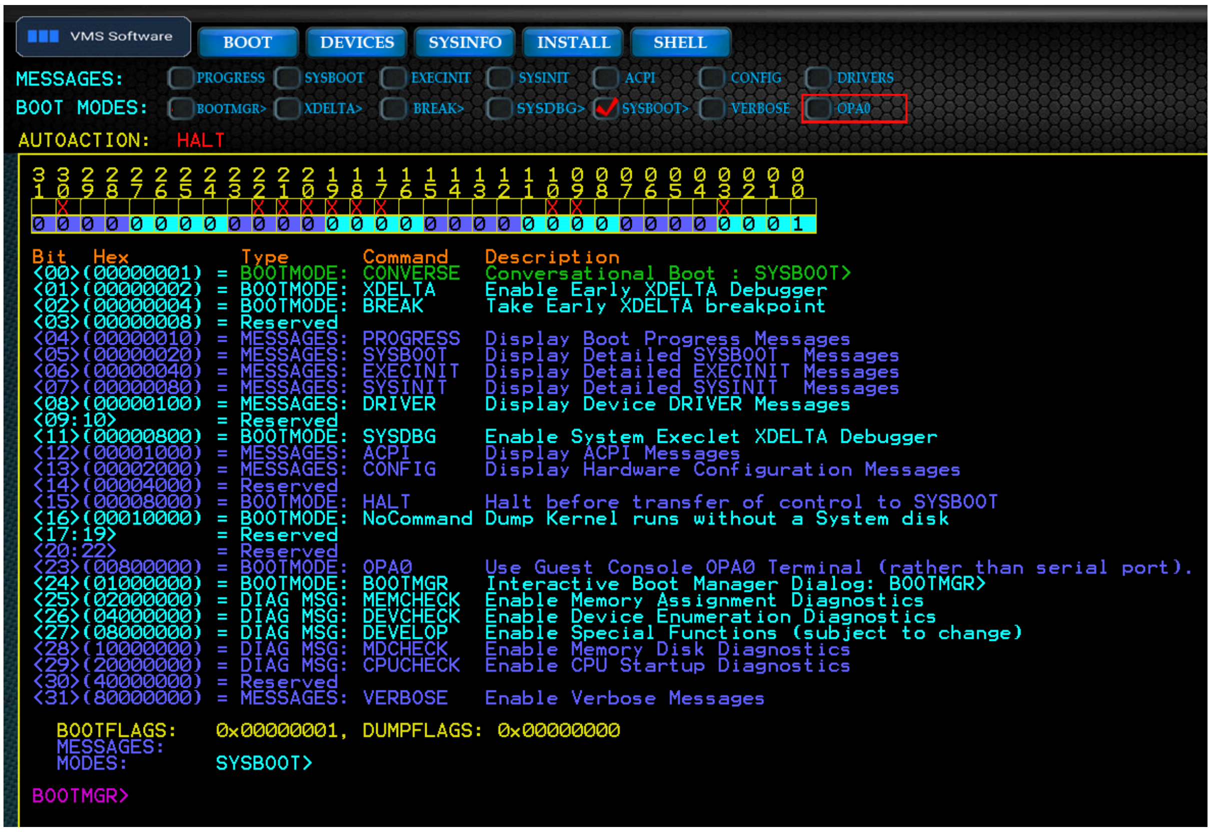
The above command sets the SYSPROMT boot flag (bit <0>) and sets system root to 2.

#### Note

x86-64 Boot Manager and VSI OpenVMS for x86-64 V9.2-2 or higher use a different set of boot flags than prior versions of VSI OpenVMS. In order to have better control over messages, each major phase of the boot process has been assigned its own flag. All phases are also affected by the VERBOSE bit <31> flag, which greatly extends the amount of troubleshooting messages that are displayed during boot and runtime.

The following figure demonstrates the output of the **FLAGS** command, which displays the current set of boot flags. The top row of check buttons also shows the commonly-used boot flags (see below).

**Figure 3.3. The FLAGS Command Showing All Boot Flag Definitions**



```
MESSAGES:     [ ] PROGRESS  [ ] SYSBOOT  [ ] EXECINIT  [ ] SYSINIT  [ ] ACPI      [ ] CONFIG   [ ] DRIVERS
BOOT MODES:   [ ] BOOTMGR>  [ ] XDELTA>  [ ] BREAK>    [ ] SYSDBG>  [✓] SYSBOOT>  [ ] VERBOSE  [ ] OPA0
AUTOACTION:  HALT

3 3 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0
1 0 9 8 7 6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1 0
  X                 X X X X X X               X X           X
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

Bit  Hex           Type        Command    Description
<00>(00000001) = BOOTMODE: CONVERSE   Conversational Boot : SYSBOOT>
<01>(00000002) = BOOTMODE: XDELTA     Enable Early XDELTA Debugger
<02>(00000004) = BOOTMODE: BREAK      Take Early XDELTA breakpoint
<03>(00000008) = Reserved
<04>(00000010) = MESSAGES: PROGRESS   Display Boot Progress Messages
<05>(00000020) = MESSAGES: SYSBOOT    Display Detailed SYSBOOT  Messages
<06>(00000040) = MESSAGES: EXECINIT   Display Detailed EXECINIT Messages
<07>(00000080) = MESSAGES: SYSINIT    Display Detailed SYSINIT  Messages
<08>(00000100) = MESSAGES: DRIVER     Display Device DRIVER Messages
<09:10>          = Reserved
<11>(00000800) = BOOTMODE: SYSDBG     Enable System Execlet XDELTA Debugger
<12>(00001000) = MESSAGES: ACPI       Display ACPI Messages
<13>(00002000) = MESSAGES: CONFIG     Display Hardware Configuration Messages
<14>(00004000) = Reserved
<15>(00008000) = BOOTMODE: HALT       Halt before transfer of control to SYSBOOT
<16>(00010000) = BOOTMODE: NoCommand Dump Kernel runs without a System disk
<17:19>          = Reserved
<20:22>          = Reserved
<23>(00800000) = BOOTMODE: OPA0       Use Guest Console OPA0 Terminal (rather than serial port).
<24>(01000000) = BOOTMODE: BOOTMGR    Interactive Boot Manager Dialog: BOOTMGR>
<25>(02000000) = DIAG MSG: MEMCHECK   Enable Memory Assignment Diagnostics
<26>(04000000) = DIAG MSG: DEVCHECK   Enable Device Enumeration Diagnostics
<27>(08000000) = DIAG MSG: DEVELOP    Enable Special Functions (subject to change)
<28>(10000000) = DIAG MSG: MDCHECK    Enable Memory Disk Diagnostics
<29>(20000000) = DIAG MSG: CPUCHECK   Enable CPU Startup Diagnostics
<30>(40000000) = Reserved
<31>(80000000) = MESSAGES: VERBOSE    Enable Verbose Messages

  BOOTFLAGS:    0x00000001, DUMPFLAGS: 0x00000000
  MESSAGES:
  MODES:        SYSBOOT>

BOOTMGR>
```

## Check Buttons

When operating in graphical mode, common features are represented by rows of check buttons (see *Figure 3.3, "The FLAGS Command Showing All Boot Flag Definitions"*). If a pointing device (mouse or touchpad) is active, the check buttons can be activated as you would expect for a graphical application.

If no pointing device is active, the check buttons can be selected using the **Right** or **Left** arrow keys. The selected button will be outlined in red. To toggle the selected button, press **Enter** or **Escape** keys. If you press any other keys, input focus will return to the command line.

Check buttons differ from push buttons because they visually represent two static states (set or clear). The state of the check buttons is preserved across boots. Each check button corresponds to a pair of commands to set and clear the represented state. These commands use the flag name as the command and the prefix **NO** to clear the flag. For example:

```
BOOTMGR> PROGRESS
```

The above command sets the PROGRESS check button and flag.

```
BOOTMGR> NOPROGRESS
```

This one clears the PROGRESS check button and flag.

Using text commands will toggle the visual state of the check buttons, and using a pointer to toggle the button state will alter the associated flag. The **FLAGS** command will display the current state of the various flags. Only the most commonly used flags have corresponding check buttons.

The top row of check buttons represents the common messaging flags using during VSI OpenVMS boot. They are as follows:

**PROGRESS**

The PROGRESS flag, when set, causes the Boot Manager and VSI OpenVMS to display a number of progress messages during boot. These progress messages are carefully selected and formatted to provide a customer-facing indication of major boot phase transitions. The Boot Manager displays these messages in green.

The PROGRESS flag is boot flag bit <4> (Hex value 00000010).

**NOPROGRESS**

Disables the PROGRESS flag and corresponding messages.

**SYSBOOT**

The SYSBOOT flag, when set, causes the SYSBOOT component to display a number of detailed messages during boot. These messages are carefully selected and formatted to assist with troubleshooting problems during the early boot phase. The Boot Manager displays these messages in light blue. The SYSBOOT flag is boot flag bit <5> (Hex value 00000020).

SYSBOOT is the earliest boot phase where paging, memory management, and system cells are initialized and early execlets are loaded from the MemoryDisk.

**NOSYSBOOT**

Disables the SYSBOOT flag and corresponding messages.

**EXECINIT**

The EXECINIT flag, when set, causes the EXECINIT components to display a number of detailed messages during boot. These messages are carefully selected and formatted to assist with troubleshooting problems during the executive initialization boot phase. The Boot Manager displays these messages in light blue. The EXECINIT flag is boot flag bit <6> (Hex value 00000040).

EXECINIT is the boot phase where page tables are constructed, the remaining execlets are loaded from the system disk (no longer the MemoryDisk), interrupts are enabled, subsystems are initialized, DCL becomes available, and symmetric multiprocessing (SMP) begins.

**NOEXECINIT**

Disables the EXECINIT flag and corresponding messages.

**SYSINIT**

The SYSINIT flag, when set, causes the SYSINIT process to display a number of detailed messages during boot. These messages are carefully selected and formatted to assist with troubleshooting problems during this phase. The Boot Manager displays these messages in light blue. The SYSINIT flag is boot flag bit <7> (Hex value 00000080).

The SYSINIT process is the final boot phase where system and user processes are initiated and the swapper runs.

**NOSYSINIT**

Disables the SYSNIT flag and corresponding messages.

**ACPI**

The ACPI flag, when set, causes the ACPI components to display a number of detailed messages during boot. These messages are carefully selected and formatted to assist with troubleshooting problems during this phase. The Boot Manager displays these messages in light blue. The ACPI flag is boot flag bit <12> (Hex value 00001000).

ACPI (Advanced Configuration and Power Interface) is the boot phase where system devices and their interrupt levels are initialized. Beware that the use of both ACPI and VERBOSE flags creates a huge amount of output.

**NOACPI**

Disables the ACPI flag and corresponding messages.

**CONFIG**

The CONFIG flag, when set, causes the I/O database components to display a number of detailed messages during boot. These messages are carefully selected and formatted to assist with troubleshooting problems during this phase. The Boot Manager displays these messages in light blue. The CONFIG flag is boot flag bit <13> (Hex value 00002000).

CONFIG is the boot phase where peripheral devices are enumerated and drivers are installed. Beware that the use of both CONFIG and VERBOSE flags creates a huge amount of output.

**NOCONFIG**

Disables the CONFIG flag and corresponding messages.

**DRIVER**

The DRIVER flag, when set, causes various device drivers to display a number of detailed messages during boot. These messages are carefully selected and formatted to assist with troubleshooting problems during this phase. The Boot Manager displays these messages in light blue. The DRIVER flag is boot flag bit <8> (Hex value 00000100).

The DRIVER flag invokes verbose output from all participating drivers; note that not all drivers support this flag.

**NODRIVER**

Disables the DRIVER flag and corresponding messages.

## GRAPHICS (Development Feature)

GRAPHICS — Enables diagnostics functions in the graphical mode of operation. Details about the graphical framebuffer and display geometry are provided, then the current pointer coordinates and button-press events are displayed (assuming their movement is reported by UEFI firmware). **`NOGRAPHICS`** disables the graphical mode diagnostic messages.

### Syntax

```
GRAPHICS
```

```
NOGRAPHICS
```

## HALT

HALT — Causes the Boot Manager to halt just prior to transferring control to SYSBOOT. This allows the developer to work with Boot Manager behavior and to view various structures just prior to booting.

### Syntax

```
HALT
```

## HEADLESS

HEADLESS — Disables LINE and page numbering when operating a VM in headless mode. **`NOHEADLESS`** (Default) re-enables LINE and page numbering.

### Syntax

```
HEADLESS
```

```
NOHEADLESS (Default)
```

## HELP

HELP — Displays a list of commands and describes their functions.

### Syntax

```
HELP
```

```
?
```

## INSTALL

INSTALL — The **`INSTALL`** command (and its associated push button) is intended to initiate various installation and update procedures using the VMS_KITBOOT.EFI utility. *This feature is not yet officially supported.*

### Syntax

```
INSTALL
```

## KEYMAP

KEYMAP — Provides a low-level programmer with interpretation of key codes and Unicode characters as they are entered. The BOOTMGR boot flag must also be set to use this diagnostic function.

### Syntax

```
KEYMAP
```

## LABEL

LABEL — Sets the UEFI volume label for the specified disk.

### Syntax

```
LABEL disk-name label
```

The label length must not exceed 12 characters. Underscores, dashes, and dollar signs are allowed. Spaces and quotation marks are *not* allowed.

## LINES

LINES — Displays line numbers along the left of the visible scroll region. **`NOLINES`** removes the display of line numbers.

