CTAN004: Cactus flash-storage devices and Operating Systems

Products Covered: Cactus Technologies CF, PCMCIA ATA, 2.5" SSD and DOM.

1. Introduction

The Cactus Technologies industrial-grade flash storage products are designed to operate in harsh environments where temperature, shock and vibration would cause magnetic or optical storage products to prematurely fail or lower the system's tolerance to environmental factors.

Many industrial computer and embedded systems uses operating systems (OS) for advanced functionalities and to simplify development effort. This application note outlines the requirements and procedures for OS installation and start up with Cactus flash-storage products.

2. Installation Issues

There are two parts for installing and starting an operating system on a Cactus Technologies flash storage device:

1. Installing and starting an operating system (OS) onto the Cactus Technologies device on the development platform.

2. Preparing an image for copying the final OS image (of whatever format) to identical Cactus Technologies devices during production.

The first consideration for OS installation and start up is whether the target system supports installation and start up from a removable device. Some systems (e.g. older x86 PC without bootable CD-ROM support) will not start up the operating system installed on any removable media, including Cactus Technologies CF/PC Card ATA devices with default 'removable' (R) configuration.

Some operating systems cannot be installed onto Cactus Technologies devices with (R) configuration due to the limitation imposed by the operating system itself and unrelated to Cactus Technologies flash storage products or hardware.

For these hardware and operating systems, fixed-mode (F) cards should be ordered instead to ensure successful partitioning, installation and start up.

All Cactus Technologies flash storage products are shipped with partition table generated with respect to the default logical disk geometry specified in our product manual. We have discovered some systems do not follow our default logical geometry (particularly older systems without LBA support) and instead enforce a different logical geometry. The enforced geometry will conflict with the default partition table and may cause the system to fail to start from the Cactus Technologies device. The solution here is to delete the default partition with MS-DOS `fdisk` or similar disk partitioning program, and re-create the partition on the target platform to match the actual logical disk geometry as used by the BIOS or system firmware.

3. OS Installation Guide

The following section outlines the procedures for installing different types of OS onto the Cactus Technologies device. This assumes the Cactus Technologies device is operating under True IDE mode (for CF and PC Card, the device is inserted into IDE adapter).

3.1. MS-DOS

Installing MS-DOS or its derivatives onto a Cactus Technologies device takes the following steps:

1. Start the target platform with the MS-DOS setup disk 1.

2. Follow the on-screen instruction to install MS-DOS to the Cactus Technologies device.

3. Installation completes when MS-DOS is started from the Cactus Technologies device where the OS is installed.

Under MS-DOS, multiple partitions can be created with either (R) or (F) CF/PC Card ATA devices as MS-DOS `fdisk` ignores word 0 of the IDENTIFY DEVICE sector.

3.2. Microsoft Windows (standard and embedded editions)

Standard Microsoft Windows will not install on Cactus Technologies devices marked as removable (R) devices. Therefore, fixed-mode (F) CF/PC Card or SSD/DOM devices must be used for installing standard Microsoft Windows. Cactus Technologies does not support using disk image programs to copy an existing image to a removable Cactus Technologies CF/PC Card ATA device for running Microsoft Windows.

Microsoft Windows (NT, 2000, or XP) Embedded are configured and installed to the target platform from the development workstation.

Another consideration for OS installation is disk partitioning. Microsoft operating systems except MS-DOS does not allow multiple partitions on removable devices regardless of final file systems installed onto the device. This is a Microsoft limitation unrelated to Cactus Technologies devices.

To partition a Cactus Technologies CF/PC Card ATA device under Microsoft Windows, the device must be recognized as a "fixed" disk. Microsoft Windows always recognize USB CF/PC Card readers as removable drives even with fixed mode (F) cards, thus disallowing partition operation. There are two other ways of forcing the OS to recognize the CF/PC Card ATA device as "fixed disk" under Windows.

1. Non-USB PC Card reader such as those found on laptop computers. There are also PCI-CardBus (PCMCIA) bridges with card

slots available on the market, which can be used with fixed-mode (F) cards for creating multiple partitions.

2. CF / PC Card – ATA adapters can be used to put the CF or PC card ATA devices into True IDE mode, thus allowing Windows to create multiple partitions.

The DOS-based `bootprep` utility must be used to copy a Windows Embedded boot sector to the Cactus Technolgies flash device, if the file system of the target application is FAT16. The following set of procedures copies the boot sector with `bootprep`.

1. Create a MS-DOS boot floppy and copy `bootprep.exe` to the floppy.

2. Connect the Cactus Technologies device to the target platform. For CF and PC Card ATA devices, connect the device with an CF/PC Card ATA to IDE adapter. Also make sure only the Cactus Technologies device is using the IDE channel.

