

Optimising Camera USB Transfer Rates

USING SHARPCAP AND A CMOS CAMERA

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Introduction

This document describes how to adjust a camera's USB settings in SharpCap in order to achieve maximum frames per second (fps) with zero dropped frames. The camera controls vary between manufacturer. The techniques used in this investigation can be applied to all cameras.

The document describes the USB controls for:

- QHY, QHY5LII-M, USB2 1.2 mega pixel mono camera
- ZWO, ASI120MC, USB2 1.2 mega pixel mono camera
- Altair, 183C v2, USB3 20 mega pixel one shot colour camera

Maximum frames per second (with zero dropped frames) is desirable when engaged in lunar/planetary imaging.

Incorrect USB control settings can result in:

- less than optimal fps
- dropped frames
- or even no frames at all

***** Ensure the latest drivers have been installed. These will be available from the camera manufacturer's website.**

General

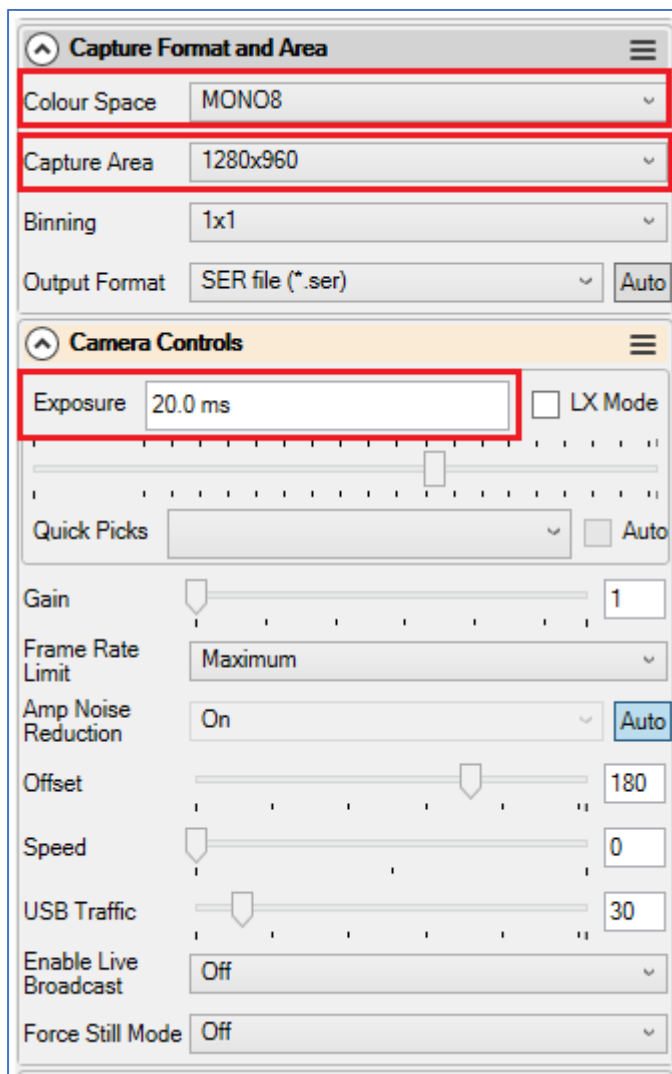
Settings which affect fps:

- Colour Space
- Capture Area
- Exposure
- USB controls (variable depending on camera manufacturer)

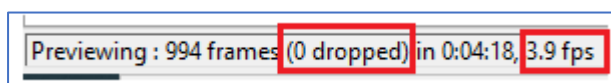
The impact of the USB controls must be understood if maximum fps rates and reliable operation are to be achieved.

The tests carried out below can be performed inside using just the capture PC and camera. No telescope is required. Once it is understood how best to configure the camera for maximum reliable frame rate, these settings can be applied to an imaging session.

The settings which affect frame rates are highlighted in the image below.



The fps indicator can be found at the bottom left of the SharpCap window.



The fps rate is shown for a given group of settings. The frames dropped figure is useful.

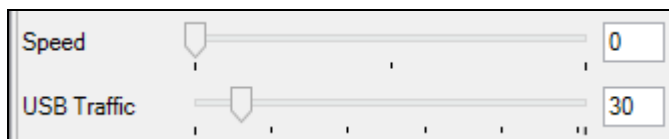
- Dropped = 0 indicates the settings are good but not necessarily optimal.
- Dropped not equal to 0 but in single digits can be caused by changing camera settings such as Colour Space and is not a problem.
- Dropped increasing rapidly is an indicator that the USB settings are too aggressive and the capture PC's USB bus is being over-run. In this scenario, the USB settings will need to be adjusted.

