

This application note is related to all uEye USB cameras connected to PC systems using current CPU models that implement modern energy saving technologies.

Symptoms:

- Low USB bandwidth provided by the PC system
- TransferFailed errors occurring even at moderate pixel clock settings
- Camera operates at low speed only

Summary:

Current CPUs with modern energy saving features can cause bandwidth limitations on USB.

The only available approach to this issue is to disable CPU sleep states. Unfortunately this is not possible for all systems.

IDS Imaging is in contact with different PC manufacturers and at the same time trying to find a solution itself.

Detailed explanation:

Modern CPUs like Intel i5 & i7 and others make use of advanced energy saving technologies ensuring a low power consumption and long battery life for mobile devices. Additionally those CPU implement features for increasing the performance of single cores if there is enough thermal headroom available when other cores have little load.

A basic idea to achieve this is to put a CPU core to sleep while there is nothing to do for it. Various different activity states of CPU cores are available in modern CPUs. These CPU states are referred to as "C-states". C0 is the working state of a core. Increasing numbers refer to less activity and longer wake up times. Current CPU fall down to variations of the C3 state which are referred to as "Sleep", "Deep Sleep" and similar.

Unfortunately negative effects of the sleep states have shown up. It is observed that the available bandwidth of PC busses drops significantly when part of the CPU enters these states.

The operation of uEye USB cameras is affected by the sleep states because they reduce the speed of the USB system. The available bandwidth on the USB may drop down to around 30% of the maximum bandwidth when the CPU, or one of its cores, enters sleeping states.

One would expect that a CPU core will not fall into a sleep state while it is obviously needed for the operation of the USB. But obviously USB data transfers do not prevent the CPU from falling to sleep. If the code execution load of a CPU core is low enough it will fall asleep and immediately reduce the USB bus speed.

For operation at high frame rates uEye cameras require an adequate USB bandwidth which might not be available when CPU cores are in sleep states.

Advice:

If you seem to be running into this low bandwidth issue please check and try the following. These first hints are general recommendations for issues with the USB data transfer.

You can check the USB performance with the “Optimum” pixel clock settings checkbox in uEye Demo software. A good USB system should be able to reach a pixel clock setting near the maximum value.

- Please remove other USB devices from the system (USB keyboard and mouse are fine). Run tests with only one camera connected at once.
- Make sure using a USB port directly on the mainboard. Front panel or other ports are connected to the mainboard with poor cabling quality frequently.
- Make sure to use USB2.0 certified cables to connect the camera.
- If you are using USB hubs or extensions: Run a test without these devices, connect the camera directly to the PC.
- Disable other equipment that is connected via USB. For example WLAN and Bluetooth adapters might use USB to connect.
- If you are using a mobile PC: run it on mains power, not battery.
- Check your energy saving options in the operating system. Disable energy saving features and set the available features to “full performance” or similarly named options.

If you checked the above and still observe low USB performance you might be experiencing the issue with CPU sleep states.

Here are some options how to deal with USB problems caused by CPU sleep states.

The reduced USB bandwidth is directly related to the CPU cores that use the sleep states. For getting rid of the low bandwidth one has to prevent the sleep states. This will reduce the battery life of mobile systems significantly. For this reason some PC manufacturers do not allow disabling the sleep states on their systems.

1. Disable sleep C-States in your system BIOS.

The relevant switch should be located in categories "Performance", "Energy Options", "CPU" or similar. You will have to disable the TurboBoost or TurboCore feature as well. These features rely on sleep states and might enable them again although you have set them to disabled.

When the sleep C-states are disabled you should observe an increased USB bandwidth and a significant increase in camera speed.

2. In case the BIOS does not offer an option for disabling the sleep states you may try to get a BIOS update for your system. Please contact your system manufacturer or check their website for an update.
3. If you do not find a way to disable the sleep states you might try to stop the CPU from using them. For example a small program might run in the background and prevent the CPU from falling asleep.

Summary:

Current CPUs with modern energy saving features can cause bandwidth limitations on USB. This is a direct consequence of CPU cores falling into so-called sleep states. CPU cores enter these sleep states independently from the load level on the USB.

The only available approach to have full USB speed on these systems is to disable CPU sleep states. This is done via BIOS switches which might be available after a BIOS update only. Disabling CPU sleep states increases the power consumption of the system and therefore is prevented on some systems.

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