### Syntax

```
LINES [arg]
```

```
NOLINES
```

When running the Boot Manager from within another system's window, such as when using a hypervisor guest screen window to launch VSI OpenVMS as a guest OS, the Boot Manager may not recognize the size of the parent window. In this case, several scroll region lines may fall beyond the visible window, requiring the user to scroll the parent window.

To solve this, the **`LINES`** command will display line numbers along the left of the visible scroll region. Simply look at the highest visible line number and use it as the optional argument for the same command. For example:

```
BOOTMGR> LINES 30
```

The above command will resize the Boot Manager to display 30 lines. This is a persistent variable.

To return to the maximum number of lines, simply enter an overly-large number of lines and the Boot Manager will adjust to the maximum lines that can be displayed in the current monitor. For example:

```
BOOTMGR> LINES 100
```

This will typically result in a line count of about 45 lines.

**Note**

The Boot Manager itself will only allow specifying the vertical size by number of lines. It does not support horizontal scaling.

## MDCHECK

MDCHECK — Executes MemoryDisk diagnostics. This is intended for development use, but support personnel may suggest this command when troubleshooting various disk structure issues.

### Syntax

```
MDCHECK
```

## MEMCHECK (Diagnostic Feature)

MEMCHECK — Enables extended diagnostics regarding memory allocation and assignment of memory to VSI OpenVMS during boot. Note that this command consumes additional memory and, in some cases, may prevent successful boot. **NOMEMCHECK** disables the MEMCHECK diagnostics.

### Syntax

```
MEMCHECK
```

```
NOMEMCHECK
```

## MOUSESENSE

MOUSESENSE — Adjusts the sensitivity of mouse movement on systems that support mouse events while operating in graphical mode. A value of 1 is the highest sensitivity and 16 is the lowest.

### Syntax

```
MOUSESENSE
```

## OPA0

OPA0 — Sets the OPDISPLAY boot flag (Hex value 800000) invoking the Guest Console terminal utility during boot.

### Guest Console

The Guest Console provides a reduced functionality operator (OPA0:) terminal that does not depend on the presence of a legacy serial port device. This is useful for installation and general management tasks on systems that do not support legacy serial ports or systems where a serial port would interfere with other management features, such as vSphere vMotion.

When set, the boot procedures load the Guest Console driver (SYS$GCDRIVER) which supersedes the serial port driver (SYS$SRDRIVER). After this, the legacy serial port, whether present or not, will not be used. The Guest Console driver assumes control over the Boot Manager graphical framebuffer for display output and the local PS/2 keyboard for input interrupts.

### Syntax

```
OPA0
```

NOOPA0 [1]

## OPTIONS

OPTIONS — As an alternative to entering **BOOT** command arguments, you can also boot from a pre-defined list of **BOOT** commands. These are *not* the same as UEFI boot option variables. UEFI boot option variables get you to the Boot Manager, *not* to a VSI OpenVMS boot device.

[1] Disables the Guest Console, returning to the use of the legacy serial port if present and configured.

## Syntax

```
OPTIONS [arg]
```

## Usage

To use a predefined list of **BOOT** commands, you must first create the list. The list is a simple text file that can be created by the UEFI editor or copied to the system using FTP or other mechanism to get the file into the EFI partition.

The file must be named VMS_OPT.TXT and must reside in the same folder as the OpenVMS Boot Manager is launched from.

The file can contain any number of **BOOT** command lines (minus the keyword **BOOT**). Each command can be followed by a descriptive comment, prefixed by a semicolon. For example:

```
DKA100: 0 1 ; Internal system disk, sysboot flag set, root 0
DKA100: 1 3 ; Internal system disk, xdelta and sysboot flags set, root 1
DGA0: ; Boot DGA0: with default flags and root
```

If the Boot Manager finds this file, the **OPTIONS** command will enumerate and display the list.

To select a listed option, instead of a boot device, enter # followed by the option number in the **BOOT** command. For example:

```
BOOTMGR> BOOT #3
```

The above command will boot the third entry in the list.

This feature is intended to simplify the task of booting many system configurations for test purposes, but it may be useful for other reasons too.

## PAGEMODE

PAGEMODE — Causes the Boot Manager to clear the screen after each page of output is displayed so as to avoid scrolling. **NOPAGEMODE** turns off the PAGEMODE display method and returns to normal line scrolling.

### Syntax

```
PAGEMODE
```

```
NOPAGEMODE
```

When accessing the Boot Manager over certain networked interfaces, such as web-browser-based management applications, text output may scroll slowly. Usage of this command in such cases can improve remote display performance.

As each page is displayed, the tag `<PAGE>` will occur at the bottom of the scroll region. Press the **Enter** key to display the next page.

The Boot Manager will automatically use PAGE mode for command output that spans multiple screens, such as the **HELP** command.

## RESET

RESET — Issues a system reset. This differs from an **EXIT** command in that the platform firmware will reinitialize the system and clear memory.

### Syntax

```
RESET
```

## ROOT

ROOT — Without any argument, displays the current default system root being booted. The optional argument becomes the default system root. This is a persistent variable.

### Syntax

ROOT [*arg*]

## SAVE

SAVE — Forces the save of current environment variable values.

### Syntax

```
SAVE
```

## SHELL

SHELL — The **SHELL** command exits the Boot Manager and returns to the UEFI shell prompt.

### Syntax

```
SHELL
```

## SMBIOS

SMBIOS — Displays and interprets the various System Management BIOS tables. Interpretation is provided according to the official SMBIOS specification. Many vendor-specific tables exist. These are displayed in a raw data form.

### Syntax

```
SMBIOS
```

## SMP (Development Feature)

SMP — Enables multiple processor core enumeration. NOSMP limits the system to a single processor.

### Syntax

SMP [*num-APs*]

```
NOSMP
```

SMP support is available and is enabled by default. To enable SMP, you must first select additional processors in your VM guest setup, then issue the **`SMP`** command in the Boot Manager prior to booting. Once you have issued the **`SMP`** command, it should remain enabled until you issue a **`NOSMP`** command. During boot, you should see a startup message from each secondary processor.

Specifying a number after SMP will limit enumeration to that number of application processors (APs). If no number is specified, the full set of APs will be enumerated.

## SYSINFO

SYSINFO — Displays the Boot Manager build number and date and, optionally, decodes the CPU ID fields and displays APICs, ACPI tables, and SMBIOS tables.

### Syntax

```
SYSINFO
```

## THREADS (Development Feature)

THREADS — Enables processor hyper-thread enumeration. **`NOTHREADS`** disables thread enumeration. By default, threads are not enumerated.

### Syntax

```
THREADS
```

```
NOTHREADS
```

## TIME

TIME — The **`TIME`** command with no argument will display the current UEFI time. Specifying a number of seconds between 1 to 10 after the **`TIME`** command will cause the Boot Manager to issue a delay of that many seconds to each of the viable system clock candidates, displaying their respective counter values. To set the UEFI time, use the ***`time hh:mm:ss`*** command at the `Shell>` prompt.

### Syntax

```
TIME
```

# Chapter 4. Pre-Installation, Installation, and Post-Installation

## 4.1. Installation Target Disk for Virtual Machines

On virtual machines, before performing an installation of VSI OpenVMS from a virtual or physical DVD or a web server, you will need to create an empty virtual disk to become your target system disk. **VSI OpenVMS x86-64 V9.2-2 or higher supports SATA and SCSI disks. Support for other disk types may be added in future releases of VSI OpenVMS x86-64.**[1] Your target system disk should be at least 15 GB.

When you create a new disk, the VSI OpenVMS Boot Manager will see the disk as a block I/O device (blk*x*:) and it will not be given a VSI OpenVMS device name until after VSI OpenVMS installation. Only bootable devices are enumerated. However, once the installation kit is booted, the installation procedure will recognize the empty disk and list it as a potential target disk for the installation.

## 4.2. Virtual DVD

Installing VSI OpenVMS from a virtual DVD is the preferred method of installation. For more details, refer to the Installation Guide for your version of VSI OpenVMS x86-64 (available at docs.vmssoftware.com [https://docs.vmssoftware.com/]).

Whether or not your system has a physical DVD reader attached, you can use a DVD image file as if it were a physical DVD. VSI provides the installation kit as an ISO file, suitable for use as a virtual optical disc or for burning to physical DVD media.

One of the benefits of using ISO standard disc images is that the ISO format is recognized by the hypervisor and no further disk format conversion is required. Simply copy the file to your guest and attach it as an optical disc. Be sure to remove any semicolon and version number when using host systems that do not recognized these file name elements. Some host systems are also case-sensitive, and you may need to use a lowercase file extension (.iso) for the file to be recognized.

## 4.3. Physical DVD

If your VM host has a physical DVD reader attached to your guest, you can use a DVD image file to burn a physical DVD for use in your reader. VMS Software provides the installation kit as an ISO file, suitable for burning to physical DVD media.

Using a suitable DVD burner application, burn the file to a DVD. The file is already in the ISO format and its structure is critical, so burn the file as-is, without any further conversion.

Although the latest release of VSI OpenVMS x86-64 has limited USB support, most VM hosts allow USB DVD readers to be defined as SATA drives on the guest storage setup. This is the recommended configuration.

[1]Refer to the roadmap at http://vmssoftware.com/about/roadmap [https://vmssoftware.com/about/roadmap/] to learn more about planned features.

Insert your new DVD in the reader that you intend to connect to your guest system. Some VM hosts do not recognize a DVD reader until media is inserted.

### Note

Most VM hosts will recognize and accept ISO-format DVDs. However, in some cases, the host OS (notably Windows hosts) will not recognize the DVD but will still allow it to be accessed by the guest. Some hosts may also require the disc image file to have a lowercase (.iso) extension name.

## 4.4. Installing From a Web Server

VSI OpenVMS can be installed from a web server. This feature can be useful when you have many installations to do for systems that may not have DVD readers.

### Note

Web-server-based installation is not the method VSI prefers, but it provides an attractive option for many customers who may already be familiar with the procedures.

For more details, refer to the Installation Guide for your version of VSI OpenVMS x86-64 (available at docs.vmssoftware.com [https://docs.vmssoftware.com/]).

## 4.5. Completing an Installation

### 4.5.1. Terminal Connection

The Boot Manager provides a bridge between the UEFI pre-boot environment and the early phase of system boot (SYSBOOT). Once control is transferred to SYSBOOT, the Boot Manager keyboard is no longer available for input (due to limited USB support in VSI OpenVMS V9.2-2 or higher) and the Boot Manager display shows only XDELTA and operator terminal output. Normal interaction with VSI OpenVMS must occur through remote terminal session connection for both keyboard input and display output.

A variety of terminal utilities can be used with VSI OpenVMS. Telnet, SSH, named pipes, and TCP are the most commonly used methods. It would be impractical to document every known terminal utility, so this document focuses on Telnet and assumes that the user can translate the methods to the terminal utility of their choice.

As a general guideline, VSI OpenVMS assumes control over command processing, so you should enable *character* command mode (as opposed to *line* mode) and disable any functions that would modify the command-line terminators (carriage returns and line feeds). Terminal utilities that attempt to negotiate connection details should be set up to avoid doing so.

In the serial port setup of your VM guest and in your terminal utility, define your named pipe as `\\.\pipe\pipe_name`, where `pipe_name` is simply a unique name you provide. Using named pipes requires that your terminal utility reside on your VM host system. To use named pipes over a different network host, you will need to use a named pipe proxy server.

When the `BOOTMGR>` prompt appears, connect your terminal emulator to your guest. If the Boot Manager does not automatically detect the connection, issuing the following command will initiate command output to the serial port:

```
BOOTMGR> COM 1
```

If you do not establish a connection, VSI OpenVMS will still respond to new terminal connections once booted. You will only miss the Boot Manager messages during boot.

The Boot Manager and UEFI use 115200 baud, 8 bit, 1 stop bit, no parity. It will auto-negotiage other baud rates.

Refer to the *Chapter 7, "Troubleshooting"* section if you have problems establishing a terminal session.

```
VMSBOX gn$ telnet 10.10.XX.XX XXXX
Trying 10.10.XX.XX..
Will send carriage returns as telnet <CR><LF>.
Connected to 10.10.XX.XX.
Escape character is '^]'.


  ENABLED:  Console output to COM1

BOOTMGR>
```

## 4.5.2. Booting the Installation

We recommend setting the PROGRESS message boot flag before proceeding. To set this flag, enter the following command:

```
BOOTMGR> PROGRESS
```

Additional flags will produce more information during the various stages of the boot process.

To initiate the installation boot, enter the command:

```
BOOTMGR> BOOT
```

For an installation, it is not typically necessary to specify a boot device because the installation device will already be the default load device.

If you are performing a web server installation, the default device will always be the MemoryDisk DMM0:.

If you are unsure of the device, use the following command:

```
BOOTMGR> DEVICE
```

This will list the available boot devices and device types. Note that individual disk partitions will have UEFI fs*x*: and blk*x*: device names. Pay attention to those that are listed as bootable VSI OpenVMS devices.

