

# Building an Energy-Efficient Home Server

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This article will give instructions on how I built my own home server with low energy consumption. It is intended to work as file and web server for local development. Moreover, it might also be used for television recording in future.

## Choosing the Hardware

As the server should not be too big, the decision fell on a **mini-ITX mainboard** and chassis.

## CPU and Mainboard

Due to its low power consumption and the possibility to use it for video playback if wanted (also HD video encoded with H.264) the **Intel Atom** with **ION architecture** was chosen as processor. Both POV and Zotac produce mainboards with Intel Atom Chips (either single or dual core) and ION technology, but they differ with regards to additional slots and adapters. The **Zotac ION ITX A** comes with an external PSU (Power Supply Unit) leaving more space in the case. However, the Zotac ION ITX A does not have any additional slots for PCI or PCIe devices, which makes it impossible to install dedicated graphics cards or PCI video cards. Since I do not intend to use either of them, but instead will go with a USB video device (only to record incoming signals), the Zotac ION ITX A does well for me. It has a MiniPCIe device, but as this one has a special pin assignment it cannot be used with other cards like SSD (Solid State Disks).

## RAM

RAM was merely a decision of price. ECC (Error Checking and Correction) would have been much more expensive, and normal RAM seemed to be quite enough for my purposes.

## Hard Drive

The hard drive should probably be one that is designed for 24/7 usage. However, I decided to use a **WD Caviar Green 2TB** to hold power consumption and noise low, even though the latter one might not be too important as the fans are probably “louder”, anyways. The Caviar Green hard drives are of course not the fastest ones, but for me it is enough (I measured 90MB/s). Yet, you have to watch out as this hard drive uses blocks of 4kB indeed, but pretends to use 512 Bytes. As many tools do not support this yet, you might have to align the partitions on your own or use WD’s tool, unless you want data transfer to go down to 15MB/s (according to internet reports). I will explain later in this article, how to align the partitions correctly on Linux.

## MiniITX Case

Considering that it might be useful to backup data via RAID 0 or install more space there should be at least 2 slots for HDD devices. One case that fulfills this requirement is the **A+ cupid 3**. Even though it includes an internal PSU, it is one of very few possibilities if you search for a case that is quite small. Moreover, the PSU can be removed to create free space for the Zotac’s CPU fan. Otherwise there would be only a few millimeters between the PSU and the CPU fan left.

If size does not matter, you can also have a look for  $\mu$ ATX devices, which often offer miniITX screw holes as well. And in case you decide to go with another one of Zotac’s or POV’s ION mainboards, then you might be eager to know that the 24-pin jack can be shortened to a 20-pin jack and attached to the mainboard’s 20-pin connector with transistor next to it (who would block a 24-pin connector).

## Fan

As the Zotac ION ITX A is not described as a passively cooled device, there is need for a CPU cooler. The Zotac ION ITX A comes with a **60x60x10mm fan**, but some people feel it to be too noisy. If the PSU of the A+ cupid 3 is removed, then

you can also use fans thicker than 10mm. Yet, you have to watch out as the Zotac board has only the following connectors:

2-pin fan	
3-pin fan	
4-pin fan	used by Zotac's fan

The 4 pin molex adapter is used for the SATA power cables, which means that you have to buy a Y-cable if you want to use a fan with a 4-pin molex jack. However, you may use two 3-pin connectors, because the 4-pin fan connector is backward compatible to 3-pin.

## Overview

The following hardware is being used:

Product	Price
Zotac ION ITX A	150,00 €
Western Digital Caviar Green 2TB	100,00 €
A+ cupid 3	70,00 €
LiteOn DVD+-R/RW/DL/RAM	20,00 €
2x2GB Kingston Value DDR2-800 CL5	75,00 €
60x60x15 Papst 612 F/2L	10,00 €
80x80x25 SilenX iXtremaPro	10,00 €

## Building the Server

### Installing the Mainboard

The user manual of the A+ cupid 3 is not really useful when installing all components as it only gives a short introduction in how to insert HDD and optical drives, but it does not tell you which types of screws to use (except of vertical HDD installation, where you can see it in the images).