3. Boot the target platform with the floppy.

4. At the MS-DOS prompt, type `bootprep` to prepare the Cactus Technologies device for booting embedded Windows.

Further information regarding to `bootprep` can be found under Microsoft Windows Embedded documentation. `bootprep` is unnecessary if the Cactus Technologies device is formatted with FAT32 or NTFS.

For both standard and embedded Microsoft Windows, we recommend disabling virtual memory for better performance under EWF and to prolong usable life when EWF is not used under standard Microsoft Windows.

Windows (NT, 2000, XP) Embedded provides the Enhance Write Filter (EWF) to increase endurance for flash storage devices, Cactus Technologies flash storage products supports EWF and we strongly recommend using EWF to improve device endurance. Because Cactus Technologies flash devices can be factory-configured as fixed-mode (F)

devices, therefore EWF Disk Mode, RAM Mode or RAM Reg Mode are supported. To setup EWF to increase endurance for the Cactus Technologies device, please consult your Windows Embedded documentation.

3.3. Linux

Installing Linux is different from installing Microsoft Windows. There are two types of installation: installing and executing the operating system directly on the Cactus Technologies device as a replacement to standard magnetic disk drive, or copying a compressed Linux kernel image and its associated modules on the Cactus Technologies device, and decompressing the image into RAM. This application note will outline the general procedures for both Linux installation types.

The first installation type is similar to a standard Linux installation. As Linux allows creating multiple partitions on removable disk devices, therefore removable (R) or fixed (F) Cactus Technologies CF/PC Card ATA devices can be used for Linux installation. Follow the installation instructions of your Linux distribution for installation procedures. For Linux installations we also recommend disabling virtual memory if possible to prolong the life of the Cactus Technologies device.

An alternative method for installing Linux onto Cactus Technologies flash storage devices is to copy a compressed Linux image onto the device, deflating that image into a RAM drive created during the initial boot process, and running the entire Linux system from RAM. This method is identical to the popular "Live CD" concept, except the destination is a Cactus Technologies flash storage device. This is more suited to embedded systems where state information persistence is not required when the system is restarted. It also has the benefit of reducing the wear to the Cactus Technologies device, and fast execution time as the whole system is running from system memory.

Besides installing standard or embedded Linux distributions, it is possible to create a custom Linux kernel and associated system on a running Linux

development workstation and transfer the system to the Cactus Technologies device. This web site (http://www.linuxjournal.com/article/4551) has an example on setting up a simple Linux HTTP server on a CompactFlash device. Similar procedures also apply to PC Card ATA, DOM and SSD devices. A general procedure for creating a custom Linux kernel and a minimal set of utilities on a Linux development workstation as follows:

1. On the Linux development workstation, delete the existing partition on the Cactus Technologies device, and create a new Linux (0x83) partition type.

2. Format the Cactus Technologies device as Ext2fs or Ext3fs with the following command:

    `mkfs.ext2 /dev/hdb` or

    `mkfs.ext3 /dev/hdb`

    Replace hdb with the actual location of the Cactus Technologies device.

3. Create a mount point to access the Cactus Technologies device with `mount -t ext2 /dev/hdb1 /mnt/flash`, where `/mnt/flash` is the location of the actual mount point, and replace `hdb1` to the actual location of the Cactus Technologies device.

4. Create the barebone Linux directory structure on the Cactus Technologies device with the following list of commands. Again replace /mnt/flash with the actual mount point on the development workstation.

    ```
    mkdir /mnt/flash/boot
    mkdir /mnt/flash/bin
    mkdir /mnt/flash/dev
    mkdir /mnt/flash/dev/cciss
    mkdir /mnt/flash/etc
    mkdir /mnt/flash/lib
    mkdir /mnt/flash/opt
    mkdir /mnt/flash/proc
    mkdir /mnt/flash/sbin
    mkdir /mnt/flash/tmp
    mkdir /mnt/flash/var
    ```

during production may become difficult or impossible due to the number of parallel installations.

The following are guidelines for preparing mass imaging from Cactus Technologies devices to other Cactus Technologies devices.

1. Disk or flash card images created from non-Cactus Technologies devices should not be deployed to Cactus Technologies devices, as the logical device geometry may be different and affect booting.

2. Always make sure that the non-compressed size of the disk/flash card image is smaller than the device capacity to avoid overwriting previously written data.

3. Turn on data verify option in the mass imaging software when available to ensure data integrity.

5. Version History

Version	Date	Change
1.00	February 12, 2008	Initial Version
1.01	June 3, 2008	Minor edits