Below is an example of the installation output (output may differ slightly from that shown depending on various factors):

```
Booting...
%VMS_BOOTMGR-I-MAIN,    Allocating Kernel Memory.
%VMS_BOOTMGR-I-SMP,     Enumerating Processors.
%VMS_BOOTMGR-I-MEMDISK, [BLOCKIO] Booting a local ISO/DVD disk.
%VMS_BOOTMGR-I-INSTALL, Booting an OpenVMS Installation Kit...

%VMS_BOOTMGR-I-MEMDISK, Loading ISO image into DMM1. This may take a few minutes...
100%

%VMS_BOOTMGR-I-MEMDISK, Extracting DMM0 from DMM1...
%VMS_BOOTMGR-I-MEMDISK, Extracting SYSBOOT from DMM0...
%VMS_BOOTMGR-I-HWRPB,   Initializing Kernel Data Structures.
```

```
%VMS_BOOTMGR-I-HWRPB,   Initializing HWRPB for Primary Kernel.
%VMS_BOOTMGR-I-HWRPB,   Configuring System Clocks... (~3 second delay)
%VMS_BOOTMGR-I-HWRPB,   Initializing HWRPB for Dump Kernel.


%VMS_BOOTMGR-I-TRANSFER: Starting VSI OpenVMS


%%%%%%%%%%% VSI OpenVMS (tm) x86-64 Console %%%%%%%%%%%

Welcome to VSI OpenVMS SYSBOOT, Baselevel XGS4, built on Oct  7 2024 15:29:35

_______________________________________________

      THE GUEST CONSOLE HAS BEEN SUSPENDED
     USE A TERMINAL UTILITY FOR OPA0 ACCESS
_______________________________________________

VSI Primary Kernel SYSBOOT

%SYSBOOT-I-VMTYPE, Booting as a VMware (tm) Guest

%SYSBOOT-I-MEMDISKMNT, Boot memory disk mounted
%SYSBOOT-I-LOADFILE, Loaded file [SYS0.SYSEXE]X86_64VMSSYS.PAR

%SYSBOOT-I-MEMDISKDISMNT, Boot memory disk dismounted
%SYSBOOT-I-ALLOCMAPBLT, Allocation bitmap built
%SYSBOOT-I-MAP_MD, Boot MemoryDisk remapped to S2 space
%SYSBOOT-I-MAP_SYSMD, System MemoryDisk remapped to S2 space

%SYSBOOT-I-MEMDISKMNT, Boot memory disk mounted
%SYSBOOT-I-ALLOCPGS, Loader huge pages allocated
%SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYSLIB]SYS$PUBLIC_VECTORS.EXE
%SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYS$BASE_IMAGE.EXE
%SYSBOOT-I-LOADSYSIMGS, Base system images loaded
%SYSBOOT-I-INITDATA, Key system data cells initialized
%SYSBOOT-I-ALLOCERL, Allocated Error Log Buffers
%SYSBOOT-I-POOLINIT, Created Paged and Nonpaged Pools
%SYSBOOT-I-PXMLCOPY, Copied PXML Database to S2 space
%SYSBOOT-I-CREATECPUDB, Created the CPU Database
%SYSBOOT-I-REMAP, Moved HWRPB and SWRPB to system space
%SYSBOOT-I-CPUID, Gathered CPUID information
%SYSBOOT-I-REMAPIDT, Remapped IDT to system space
%SYSBOOT-I-INITCPUDB, Initialized Primary CPU Database
%SYSBOOT-I-INITGPT, Initialized Global Page Table
%SYSBOOT-I-PFNMAP, Created PFN Memory Map
%SYSBOOT-I-CREATEPFNDB, Created PFN Database

%SYSBOOT-I-UEFIREMAP, Remapping UEFI Services...
%SYSBOOT-I-UEFIRUNVIRT, Enabling Virtual Runtime Services.
%SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYS$PLATFORM_SUPPORT.EXE
%SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]ERRORLOG.EXE
%SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYS$ACPI.EXE
%SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYSTEM_PRIMITIVES_MIN.EXE
%SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYSTEM_SYNCHRONIZATION.EXE
%SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYS$OPDRIVER.EXE
%SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]EXEC_INIT.EXE
%SYSBOOT-I-LOADEXEC, Execlets loaded
%SYSBOOT-I-PARMSCOPIED, System parameters copied to the base image
%SYSBOOT-I-TRANSFER, Transferring to EXEC_INIT at: ffff8300.64b50f00
EXE$INIT_RAD_INFO: Start
    SGN$GL_RAD_SUPPORT = 00000000


VMS Software, Inc. OpenVMS (TM) x86_64 Operating System, V9.2-3
                    Copyright 2024 VMS Software, Inc.
```

```
  MDS Mitigation active, variant verw(MD_CLEAR)

%SYSBOOT-I-MEMDISKMNT, Boot memory disk mounted

                                                %SYSBOOT-I-MEMDISKMNT, Boot memory
 disk mounted

              %SYSBOOT-I-MEMDISKMNT, Boot memory disk mounted
                                                              %GPS-I-ACPI_SUPPORT,
 Initializing ACPI Operating System Layer...
%GPS-I-ACPI_SUPPORT,  Configuring IOAPICs...
%GPS-I-ACPI_SUPPORT,  Configuring ACPI Devices...

%SYSBOOT-I-MEMDISKMNT, Boot memory disk mounted
                                                %GPS-I-ACPI_SUPPORT,  Configuring GPE
 Blocks...
%GPS-I-ACPI_SUPPORT,  Configuring ACPI CPUs...

%SYSBOOT-I-MEMDISKDISMNT, Boot memory disk dismounted

%SRDRIVER-I-INITDRV, Serial Port Console owns OPA0 keyboard & display.
EXE$INIT_RAD_DATA: Start
```

Refer to *Section A.4, "Progress Messages on Guest Display After BOOT"* for an alternative example of installation output.

### 4.5.3. VSI OpenVMS Installation Menu and Post-Installation Steps

As the boot proceeds, you will eventually reach the VSI OpenVMS installation menu. At this point, the installation procedures are similar to a traditional installation. You will be prompted to select your target device to install to and any optional kits you wish to install.

**Note**

Refer to the Installation Guide for your version of VSI OpenVMS x86-64 (available at docs.vmssoftware.com [https://docs.vmssoftware.com/]) for full details of this process.

# Chapter 5. Device Enumeration

## Important

Device Enumeration is an evolving process as support is added for additional device types and more complex controller configurations. SATA, Fibre Channel (FC), SAS, and SCSI are enumerated. If device enumeration is inaccurate, you can still boot a device using its UEFI file system device identifier (i.e. **`BOOT fs2:`**) instead of the VSI OpenVMS device name. Please report any configurations that result in such inaccuracies to VSI support representatives.

## 5.1. Scope of Device Scan

A feature of the Boot Manager is to support VSI OpenVMS device names when booting. This avoids the need to associate a UEFI file system device (e.g., fs0:, fs5:, etc.) with a VSI OpenVMS device. You can still specify a UEFI file system device at the **`BOOT`** command if you choose to (i.e. `BOOTMGR> BOOT fs0`), but you can also use the enumerated VSI OpenVMS device name (i.e. `BOOTMGR> BOOT DKA100`).

It is important to note that UEFI firmware has limited visibility into complex storage configurations. Your boot device must fall within the scope of devices that are visible to UEFI firmware. It is entirely possible that devices which reside on complex storage arrays may not be visible to UEFI and only be discovered once VSI OpenVMS has found them and loaded drivers for them.

On IA-64 systems, you needed to select the UEFI file system device before invoking the VMS_LOADER.EFI utility. This is not the case for the x86-64 architecture. The VSI OpenVMS Boot Manager is a completely stand-alone utility which is not tied to a specific version of VSI OpenVMS. You can run any version of the Boot Manager from any UEFI file system device and invoke a boot from a different device. The only reason to explicitly specify a UEFI file system device first is if you want to use a specific Boot Manager or startup procedure located on that device. While Boot Manager versions may be compatible as far as basic booting goes, they will evolve to provide additional features.

When the Boot Manager evaluates devices, it looks for those devices which support UEFI file I/O protocol. It then probes each of these devices to see if the device contains a VSI OpenVMS UEFI partition, that the partition contains the necessary files to boot VSI OpenVMS, and that it passes a few other integrity checks. Only after passing these validation steps does the Boot Manager attempt to enumerate the device with a VSI OpenVMS device name. Devices that fail validation will still be displayed as block I/O devices but are not considered bootable.

To list bootable devices, issue the following command:

```
BOOTMGR> DEVICE
```

Add one of the following qualifiers to filter the list of devices:

**FS**

Lists all disk devices supporting the file I/O protocol (whether or not bootable)

**BOOT**

Lists all devices which contain bootable VSI OpenVMS images

**USB**

Lists all USB devices

**PCI**

Lists all PCI devices

**LIST**

Displays extended info about all devices

**CPU**

Displays extended info about the processor chip and performs a hardware compatibility check

When network devices are displayed, those that indicate support of the UNDI Protocol are also considered bootable.

The **DEVCHECK** diagnostic command will re-execute a PCI-E bus scan and display details of device enumeration.

## 5.2. VSI OpenVMS Device Naming Peculiarities

The Boot Manager attempts to enumerate devices in accordance with the way the operating system does, but there are some unavoidable exceptions to this which may result in a boot device changing names once VSI OpenVMS has re-enumerated devices. For example, DKA0 may become DKA100: once VSI OpenVMS applies certain topology rules.

Virtual machines have introduced yet further difficulty in device naming. For example, a USB-based DVD Reader may appear as a SATA disk under VirtualBox. Therefore, instead of assigning a VSI OpenVMS USB device name that always begins with DN, it will receive a name prefixed with DK.

Network devices are particularly difficult to enumerate because the various device name prefixes are not based on features which are accessible through firmware methods. The current Boot Manager implementation enumerates network devices as UEFI devices (NET0, NET1, etc.). If the network device downloaded a MemoryDisk, then the device itself will appear as DMM0:. Network devices will take official VSI OpenVMS names once VSI OpenVMS is booted.

## 5.3. USB Device Enumeration

USB devices have their own set of issues when it comes to assigning VSI OpenVMS device names. When USB was first supported by VSI OpenVMS, a simple sequential number was assigned to each device and the UCM (USB Configuration Manager) utility was created to match devices, drivers, and unit numbers based on embedded serial numbers of the devices.

Assigning USB device names based on physical topology solves some of the naming issues, but introduces a few new ones. For example, the USB architecture supports up to seven levels of hubs, but the spec goes on to state that you would most certainly run out of power long before reaching such a full configuration. It is unlikely that VSI OpenVMS customers would configure more than a small hierarchy of USB hubs and devices. Supporting a topology-based naming scheme capable of representing the full hierarchy would require significant changes to key data structures, but we can accommodate up to four levels of hub hierarchy within the bounds of existing structures.

The Boot Manager has implemented this type of topology-based USB device naming. On x86-64 systems, USB support is limited.

## Note

A common issue exists where the user is inadvertently executing the OpenVMS Boot Manager from a DVD. This usually occurs after an installation, if the user has not disconnected the optical disk storage or is simply not aware of where the OpenVMS Boot Manager was launched from. Although the OpenVMS Boot Manager will run from a optical disk, the write-locked media will not allow for write access to environment files, which may adversely impact some features. To avoid this confusion, pay attention to the first display screen when the OpenVMS Boot Manager is launched. It will show a `BOOT MANAGER DEVICE`, which is the disk where the current Boot Manager has been launched from, and a `DEFAULT BOOT COMMAND`, which is the disk and command that will be executed if a simple **`BOOT`** command is issued.

Typical USB device names may appear as follows:

**DNA0**

Storage device on USB controller A, Hub L0 (implied), End Port 0

**DNB7**

Storage device on USB controller B, Hub L0 (implied), End Port 7

**DNA14**

Storage device on USB controller A, Hub L1 Port 1, End Port 4

**DNC024**

Storage device on USB controller C, Hub L2 Port 0, Hub L1 Port 2, End Port 4

**DNA7777**

Storage device on USB controller A, Hub L3 Port 7, Hub L2 Port 7, Hub L1 Port 7, End Port 7

The last example above illustrates the maximum four-level hub hierarchy (per controller) that can be accommodated by this scheme and existing data structures. There are pros and cons of implementing a topology-based scheme for USB, but this one is closer to the way other devices are enumerated and it ensures that a device inserted into a specific port will always receive the same device name. As always, VSI OpenVMS will assign logical names and prefixes to these names with additional details if the device is cluster mounted.

# Chapter 6. Dump Kernel

## 6.1. Crash Dump Kernel

VSI OpenVMS x86-64 implements a new way of quickly saving memory contents for subsequent analysis and returning the system to service. Crash processing is performed using a second instance of the operating system kernel, known as the dump kernel.

### 6.1.1. Dump Kernel Overview

The dump kernel is a limited-functionality VSI OpenVMS kernel designed to handle crash dump data collection, compression and storage.

During boot, the dump kernel is created in parallel with the primary kernel. It resides in a separate memory space and shares the MemoryDisk. The dump kernel requires only 512 MB of memory.

The MemoryDisk remains in memory after the primary kernel is booted and the device associated with the MemoryDisk (DMM0:) is set offline and write-protected. A logical disk device LDM*n*: (where *n* is a device number) is created during boot, to allow access to files residing in the MemoryDisk using symlinks.

Having a second kernel for crash dump processing reduces the dependency on the crashing system and allows for greater flexibility in collecting, compressing, and writing to the dump device(s) using runtime drivers. VSI OpenVMS x86-64 does not use the traditional boot drivers.

The dump kernel is loaded, but does not boot until the primary kernel encounters a bugcheck. The bugcheck process prepares the crashing system (halting processors, identifying important areas of memory, etc.), transfers control to the dump kernel's SYSBOOT image, and then the dump kernel boots.

The dump kernel, being resident in memory, boots quickly. A dump kernel-specific startup procedure ([SYSEXE]SYS$DUMP_STARTUP.COM) executes the dump kernel's main image ([SYSEXE]SYS$DUMP_KERNEL.EXE). The dump kernel maps and collects the important areas of memory, compresses and writes the data to the dump file SYSDUMP.DMP for later analysis.