There are three types of screws shipped with the A+ cupid 3 case.

"Name"	note	number
Type1	slightly thicker	16
Type2	CD-ROM, slightly thinner	4
Type3	self-cutting	2

As there are only two screws of type 3 which are needed for the vertical HDD and four screws of type 2 used for the optical drive, you need to use type 1 for anything else. This means that when starting with the mainboard, type 1 has to be used. The included back panel does not really fit the Zotac ION ITX, because the WLAN connector is hexagonal while the hole is round. You can either enlarge the hole a bit or just omit the panel. Since I already removed the PSU leaving a big gap, it did not really matter if there was a back panel for the mainboard or not.

Two of the case's front panel connectors do not have descriptions on the polarity, so I added them with the text showing outside—and it seems to work. The USB connector obviously has to be connected to the USB pins on the mainboard, same with the card reader connector (VCC, USB-, USB+, GND). As for the audio connector, there are both AC'97 and HDA adapters included and they look the same; the Zotac ION ITX uses HD Audio, so you have to use the HDA connector.

### Installing the first HDD

The installation of the vertical HDD is described on the case's user manual paper. Just attach the plastic bars to the hard drive with screws type 3 and then move it into the slot.

### Installing the Optical Drive

Optical drive installation is a bit tricky, as I am still not really sure if you should remove the default front panel or not before inserting it. Usually, you would guess that the drive's front panel has to be

removed, because the A+ Cupid 3 has it's own, but if I had removed the front panel of my LiteOn device, the open/close button would not have worked, anymore. Thus, I just left the panel and pushed the device inside from above (with a bit of force).

You then have to carefully align the device and make sure not to let it move while screwing. Just push the open/close button a few times and move the device if it is not perfect, anymore.

## ***Installing the System***

There are some pitfalls when setting up the configuration I am using.

### **Fixing the Hard Drive's Idle Management**

The Western Digital Caviar Green 2TB hard drive will park its reading head after 8 seconds of idle, which is a far too low value (but seems to be part of their strategy to reduce power consumption). Since the HDD is designed to do about 300.000 parking processes, you would reach the critical point after a few months. Western Digital offers a tool to increase the value or disable the functionality totally.

Unfortunately the maximum value seems to be 25.5 seconds, which means that disabling IDLE3 (as the feature is called) remains the only possibility. Luckily, you can still control the HDD via software by using `hdparm`.

The firmware update can be downloaded on Western Digital's support site<sup>1</sup> and can be installed with Ultimate Boot CD<sup>2</sup>. For this, the UBCD has to be altered so that Western Digital's patch is part of it. After having downloaded the UBCD iso-image, it can be mounted to some directory with `mount -o loop ubcd502.iso /mnt/iso/`. The mounted directory might be read-only, so you have to copy everything to another directory (`cp -a /mnt/iso /mnt/iso2`) and then move the patch there. The

patch has to be copied to the directory `ubcd/dosapps/WDIDLE3/`.

After this step you can recreate an iso-image, but make sure to create it as a bootable CD. In my case, executing the following command from within `/mnt/iso2` worked fine: `genisoimage -R -b boot/grub/grldr -V "UBCD WD" -no-emul-boot -boot-load-size 4 -boot-info-table -o /mnt/ubcd.iso ./`

After having booted the new CD, it is possible to start FreeDOS. Switch to the right hard disk (in my case T:) by typing T: then change to the right directory with `cd ubcd/dosapps/WDIDLE3` and finally execute `WDIDLE3.EXE /d` to disable parking of the reading head.

### **Formatting the Hard Drive**

The hard drive has to be formatted according to one's own needs, in my case I created a huge partition for /srv where I store all files spread via NFS.