Once the crash dump has been processed and the dump file has been written, the dump kernel will invoke a power off or system reset to restart the primary kernel and re-arm a new instance of the dump kernel.

The dump kernel has a few new system parameters to control its operation. These are described in following sections.

### 6.1.2. Preparing a Dump Device

To create a dump file on your system disk, use SYS$UPDATE:SWAPFILES.COM. When the command procedure requests a file size, start with 200,000 blocks (extend as needed).

---

**Note**

You can ignore the message about rebooting. If the dump file exists, it will be used.

---

To create a dump file on a different disk, use the following procedure. In this example, we will use `DKA100:` and system root 0 (`SYS0`):

```
$ CREATE/DIRECTORY DKA100:[SYS0.SYSEXE]
$ MCR SYSGEN
SYSGEN> CREATE DKA100:[SYS0.SYSEXE]SYSDUMP.DMP/SIZE=200000
SYSGEN> EXIT
```

### 6.1.3. Specifying One or More Dump Devices

Crash dumps can be written to the system disk or to one or more designated dump devices. In prior releases of VSI OpenVMS, designating dump devices was accomplished through UEFI environment variables. For VSI OpenVMS x86-64, we have chosen to minimize their use. Instead, specify your dump device using the DCL command **`SET DUMP_OPTIONS`**:

```
$ SET DUMP_OPTIONS/DEVICE=DKA100:
```

Use a comma-separated list to specify additional dump devices:
**`/DEVICE=(`*`ddcu`*`:,`*`ddcu`*`:,`*`ddcu`*`:)`**

The changes are effective immediately. A reboot is not necessary.

### 6.1.4. Control Parameters

The SYSGEN parameter DUMPSTYLE must be set. VSI OpenVMS V9.2-x supports only *selective* (bit 0) and *compressed* bit (3) dump features. Setting DUMPSTYLE to 9 enables these features for a dump to the system disk. Dumping to a non-system disk is always enabled, and there is no need to set bit 2 in DUMPSTYLE.

```
$ MCR SYSGEN
USE CURRENT
SET DUMPSTYLE 9
WRITE ACTIVE
WRITE CURRENT
EXIT
```

No reboot is required after changing dump control parameters if **`WRITE ACTIVE`** is included in the SYSGEN dialogue.

### 6.1.5. Automatic Actions

When the dump kernel completes its tasks, it will execute a user-specified automatic action to restart or power off the system. Several parameters are involved in defining this behavior. The following is a description of how these parameters interact.

The flags OPC$REBOOT and OPC$POWER_OFF are set or cleared in response to SHUTDOWN parameters (or answers to SHUTDOWN prompts).

- If OPC$REBOOT is set at shutdown (Operator Requested Shutdown is a form of bugcheck) or SYSGEN parameter BUGREBOOT is set during any other form of bugcheck, the system will be reset and will return to the UEFI `Shell>` prompt.

  Be aware that any automatic actions established for UEFI and the Boot Manager will then occur.

  Automatic reboot is achieved by invoking VMS_BOOTMGR in STARTUP.NSH and setting AUTO BOOT in VMS_BOOTMGR.

- If OPC$POWER_OFF is set at shutdown, the system or virtual guest will be powered off.

- If both OPC$REBOOT and OPC$POWER_OFF are set (an illogical combination), the system or virtual guest will be reset and any automatic actions will be taken.
- If neither OPC$REBOOT or OPC$POWER_OFF are set at shutdown and the SYSGEN parameter BUGREBOOT is not set when any other bugcheck occurs, the operator will be prompted to press any key to reset the system and return to the UEFI `Shell>` prompt. In other words, with no automatic action specified, the system will wait for an operator. The operator can then decide whether to allow or abort any subsequent automatic actions from UEFI (STARTUP.NSH) and the Boot Manager (AUTO BOOT).

## Note

This assumes that a terminal session on the COM1 port is available for keyboard input.

Additional failure modes are handled by performing a system reset to the UEFI shell and any specified automatic actions that follow. These failure modes include:

- The primary kernel fails to start the dump kernel.
- The dump kernel itself, bugchecks.
- The dump kernel image fails and OPCCRASH gets started.

Crash analysis is beyond the scope of this guide. The traditional VSI OpenVMS crash analysis tools are available. For more information, refer to the *VSI OpenVMS System Analysis Tools Manual* [https://docs.vmssoftware.com/vsi-openvms-system-analysis-tools-manual/] (in particular, the **`ANALYZE/CRASH_DUMP [`*`filespec`*`]`** command).

# Chapter 7. Troubleshooting

Instruction level debugging is available using XDelta or Delta debuggers and code listings. Many other features are available to enable extended messages, run diagnostic tests, and so on.

The following sections detail a few troubleshooting tools. Contact VMS Software for any assistance you may need.

## 7.1. XDelta

The XDelta debugger may be helpful to low-level programmers (for additional information, refer to the *VSI OpenVMS Delta/XDelta Debugger Manual* [https://docs.vmssoftware.com/vsi-openvms-deltaxdelta-debugger-manual/]). VMS Software has implemented several XDelta extensions that can help with page table related issues among other things. These extensions are undocumented, but information is available through VSI Support.

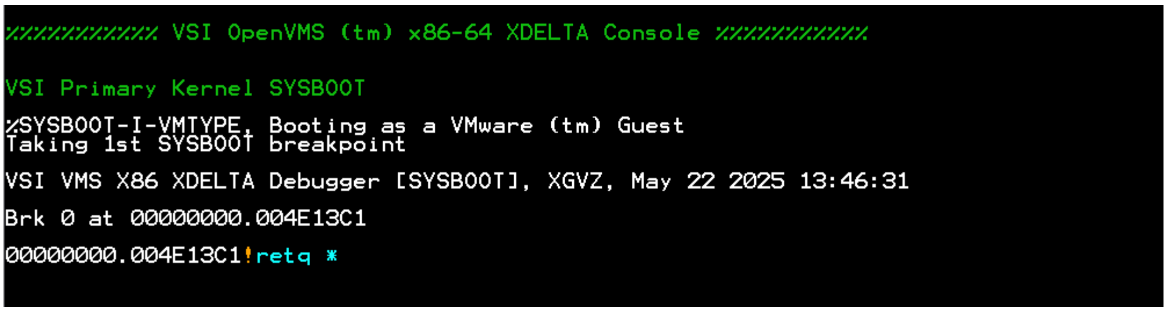
There are two types of XDELTA:

- XDELTA is compiled into the primary bootstrap program SYSBOOT.EXE for use during the early boot stages where the system is transitioning from physical to virtual addressing. To invoke this early XDELTA, issue the following commands prior to booting:

  ```
  BOOTMGR> XDELTA
  BOOTMGR> BREAK
  ```

  This will enable the debugger and take the first available breakpoint inside SYSBOOT.EXE.

  **Figure 7.1. XDELTA + BREAK**

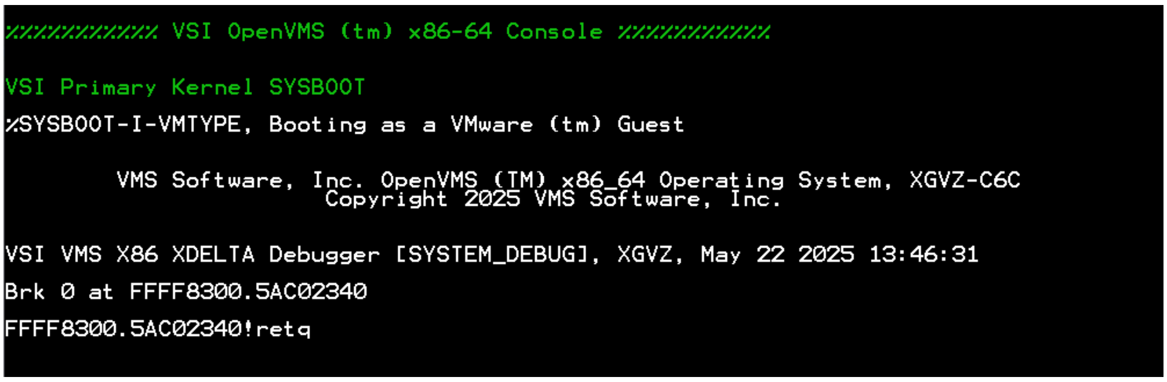
  ```
  %%%%%%%%%%% VSI OpenVMS (tm) x86-64 XDELTA Console %%%%%%%%%%%

  VSI Primary Kernel SYSBOOT

  %SYSBOOT-I-VMTYPE, Booting as a VMware (tm) Guest
  Taking 1st SYSBOOT breakpoint

  VSI VMS X86 XDELTA Debugger [SYSBOOT], XGVZ, May 22 2025 13:46:31

  Brk 0 at 00000000.004E13C1

  00000000.004E13C1!retq *
  ```

- XDELTA (aka SYSDBG) also exists as a loadable executive image. This allows it to be used on programs that run in virtual address space including drivers. To invoke the loadable XDELTA, issue the following commands prior to booting:

  ```
  BOOTMGR> SYSDBG
  BOOTMGR> BREAK
  ```

  This will load the debugger and take the first available breakpoint inside EXECINIT.EXE. If you prefer to take breakpoints inside program modules, insert INI$BRK() calls in your sources.

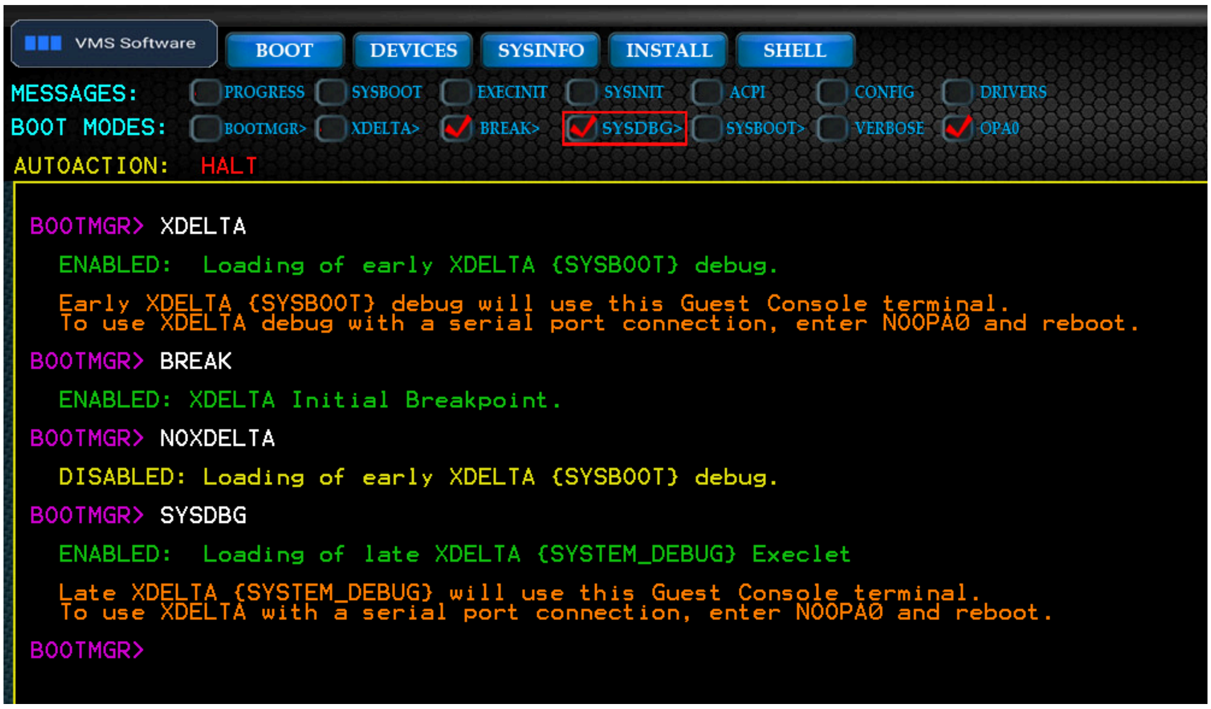
**Figure 7.2. SYSDBG + BREAK**



```
%%%%%%%%%%% VSI OpenVMS (tm) x86-64 Console %%%%%%%%%%%

VSI Primary Kernel SYSBOOT
%SYSBOOT-I-VMTYPE, Booting as a VMware (tm) Guest

        VMS Software, Inc. OpenVMS (TM) x86_64 Operating System, XGVZ-C6C
                       Copyright 2025 VMS Software, Inc.

VSI VMS X86 XDELTA Debugger [SYSTEM_DEBUG], XGVZ, May 22 2025 13:46:31
Brk 0 at FFFF8300.5AC02340
FFFF8300.5AC02340!retq
```

The screenshot below shows the enabling of early XDELTA, then disabling it and enabling the *loadable XDELTA* instruction level Debugger.

**Figure 7.3. Booting With XDELTA**



```
MESSAGES:    PROGRESS  SYSBOOT  EXECINIT  SYSINIT  ACPI  CONFIG  DRIVERS
BOOT MODES:  BOOTMGR>  XDELTA>  [✓ BREAK>]  [✓ SYSDBG>]  SYSBOOT>  VERBOSE  [✓ OPA0]
AUTOACTION:  HALT

BOOTMGR> XDELTA
  ENABLED:  Loading of early XDELTA {SYSBOOT} debug.

  Early XDELTA {SYSBOOT} debug will use this Guest Console terminal.
  To use XDELTA debug with a serial port connection, enter NOOPA0 and reboot.
BOOTMGR> BREAK
  ENABLED: XDELTA Initial Breakpoint.
BOOTMGR> NOXDELTA
  DISABLED: Loading of early XDELTA {SYSBOOT} debug.
BOOTMGR> SYSDBG
  ENABLED:  Loading of late XDELTA {SYSTEM_DEBUG} Execlet

  Late XDELTA {SYSTEM_DEBUG} will use this Guest Console terminal.
  To use XDELTA with a serial port connection, enter NOOPA0 and reboot.
BOOTMGR>
```

## 7.2. Boot Manager Startup

The Boot Manager provides diagnostic messages to help troubleshoot any problems that affect the loading and initialization of the system prior to transfer to SYSBOOT.EXE.

### Note

Once the first SYSBOOT message appears, the Boot Manager's job is over and system debugging tools are required for further problem analysis.

To set the Boot Manager interaction flag, issue the following command:

```
BOOTMGR> BOOTMGR
```

This will enable messages with details of the early boot process up to the transfer of control to SYSBOOT.EXE. Along with additional messages, the user will be prompted for examination of key data structures related to boot.

In rare cases where the Boot Manager has trouble relocating images, setting the BOOTMGR and VERBOSE flags together will display intricate details of image relocation. Note, however, that this is time-consuming and generates large amounts of output.

The Boot Manager evaluates and allocates memory very early after being launched and again just before transfer of control to SYSBOOT.EXE, when the memory map is finalized. To observe further details pertaining to memory mapping, prior to booting, issue the command:

```
BOOTMGR> MEMCHECK
```

To prevent booting in order to use this diagnostic, issue the following command:

```
BOOTMGR> HALT
```

The Boot Manager evaluates potential boot devices very early after being launched and again when the system is being booted. To observe further details pertaining to device discovery and enumeration, issue the **`DEVCHECK`** command.

Additional device related information can be obtained from the following commands:

```
BOOTMGR> DEVICE PCI
BOOTMGR> DEVICE USB
BOOTMGR> DEVICE LIST
```

Logging of Boot Manager messages must be done through a connected terminal emulator. The Boot Manager does not itself provide logging features.

If you wish to capture a Boot Manager screenshot, you can press the **F1** key at any `BOOTMGR>` or `PAGE` prompt, and a bitmap file named SNAPSHOT.BMP will be saved to the root UEFI file system device (fs0:, etc.). Only one file will be saved at a time and is overwritten each time **F1** is pressed.

## 7.3. MemoryDisk

The MemoryDisk (SYS$MD.DSK) is a logical disk container file which is critical for booting as it contains all of the files that comprise a minimum bootable VSI OpenVMS kernel. The structure and custom boot block used during boot are critical and should not be tampered with.

The MemoryDisk is initialized and maintained by a system command procedure SYS$UPDATE:SYS$MD.COM. This procedure is run during installation and again in the event that a file contained in the MemoryDisk is updated through a PCSI kit or patch installation. This is done automatically by the various utilities that modify the MemoryDisk. The procedure takes great care to maintain the integrity of the MemoryDisk, as well as the symlinks that are used by the OS when referencing these files.

The **`MDCHECK`** command enables additional messages and debugging features involving MemoryDisk operations. This can be useful to support engineers when investigating boot problems.

### Caution

Since the MemoryDisk itself is a bootable entity, located inside the system disk and having three partitions of its own, there are several critical boot blocks and related structures involved in booting. Use care to avoid renaming or relocating the files: SYS$MD.DSK (the MemoryDisk) or SYS$EFI.SYS (the UEFI partition) on the system disk. Additionally, avoid putting files in or removing them from within the MemoryDisk or UEFI partition. Corruption of either of these container files may result in an unbootable system.

## 7.4. Network/Web Server and VMS_KITBOOT

Many things can interfere with network booting. When you initially launch VMS_KITBOOT.EFI, it will attempt to identify available network adapters. Failing to locate a suitable adapter is a clear sign that your guest network is not properly configured. Verify that you have defined a network adapter and that your host is able to access the network itself since all network traffic ultimately passes through the host.

VMS_KITBOOT requires that your target system be on a network segment with a DHCP Server. Lack of a DHCP Server is one of the most common problems reported.

If you guest adapter appears to be properly configured but still fails to respond, try changing your adapter type from Bridged Adapter to NAT or vice versa. If this does not resolve the problem, seek assistance from a network administrator or other sources familiar with your chosen hypervisor.

The VMS_KITBOOT.EFI utility is based on the open-source iPXE software. When this underlying software encounters an error, it displays a URL and error code. If you enter this URL and code into a web browser, it will take you to a brief explanation of the error. While these messages are not always detailed, they may point you in the right direction for solving connection issues.

Once VMS_KITBOOT.EFI has selected a network adapter, it attempts to locate a web server at the IPv4 address that you provided in response to the prompt. The full URL of this request must coincide with your web server setup.

This implies that you have a web server running at this IP address, that you have the corresponding project folder/directory named, that the installation files have been copied to this folder/directory, and that file protection allows for read access. If this file is correctly located and received by VMS_KITBOOT, then the Boot Manager should be downloaded and displayed.

If the kit download fails, make sure you have provided enough memory to your guest. 8 GB is the recommended minimum, but during installation it may help to increase memory. If this solves the problem, you can always reduce memory after installation.

Another thing that can cause the network installation to fail is if any of the files were downloaded from the Service Portal and then copied to your system using the wrong FTP mode (binary versus ASCII). Files of type .ISO, .EFI, and .BMP are *binary* files. Note too that some web servers do not work with files having VSI OpenVMS version numbers, and you will need to rename these files to remove the version number and semicolons. Some web servers are also case-sensitive.

The VSI OpenVMS installation kit is a large file and may take several minutes to download to your guest.

## 7.5. Problems After Transfer to VSI OpenVMS

If you are able to download and execute the VMS_BOOTMGR.EFI utility but it appears to hang when you issue a **BOOT** command, try restarting your guest and setting the various message-related boot flags to get an indication of how far the boot progresses before hanging. The PROGRESS, SYSBOOT, and EXEC flags should help.

If you think the Boot Manager has not transferred control to SYSBOOT, set the BOOTMGR flag too. If you see even a single message from SYSBOOT or EXECINIT, then you have progressed beyond the Boot Manager's role. If it appears that your system hangs when discovering devices, you might set the CONFIG and ACPI boot flags.

The VERBOSE mode flag will enable extended messages in many cases, but be prepared to log a large amount of information. Avoid using the VERBOSE and BOOTMGR flags together, as this results in a very slow boot process and an extremely large amount of message data output.

If you cannot determine why the boot is failing, contact VSI Support for assistance.

## 7.6. Terminal Emulator Tips

When you are in the Boot Manager and before proceeding with the installation of VSI OpenVMS x86-64, you are required to access the system either via the new Guest Console feature (see this section on the Guest Console [https://docs.vmssoftware.com/vsi-openvms-x86-64-v923-release-notes/#guestConsole]) or through a serial port connection with a terminal emulator (such as PuTTY). The latter option is discussed in detail below.

The Boot Manager and the kitboot utility can use terminal emulators and serial ports for input and output. Establishing a remote terminal connection is essential if you intend to use XDelta and as a general user. The logging feature of your terminal emulator provides the recommended way to obtain a log file of your entire boot process should that be necessary.

The Boot Manager and VSI OpenVMS want control of the terminal characteristics. Most of the issues with setting up a terminal utility involve command modes and line terminations.

For best results, a terminal session should be in character mode, as opposed to line mode. This ensures that each character is transmitted as it is entered. This is particularly important when using a debugger since they tend to have single-character command interpreters.

Additionally, avoid having your terminal utility modify line terminators, carriage returns, and line feeds. Let VSI OpenVMS handle the terminators. Lastly, where possible, disable protocol negotiations. A Telnet connection generally involves a negotiation sequence unless explicitly disabled, whereas a Raw connection has no such issues.

When using Telnet, if you have problems entering a system password during installation, check your terminal settings and clear the **Return key sends Telnet New Line instead of ^M** checkbox.

### 7.6.1. Terminal Connection Sequence

Some terminal emulators will attempt to take ownership of a serial port if it is not already in use. If this happens, the VMS_KITBOOT procedure or the VMS_BOOTMGR utility may consider the port as unavailable and fail to make a connection.

If this occurs, you need to follow a specific sequence when connecting:

1. If using a VM, start your guest and launch VMS_BOOTMGR.EFI from the UEFI shell.
2. When you reach the `BOOTMGR>` prompt, start your terminal emulator.
3. Connect using a Raw or Telnet session.
4. You should now see the `BOOTMGR>` prompt in your emulator. Input from the graphical console session should be functional. If this isn't working, try issuing the command:

```
BOOTMGR> COM 1
```

If this still doesn't establish a connection, review the TCP port you have assigned to COM1. Refer to the following sections for specific emulator details or contact VSI Support for assistance.

### 7.6.2. Using the PuTTY Terminal Emulator

If you wish to direct console I/O to a system running Microsoft Windows, VSI recommends using the PuTTY terminal emulator. You can download PuTTY from http://putty.org. While VMS Software tests with PuTTY, other terminal utilities are also available.

Depending on how the system you are running your terminal emulator on is connected to the target system, you should select a Raw or Telnet session. The Raw option works well with VSI OpenVMS. If using Telnet, you will need to adjust various settings described below to avoid duplicate output and line termination issues.

PuTTY has several features that allow for control of your session. If you are working remotely using a SSH connection through your VPN, make sure that the IP address forwarding option is enabled (typically it is by default).

Set up your PuTTY session as follows: [1]

1. Right-click on the window frame of your PuTTY session and select **Change Settings...**.

   In **Terminal settings**, check the following boxes:

   - Turn off Implicit CR in every LF
   - Turn off Implicit LF in every CR
   - Turn off Local Echo
   - Turn off Local line editing

2. In **Window settings**, set your columns and rows to match the Boot Manager display (typically 120 columns, 40 rows).

3. Depending on the connection type, the following settings should be used:

   **Raw** (recommended)

| Category | Setting | Value |
|---|---|---|
| Session | Connection type | Raw |
| Terminal | Implicit CR in every LF | Unchecked |
| Terminal | Implicit LF in every CR | Unchecked |
| Terminal | Local echo | Force off |
| Terminal | Local line editing | Force off (character mode) |

   **Telnet** [2]

[1]VMS Software recommends the following settings. However, you may need to experiment in order to find the appropriate settings for your terminal emulator.

[2]As there is no Telnet server on the virtual machine host for the console communication, it is not literally a Telnet connection, but it can be used because not all terminal emulators support a Raw connection.

| **Category** | **Setting** | **Value** |
|---|---|---|
| Session | Connection type | Telnet |
| Connection > Telnet | Telnet negotiation mode | Switch from **Active** to **Passive**. This yields a connection to a PuTTY window. |
| Connection > Telnet | Telnet negotiation mode | Uncheck **Return key sends new line instead of ^M** |

4. If you are using a serial (cabled) session:

   - Speed: 115200
   - Data Bits: 8
   - Stop Bits: 1
   - Parity: None
   - Flow Control: XON/XOFF

If you are using Telnet with XDelta, you need to put Telnet into character mode in order to avoid having to hit **Return** after every XDelta command. This can be done via the following command:

```
telnet> mode char
```

To return to line mode, issue the command:

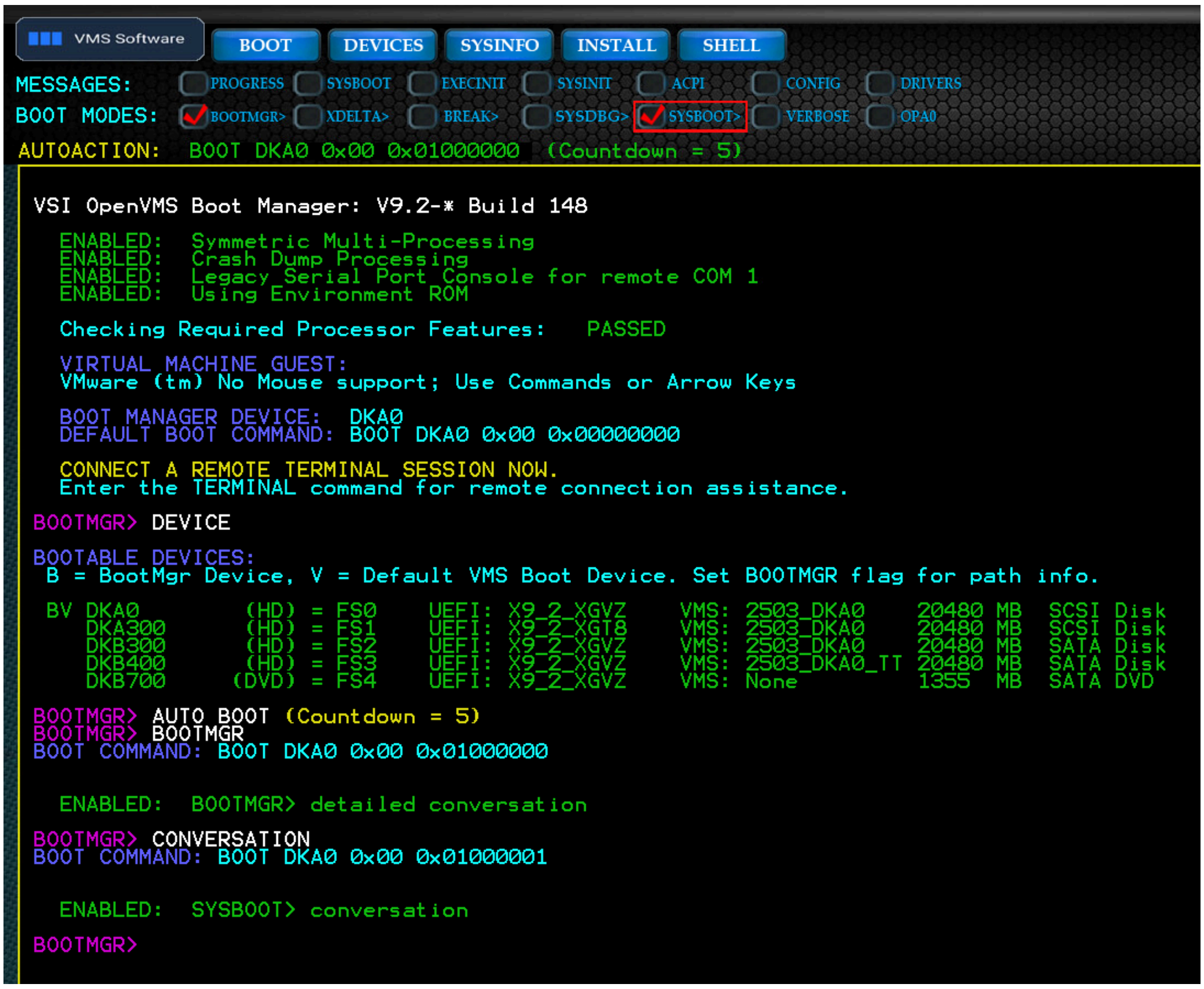
```
telnet> mode line
```

# Appendix A. Boot Manager Output Samples

This appendix provides sample outputs of various Boot Manager commands.