Since the hard drive uses 4kB blocks, but tells the system that it used 512 Byte blocks you have to make sure that each partition starts at a block number dividable by eight. So when the first usable block is 63, you have to ensure that the partition does not start at block 63, but instead at 64.

You can do this by formatting your hard drive with `fdisk` at first (if the installer for your distribution does not support setting blocks just switch to another desktop using Ctrl+Alt+F2). After your hard drive has been partitioned, switch to expert mode by typing `x` and use `b` to move the beginning of your partition to a number dividable by eight.

### ***Pitfalls Overview!***

The Zotac ION ITX A has a MiniPCIe adapter, but this has special pin assignment and thus cannot be used with any other cards than the included WLAN card.

<sup>1</sup> <http://support.wdc.com/product/download.asp?groupid=609&sid=113&lang=en>

<sup>2</sup> <http://www.ultimatebootcd.com/download.html>

Western Digital's large Caviar Green devices tell to use 512 Byte blocks for compatibility reasons, but uses 4kB blocks internally. Thus you have to take care to format it correctly (see above).

## Enabling Surround Sound

The Zotac ION ITX A supports 5.1 surround sound output via the line-in connections. Officially, this is done with a Windows driver, but it can also be achieved on Linux. To achieve this, you just have to load the audio module with an additional parameter: `modprobe snd-hda-intel model=3stack-6ch-dig`

The following line has to be added to a file in `/etc/modprobe.d/` (e.g. `/etc/modprobe.d/sound.conf`) to make the option available after boot: `options modprobe snd-hda-intel model=3stack-6ch-dig`

Some new options will appear in `alsamixer`, one of them "channel" which can be switched from "2ch" to "6ch". In case all important channels are unmuted, you should be able to hear all speakers when testing with `speaker-test -Dplug:surround51 -c6 -l1 -twav3`.

The new connection assignment will be as follows:

Mainboard	Audio connector
Blue	Black
Green	Green
Pink	Yellow

As the options in `alsamixer` do not seem to be saved even though using `alsactl store`, you need to add a small startscript which will set the option at boot time: `amixer set "Channel Mode" 6ch`

## Installing your Software

Now, feel free to install any software you want. In my case import ones have been Apache, PHP, MySQL and mpd (music player daemon).

<sup>3</sup> <http://ubuntuforums.org/showthread.php?t=1072792&page=3>

## Additional Stuff

### Auto Backup to External HDD

Some people might find it useful to get a backup onto their external hard drive as soon as they attach it. This is possible by writing a custom rule for udev.

You can gather some information about your partition by calling: `udevadm /dev/sdXN`

Now you have to choose some good identifiers. Some udev tutorials use `ATTR{SIZE}`, but as I feel this to be not unique enough, I will use the HDD's serial and partition number.

You can find the serial by using the following command and searching for the section of your HDD (`ATTRS{manufacturer}` and `ATTRS{product}` will be good indicators) and then having a look for `ATTRS{serial}`:

```
udevadm info -a -p $(udevadm info -q path -n /dev/sdc1)
```

Make sure to replace `sdcl` with the block device of your own HDD.

As soon as you know this information, you can add a new rule file (e.g. `/etc/udev/rules.d/10-local.rules`) and add this line:

```
SUBSYSTEMS=="usb",
ATTRS{serial}=="abcdefghijklmn",
KERNEL=="sd?1", RUN+="/root/backup-to-external.sh"
```

The rule has to be written in **one single line** and the number after the question mark is the partition number of your external hard drive's partition. The file after RUN is the command to be executed as soon as the device is attached. You might refer to the `udev manual4` and some tutorials<sup>5</sup> to get some more information about the meanings of each block.

The bash script `backup-to-external.sh` will then execute all commands needed for backing up the files (e.g. `rsync`).

<sup>4</sup> <http://linux.die.net/man/8/udev>

<sup>5</sup> [http://www.reactivated.net/writing\\_udev\\_rules.html](http://www.reactivated.net/writing_udev_rules.html)