## A.1. DEVICE, AUTOACTION, and CONVERSATION Commands

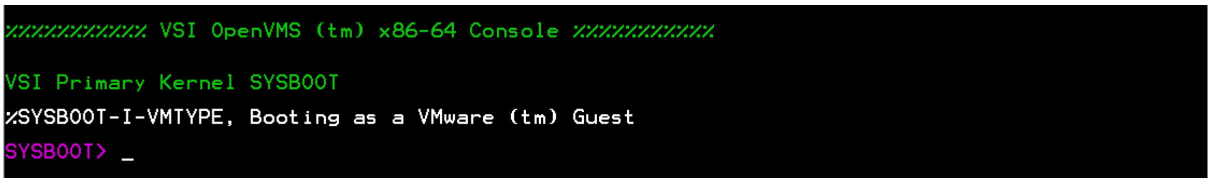
The following figure demonstrates the output from executing the **`DEVICE`**, **`AUTO(ACTION) [BOOT]`**, and **`CONVERSATION`** commands.



```
MESSAGES:    ☐ PROGRESS ☐ SYSBOOT ☐ EXECINIT ☐ SYSINIT ☐ ACPI ☐ CONFIG ☐ DRIVERS
BOOT MODES:  ✓ BOOTMGR> ☐ XDELTA> ☐ BREAK> ☐ SYSDBG> ✓ SYSBOOT> ☐ VERBOSE ☐ OPA0
AUTOACTION:  BOOT DKA0 0x00 0x01000000  (Countdown = 5)

VSI OpenVMS Boot Manager: V9.2-* Build 148

   ENABLED:  Symmetric Multi-Processing
   ENABLED:  Crash Dump Processing
   ENABLED:  Legacy Serial Port Console for remote COM 1
   ENABLED:  Using Environment ROM

   Checking Required Processor Features:    PASSED

   VIRTUAL MACHINE GUEST:
   VMware (tm) No Mouse support; Use Commands or Arrow Keys

   BOOT MANAGER DEVICE:  DKA0
   DEFAULT BOOT COMMAND: BOOT DKA0 0x00 0x00000000

   CONNECT A REMOTE TERMINAL SESSION NOW.
   Enter the TERMINAL command for remote connection assistance.

BOOTMGR> DEVICE

BOOTABLE DEVICES:
 B = BootMgr Device, V = Default VMS Boot Device. Set BOOTMGR flag for path info.

 BV DKA0        (HD) = FS0    UEFI: X9_2_XGVZ    VMS: 2503_DKA0     20480 MB  SCSI Disk
    DKA300      (HD) = FS1    UEFI: X9_2_XGT8    VMS: 2503_DKA0     20480 MB  SCSI Disk
    DKB300      (HD) = FS2    UEFI: X9_2_XGVZ    VMS: 2503_DKA0     20480 MB  SATA Disk
    DKB400      (HD) = FS3    UEFI: X9_2_XGVZ    VMS: 2503_DKA0_TT  20480 MB  SATA Disk
    DKB700     (DVD) = FS4    UEFI: X9_2_XGVZ    VMS: None          1355  MB  SATA DVD

BOOTMGR> AUTO BOOT (Countdown = 5)
BOOTMGR> BOOTMGR
BOOT COMMAND: BOOT DKA0 0x00 0x01000000

   ENABLED:  BOOTMGR> detailed conversation

BOOTMGR> CONVERSATION
BOOT COMMAND: BOOT DKA0 0x00 0x01000001

   ENABLED:  SYSBOOT> conversation

BOOTMGR>
```

## A.2. Conversational Boot

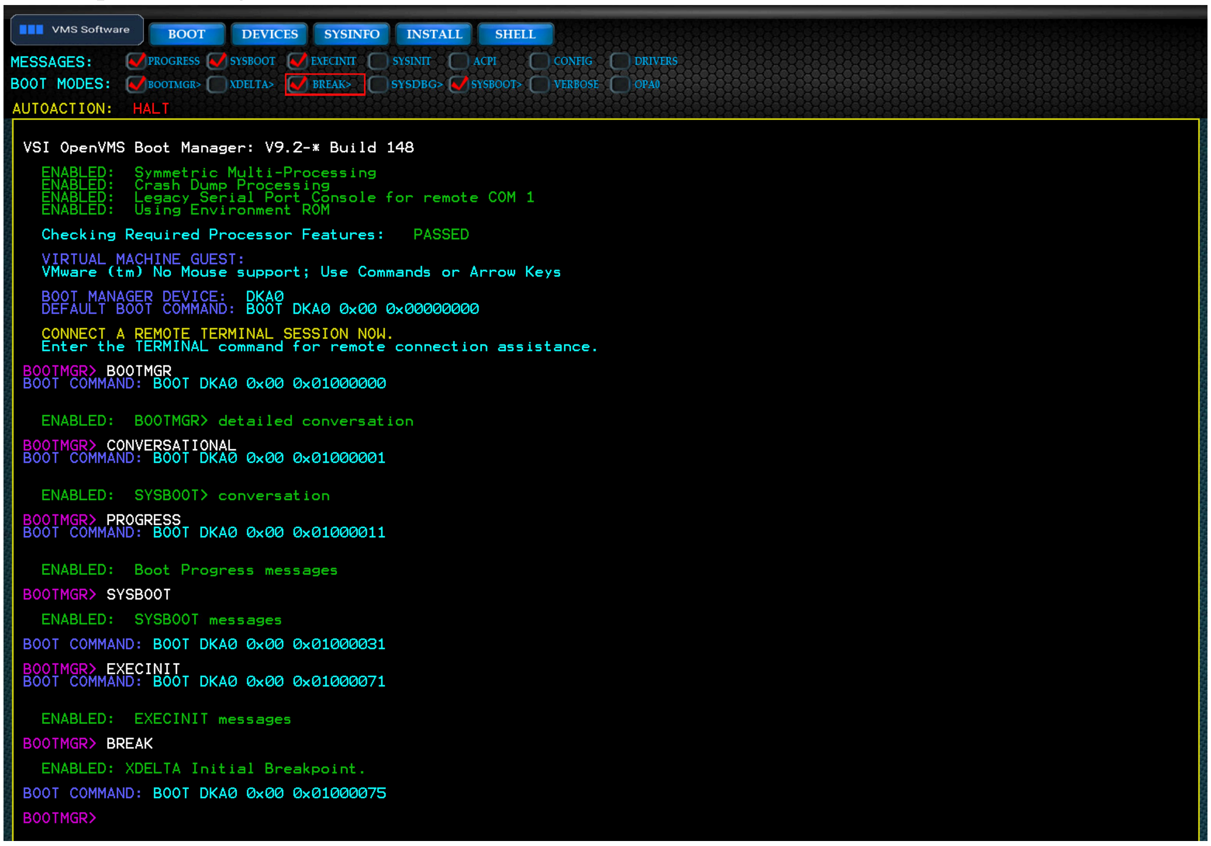
This figure shows booting to the conversational boot prompt if the conversational boot flag is enabled.



```
%%%%%%%%%%% VSI OpenVMS (tm) x86-64 Console %%%%%%%%%%%

VSI Primary Kernel SYSBOOT

%SYSBOOT-I-VMTYPE, Booting as a VMware (tm) Guest

SYSBOOT> _
```

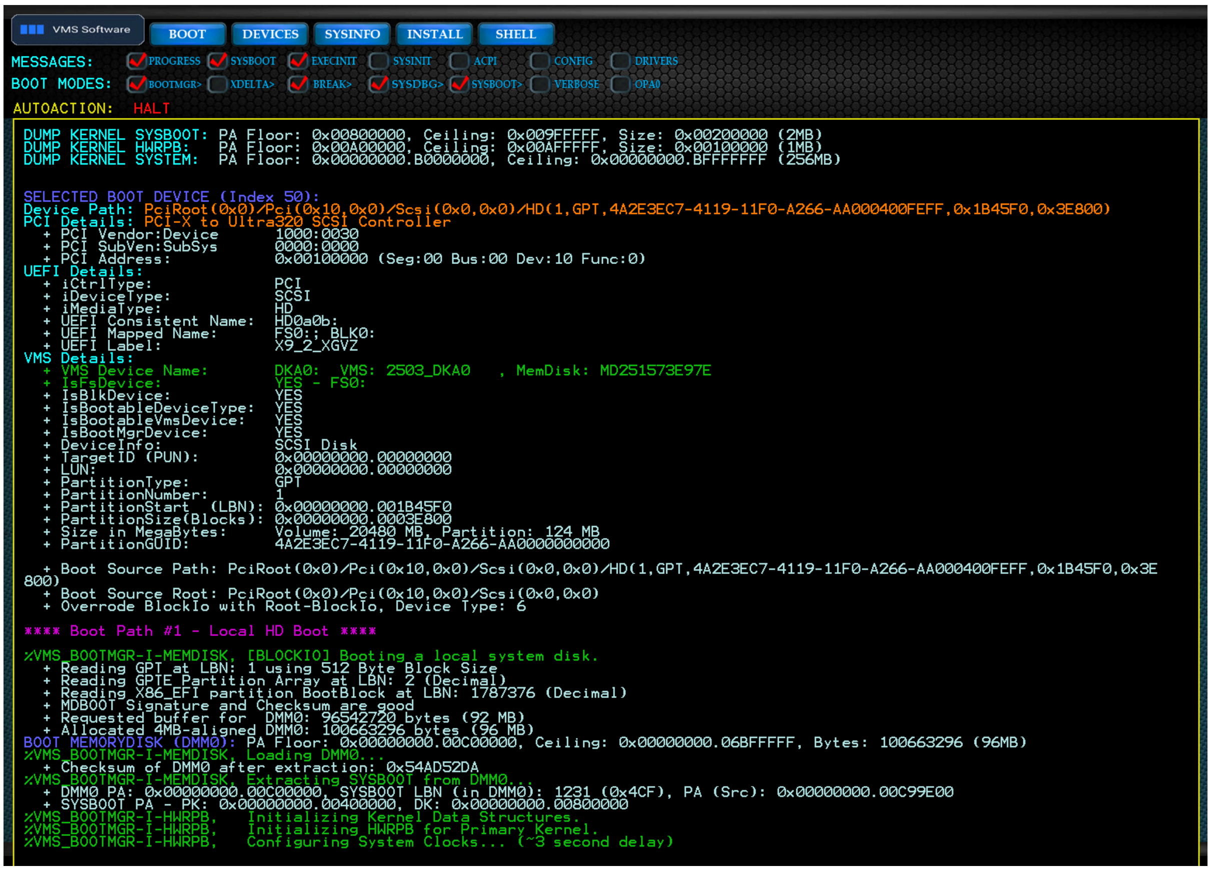
## A.3. BOOT With Boot Manager Flag Set

The following figures demonstrate booting with various Boot Manager flags set (note the check buttons at the top of the images).



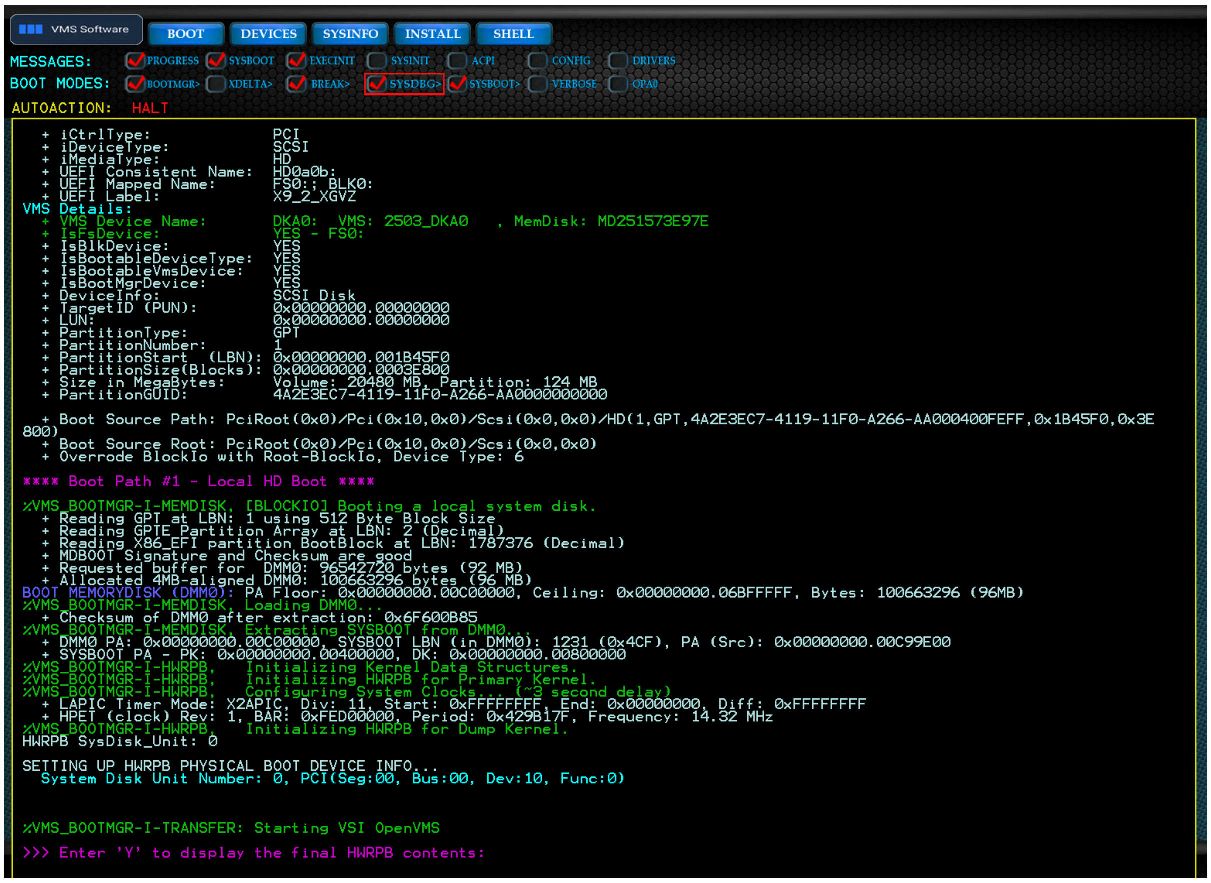
```
MESSAGES:     [✓ PROGRESS] [✓ SYSBOOT] [✓ EXECINIT] SYSINIT ACPI CONFIG DRIVERS
BOOT MODES:   [✓ BOOTMGR>] XDELTA> [✓ BREAK>] SYSDBG> [✓ SYSBOOT>] VERBOSE OPA0
AUTOACTION:   HALT
```

```
VSI OpenVMS Boot Manager: V9.2-* Build 148
  ENABLED:  Symmetric Multi-Processing
  ENABLED:  Crash Dump Processing
  ENABLED:  Legacy Serial Port Console for remote COM 1
  ENABLED:  Using Environment ROM

  Checking Required Processor Features:   PASSED

  VIRTUAL MACHINE GUEST:
  VMware (tm) No Mouse support; Use Commands or Arrow Keys

  BOOT MANAGER DEVICE:  DKA0
  DEFAULT BOOT COMMAND: BOOT DKA0 0x00 0x00000000

  CONNECT A REMOTE TERMINAL SESSION NOW.
  Enter the TERMINAL command for remote connection assistance.
BOOTMGR> BOOTMGR
BOOT COMMAND: BOOT DKA0 0x00 0x01000000

  ENABLED:  BOOTMGR> detailed conversation

BOOTMGR> CONVERSATIONAL
BOOT COMMAND: BOOT DKA0 0x00 0x01000001

  ENABLED:  SYSBOOT> conversation

BOOTMGR> PROGRESS
BOOT COMMAND: BOOT DKA0 0x00 0x01000011

  ENABLED:  Boot Progress messages

BOOTMGR> SYSBOOT

  ENABLED:  SYSBOOT messages

BOOT COMMAND: BOOT DKA0 0x00 0x01000031

BOOTMGR> EXECINIT
BOOT COMMAND: BOOT DKA0 0x00 0x01000071

  ENABLED:  EXECINIT messages

BOOTMGR> BREAK

  ENABLED: XDELTA Initial Breakpoint.

BOOT COMMAND: BOOT DKA0 0x00 0x01000075

BOOTMGR>
```



```
MESSAGES:    [✓] PROGRESS [✓] SYSBOOT [✓] EXECINIT [ ] SYSINIT [ ] ACPI [ ] CONFIG [ ] DRIVERS
BOOT MODES:  [✓] BOOTMGR> [ ] XDELTA> [✓] BREAK> [✓] SYSDBG> [✓] SYSBOOT> [ ] VERBOSE [ ] OPA0
AUTOACTION:  HALT
```

```
DUMP KERNEL SYSBOOT: PA Floor: 0x00800000, Ceiling: 0x009FFFFF, Size: 0x00200000 (2MB)
DUMP KERNEL HWRPB:   PA Floor: 0x00A00000, Ceiling: 0x00AFFFFF, Size: 0x00100000 (1MB)
DUMP KERNEL SYSTEM:  PA Floor: 0x00000000.B0000000, Ceiling: 0x00000000.BFFFFFFF (256MB)

SELECTED BOOT DEVICE (Index 50):
Device Path: PciRoot(0x0)/Pci(0x10,0x0)/Scsi(0x0,0x0)/HD(1,GPT,4A2E3EC7-4119-11F0-A266-AA000400FEFF,0x1B45F0,0x3E800)
PCI Details: PCI-X to Ultra320 SCSI Controller
   + PCI Vendor:Device       1000:0030
   + PCI SubVen:SubSys       0000:0000
   + PCI Address:            0x00100000 (Seg:00 Bus:00 Dev:10 Func:0)
UEFI Details:
   + iCtrlType:              PCI
   + iDeviceType:            SCSI
   + iMediaType:             HD
   + UEFI Consistent Name:   HD0a0b:
   + UEFI Mapped Name:       FS0:; BLK0:
   + UEFI Label:             X9_2_XGVZ
VMS Details:
   + VMS Device Name:        DKA0:  VMS: 2503_DKA0    , MemDisk: MD251573E97E
   + IsFsDevice:             YES - FS0:
   + IsBlkDevice:            YES
   + IsBootableDeviceType:   YES
   + IsBootableVmsDevice:    YES
   + IsBootMgrDevice:        YES
   + DeviceInfo:             SCSI Disk
   + TargetID (PUN):         0x00000000.00000000
   + LUN:                    0x00000000.00000000
   + PartitionType:          GPT
   + PartitionNumber:        1
   + PartitionStart  (LBN):  0x00000000.001B45F0
   + PartitionSize(Blocks):  0x00000000.0003E800
   + Size in MegaBytes:      Volume: 20480 MB, Partition: 124 MB
   + PartitionGUID:          4A2E3EC7-4119-11F0-A266-AA0000000000

   + Boot Source Path: PciRoot(0x0)/Pci(0x10,0x0)/Scsi(0x0,0x0)/HD(1,GPT,4A2E3EC7-4119-11F0-A266-AA000400FEFF,0x1B45F0,0x3E
800)
   + Boot Source Root: PciRoot(0x0)/Pci(0x10,0x0)/Scsi(0x0,0x0)
   + Overrode BlockIo with Root-BlockIo, Device Type: 6

**** Boot Path #1 - Local HD Boot ****

%VMS_BOOTMGR-I-MEMDISK, [BLOCKIO] Booting a local system disk.
   + Reading GPT at LBN: 1 using 512 Byte Block Size
   + Reading GPTE Partition Array at LBN: 2 (Decimal)
   + Reading X86_EFI partition BootBlock at LBN: 1787376 (Decimal)
   + MDBOOT Signature and Checksum are good
   + Requested buffer for  DMM0: 96542720 bytes (92 MB)
   + Allocated 4MB-aligned DMM0: 100663296 bytes (96 MB)
BOOT MEMORYDISK (DMM0): PA Floor: 0x00000000.00C00000, Ceiling: 0x00000000.06BFFFFF, Bytes: 100663296 (96MB)
%VMS_BOOTMGR-I-MEMDISK, Loading DMM0...
   + Checksum of DMM0 after extraction: 0x54AD52DA
%VMS_BOOTMGR-I-MEMDISK, Extracting SYSBOOT from DMM0...
   + DMM0 PA: 0x00000000.00C00000, SYSBOOT LBN (in DMM0): 1231 (0x4CF), PA (Src): 0x00000000.00C99E00
   + SYSBOOT PA - PK: 0x00000000.00400000, DK: 0x00000000.00800000
%VMS_BOOTMGR-I-HWRPB,   Initializing Kernel Data Structures.
%VMS_BOOTMGR-I-HWRPB,   Initializing HWRPB for Primary Kernel.
%VMS_BOOTMGR-I-HWRPB,   Configuring System Clocks... (~3 second delay)
```

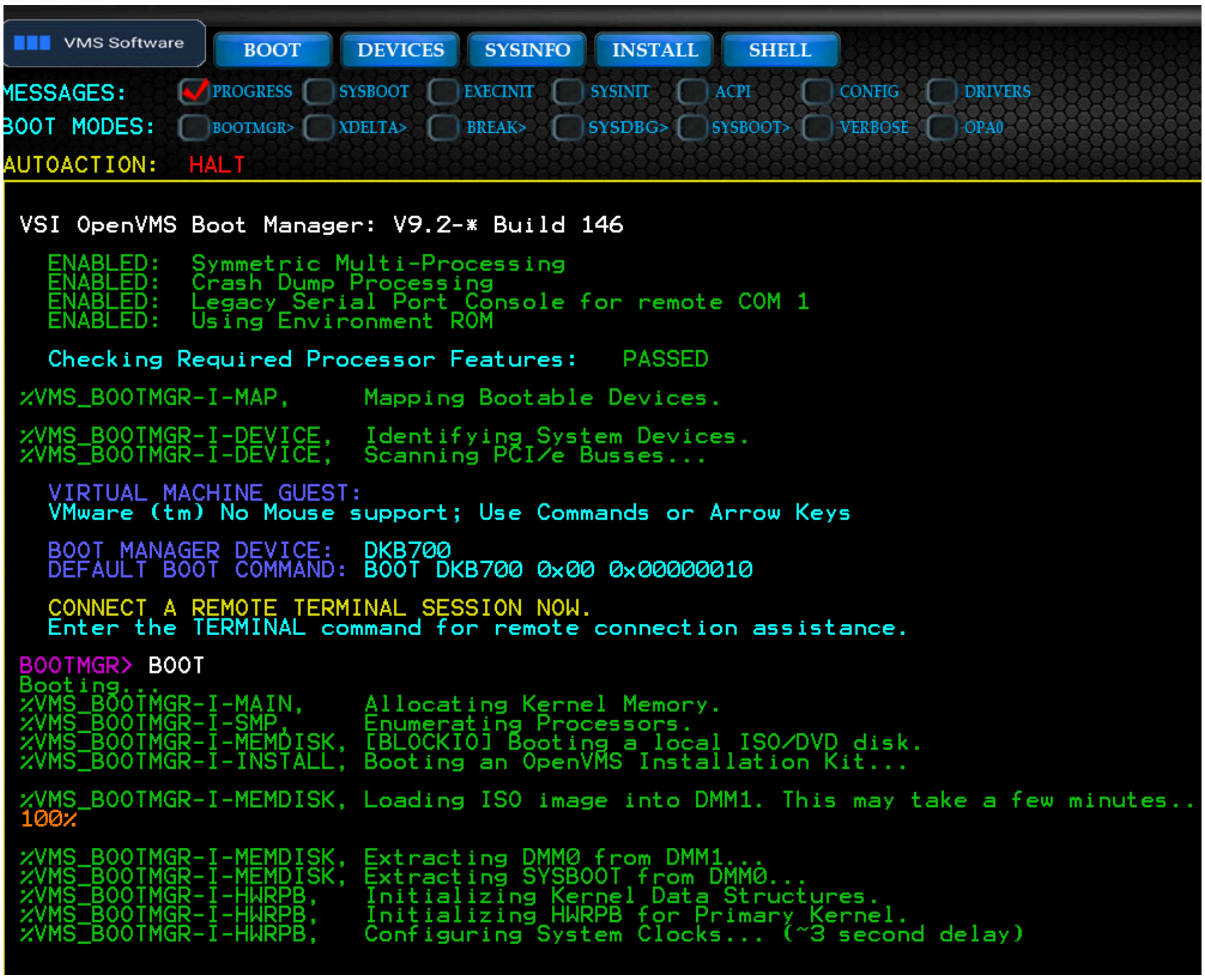


```
MESSAGES:    [✓] PROGRESS [✓] SYSBOOT [✓] EXECINIT [ ] SYSINIT [ ] ACPI [ ] CONFIG [ ] DRIVERS
BOOT MODES:  [✓] BOOTMGR> [ ] XDELTA> [✓] BREAK> [✓] SYSDBG> [✓] SYSBOOT> [ ] VERBOSE [ ] OPA0
AUTOACTION:  HALT
```

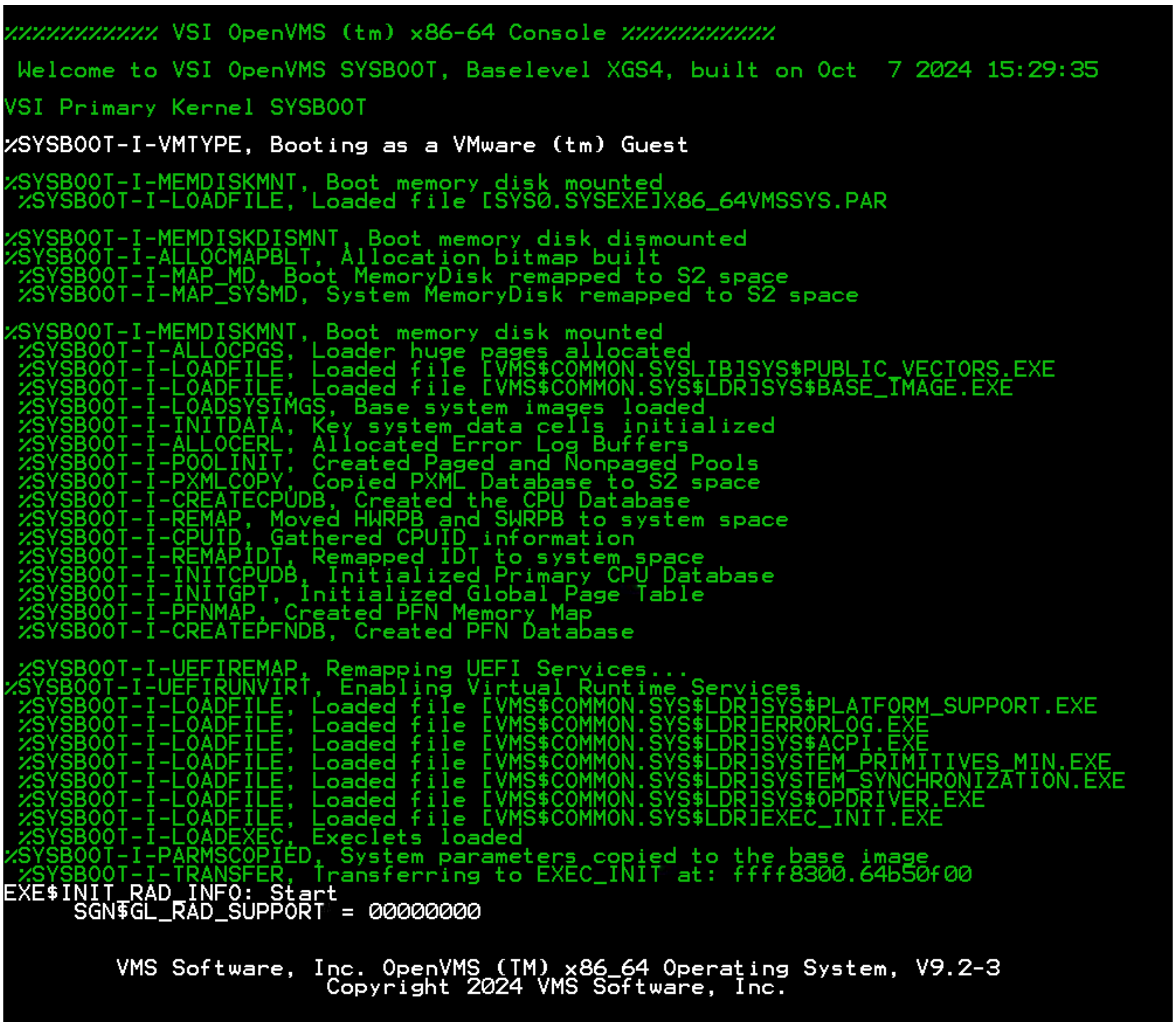
```
   + iCtrlType:              PCI
   + iDeviceType:            SCSI
   + iMediaType:             HD
   + UEFI Consistent Name:   HD0a0b:
   + UEFI Mapped Name:       FS0:; BLK0:
   + UEFI Label:             X9_2_XGVZ
VMS Details:
   + VMS Device Name:        DKA0:  VMS: 2503_DKA0    , MemDisk: MD251573E97E
   + IsFsDevice:             YES - FS0:
   + IsBlkDevice:            YES
   + IsBootableDeviceType:   YES
   + IsBootableVmsDevice:    YES
   + IsBootMgrDevice:        YES
   + DeviceInfo:             SCSI Disk
   + TargetID (PUN):         0x00000000.00000000
   + LUN:                    0x00000000.00000000
   + PartitionType:          GPT
   + PartitionNumber:        1
   + PartitionStart  (LBN):  0x00000000.001B45F0
   + PartitionSize(Blocks):  0x00000000.0003E800
   + Size in MegaBytes:      Volume: 20480 MB, Partition: 124 MB
   + PartitionGUID:          4A2E3EC7-4119-11F0-A266-AA0000000000

   + Boot Source Path: PciRoot(0x0)/Pci(0x10,0x0)/Scsi(0x0,0x0)/HD(1,GPT,4A2E3EC7-4119-11F0-A266-AA000400FEFF,0x1B45F0,0x3E
800)
   + Boot Source Root: PciRoot(0x0)/Pci(0x10,0x0)/Scsi(0x0,0x0)
   + Overrode BlockIo with Root-BlockIo, Device Type: 6

**** Boot Path #1 - Local HD Boot ****

%VMS_BOOTMGR-I-MEMDISK, [BLOCKIO] Booting a local system disk.
   + Reading GPT at LBN: 1 using 512 Byte Block Size
   + Reading GPTE Partition Array at LBN: 2 (Decimal)
   + Reading X86_EFI partition BootBlock at LBN: 1787376 (Decimal)
   + MDBOOT Signature and Checksum are good
   + Requested buffer for  DMM0: 96542720 bytes (92 MB)
   + Allocated 4MB-aligned DMM0: 100663296 bytes (96 MB)
BOOT MEMORYDISK (DMM0): PA Floor: 0x00000000.00C00000, Ceiling: 0x00000000.06BFFFFF, Bytes: 100663296 (96MB)
%VMS_BOOTMGR-I-MEMDISK, Loading DMM0...
   + Checksum of DMM0 after extraction: 0x6F600B85
%VMS_BOOTMGR-I-MEMDISK, Extracting SYSBOOT from DMM0...
   + DMM0 PA: 0x00000000.00C00000, SYSBOOT LBN (in DMM0): 1231 (0x4CF), PA (Src): 0x00000000.00C99E00
   + SYSBOOT PA - PK: 0x00000000.00400000, DK: 0x00000000.00800000
%VMS_BOOTMGR-I-HWRPB,   Initializing Kernel Data Structures.
%VMS_BOOTMGR-I-HWRPB,   Initializing HWRPB for Primary Kernel.
%VMS_BOOTMGR-I-HWRPB,   Configuring System Clocks... (~3 second delay)
   + LAPIC Timer Mode: X2APIC, Div: 11, Start: 0xFFFFFFFF, End: 0x00000000, Diff: 0xFFFFFFFF
   + HPET (clock) Rev: 1, BAR: 0xFED00000, Period: 0x429B17F, Frequency: 14.32 MHz
%VMS_BOOTMGR-I-HWRPB,   Initializing HWRPB for Dump Kernel.
HWRPB SysDisk_Unit: 0

SETTING UP HWRPB PHYSICAL BOOT DEVICE INFO...
  System Disk Unit Number: 0, PCI(Seg:00, Bus:00, Dev:10, Func:0)


%VMS_BOOTMGR-I-TRANSFER: Starting VSI OpenVMS

>>> Enter 'Y' to display the final HWRPB contents:
```

## A.4. Progress Messages on Guest Display After BOOT

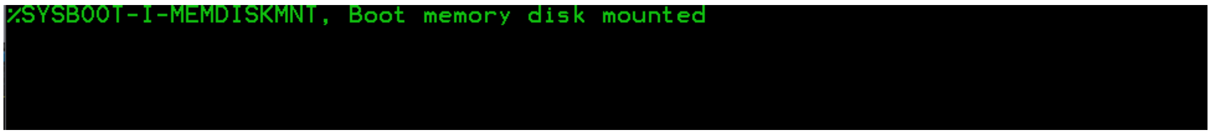
The following figures show progress messages that would be received on a guest display after executing a **BOOT** command. Note that this is an example, and output may differ slightly from that shown depending on various factors.



```
MESSAGES:     [✓ PROGRESS] SYSBOOT  EXECINIT  SYSINIT   ACPI      CONFIG   DRIVERS
BOOT MODES:   BOOTMGR>   XDELTA>  BREAK>    SYSDBG>   SYSBOOT>  VERBOSE  OPA0
AUTOACTION:   HALT

VSI OpenVMS Boot Manager: V9.2-* Build 146

   ENABLED:  Symmetric Multi-Processing
   ENABLED:  Crash Dump Processing
   ENABLED:  Legacy Serial Port Console for remote COM 1
   ENABLED:  Using Environment ROM

   Checking Required Processor Features:   PASSED

%VMS_BOOTMGR-I-MAP,      Mapping Bootable Devices.

%VMS_BOOTMGR-I-DEVICE,  Identifying System Devices.
%VMS_BOOTMGR-I-DEVICE,  Scanning PCI/e Busses...

   VIRTUAL MACHINE GUEST:
   VMware (tm) No Mouse support; Use Commands or Arrow Keys

   BOOT MANAGER DEVICE:  DKB700
   DEFAULT BOOT COMMAND: BOOT DKB700 0x00 0x00000010

   CONNECT A REMOTE TERMINAL SESSION NOW.
   Enter the TERMINAL command for remote connection assistance.

BOOTMGR> BOOT
Booting...
%VMS_BOOTMGR-I-MAIN,     Allocating Kernel Memory.
%VMS_BOOTMGR-I-SMP,      Enumerating Processors.
%VMS_BOOTMGR-I-MEMDISK,  [BLOCKIO] Booting a local ISO/DVD disk.
%VMS_BOOTMGR-I-INSTALL,  Booting an OpenVMS Installation Kit...

%VMS_BOOTMGR-I-MEMDISK,  Loading ISO image into DMM1. This may take a few minutes..
100%

%VMS_BOOTMGR-I-MEMDISK,  Extracting DMM0 from DMM1...
%VMS_BOOTMGR-I-MEMDISK,  Extracting SYSBOOT from DMM0...
%VMS_BOOTMGR-I-HWRPB,    Initializing Kernel Data Structures.
%VMS_BOOTMGR-I-HWRPB,    Initializing HWRPB for Primary Kernel.
%VMS_BOOTMGR-I-HWRPB,    Configuring System Clocks... (~3 second delay)
```



```
%%%%%%%%%%% VSI OpenVMS (tm) x86-64 Console %%%%%%%%%%%

 Welcome to VSI OpenVMS SYSBOOT, Baselevel XGS4, built on Oct  7 2024 15:29:35

VSI Primary Kernel SYSBOOT

%SYSBOOT-I-VMTYPE, Booting as a VMware (tm) Guest

%SYSBOOT-I-MEMDISKMNT, Boot memory disk mounted
 %SYSBOOT-I-LOADFILE, Loaded file [SYS0.SYSEXE]X86_64VMSSYS.PAR

%SYSBOOT-I-MEMDISKDISMNT, Boot memory disk dismounted
%SYSBOOT-I-ALLOCMAPBLT, Allocation bitmap built
 %SYSBOOT-I-MAP_MD, Boot MemoryDisk remapped to S2 space
 %SYSBOOT-I-MAP_SYSMD, System MemoryDisk remapped to S2 space

%SYSBOOT-I-MEMDISKMNT, Boot memory disk mounted
 %SYSBOOT-I-ALLOCPGS, Loader huge pages allocated
 %SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYSLIB]SYS$PUBLIC_VECTORS.EXE
 %SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYS$BASE_IMAGE.EXE
 %SYSBOOT-I-LOADSYSIMGS, Base system images loaded
 %SYSBOOT-I-INITDATA, Key system data cells initialized
 %SYSBOOT-I-ALLOCERL, Allocated Error Log Buffers
 %SYSBOOT-I-POOLINIT, Created Paged and Nonpaged Pools
 %SYSBOOT-I-PXMLCOPY, Copied PXML Database to S2 space
 %SYSBOOT-I-CREATECPUDB, Created the CPU Database
 %SYSBOOT-I-REMAP, Moved HWRPB and SWRPB to system space
 %SYSBOOT-I-CPUID, Gathered CPUID information
 %SYSBOOT-I-REMAPIDT, Remapped IDT to system space
 %SYSBOOT-I-INITCPUDB, Initialized Primary CPU Database
 %SYSBOOT-I-INITGPT, Initialized Global Page Table
 %SYSBOOT-I-PFNMAP, Created PFN Memory Map
 %SYSBOOT-I-CREATEPFNDB, Created PFN Database

 %SYSBOOT-I-UEFIREMAP, Remapping UEFI Services...
%SYSBOOT-I-UEFIRUNVIRT, Enabling Virtual Runtime Services.
 %SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYS$PLATFORM_SUPPORT.EXE
 %SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]ERRORLOG.EXE
 %SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYS$ACPI.EXE
 %SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYSTEM_PRIMITIVES_MIN.EXE
 %SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYSTEM_SYNCHRONIZATION.EXE
 %SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]SYS$OPDRIVER.EXE
 %SYSBOOT-I-LOADFILE, Loaded file [VMS$COMMON.SYS$LDR]EXEC_INIT.EXE
 %SYSBOOT-I-LOADEXEC, Execlets loaded
%SYSBOOT-I-PARMSCOPIED, System parameters copied to the base image
 %SYSBOOT-I-TRANSFER, Transferring to EXEC_INIT at: ffff8300.64b50f00
EXE$INIT_RAD_INFO: Start
     SGN$GL_RAD_SUPPORT = 00000000


        VMS Software, Inc. OpenVMS (TM) x86_64 Operating System, V9.2-3
                       Copyright 2024 VMS Software, Inc.
```



```
%SYSBOOT-I-MEMDISKMNT, Boot memory disk mounted
```