The objective, for reliable imaging, is to adjust USB settings to achieve maximum fps with no dropped frames.

For testing purposes, the exposure has been set to 10ms. This is a typical exposure setting used when capturing lunar images.

QHY5L11-M

These are the USB camera controls for the QHY5LII-M (and QHY5LII-C) available in the camera control panel.



Speed has 3 settings - 0, 1, 2

USB Traffic has a range 0..255

For the test laptop, with the camera attached to a USB2 port, here is a summary of the fps rates achieved.

Colour Space = MONO8, Capture Area = 1280x960, exposure = 10ms

USB Traffic	Speed	Frames per second	Frames dropped
255	0	0.7	0
255	1	2.2	0
255	2	3.5	0

Speed	USB traffic	Frames per second	Frames dropped
2	255	3.5	0
2	0	26.5	0

The optimum USB settings for this camera, with the laptop used, are Speed = 1, USB Traffic = 0.

The USB Traffic setting is counter intuitive but that was a manufacturer choice.

By changing the Colour Space to MONO16, the fps becomes 14.1 (approximately halved). This is because with higher bit depth more data is transferred from the camera to the PC. *Note that changing the Colour Space sets the Speed to 1 and it needs to be adjusted back to 2.*

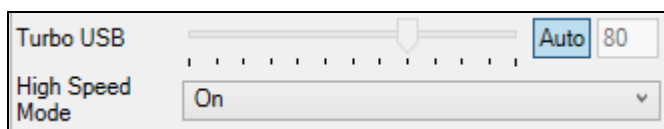
A summary of Colour Space & Capture Areas fps rates

Capture Area	MONO8	MONO16
1280x960	26.5	14.1
800x600	46.5	23.2
640x480	57.5	28.9

The fps range is from 14.1 up to 57.5 depending on the combination of Colour Space and Capture Area.

ZWO ASI120MC

These are the USB controls for the ASI120MC available in the camera control panel.



Turbo USB has a range from 40..100. The default of Auto (80) is usually a reliable setting.

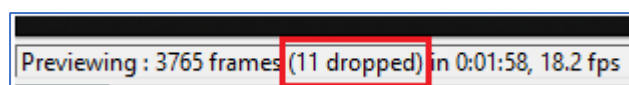
High Speed Mode can be On/Off.

High Speed Mode may improve the frame rate under some circumstances. High Speed Mode changes from using the 12bit ADC on the camera to using a 10bit ADC. Enabling high speed mode may increase image noise when the gain is set to a low value.

For the test laptop, with the camera attached to a USB2 port, here is a summary of the fps rates achieved.

Colour Space RAW8, Capture Area 1280x960, Exposure = 10ms

High Speed Mode	Turbo USB	Frames per second	Frames dropped
On	40	14.0	0
On	80	27.4	0
On	100	32.9	1 every 5s



High Speed Mode	Turbo USB	Frames per second	Frames dropped
Off	40	13.3	0
Off	80	18.0	0
Off	100	18.3	0

A safe setting with a good fps throughput is to use Turbo USB Auto (80) and High Speed Mode = On.

A summary of Colour Space & Capture Areas fps rates.

Capture Area	RAW8	RAW16
1280x960	27.5	13.5
780x608	69.1	34.6
640x480	99.5	54.8

The fps range is from 13.5 up to 99.5 depending on the combination of Colour Space and Capture Area.

Altair 183C

This is the USB speed control available in the camera control panel.



There are 3 settings 0, 1, 2.

For the test laptop, with the camera attached to a USB3 port, here is a summary of the fps rates achieved.

Colour Space = RAW8, Capture Area = 5440x3648, exposure = 10ms

USB Speed	Frames per second	Frames dropped
0	8.8	0
1	13.5	0
2	17.9	0

A summary of Colour Space & Capture Areas fps rates.

Capture Area	RAW8	RAW12
5440x3648	17.9	8.8
1920x1200	35.8	8.8
1280x1024	35.8	8.8
800x600	35.8	8.8
640x480	35.8	8.8

A RAW12 5440x3648 frame is 38Mb. This camera is targeted at deep sky, wide field images rather than lunar/planetary imaging.

Exercises

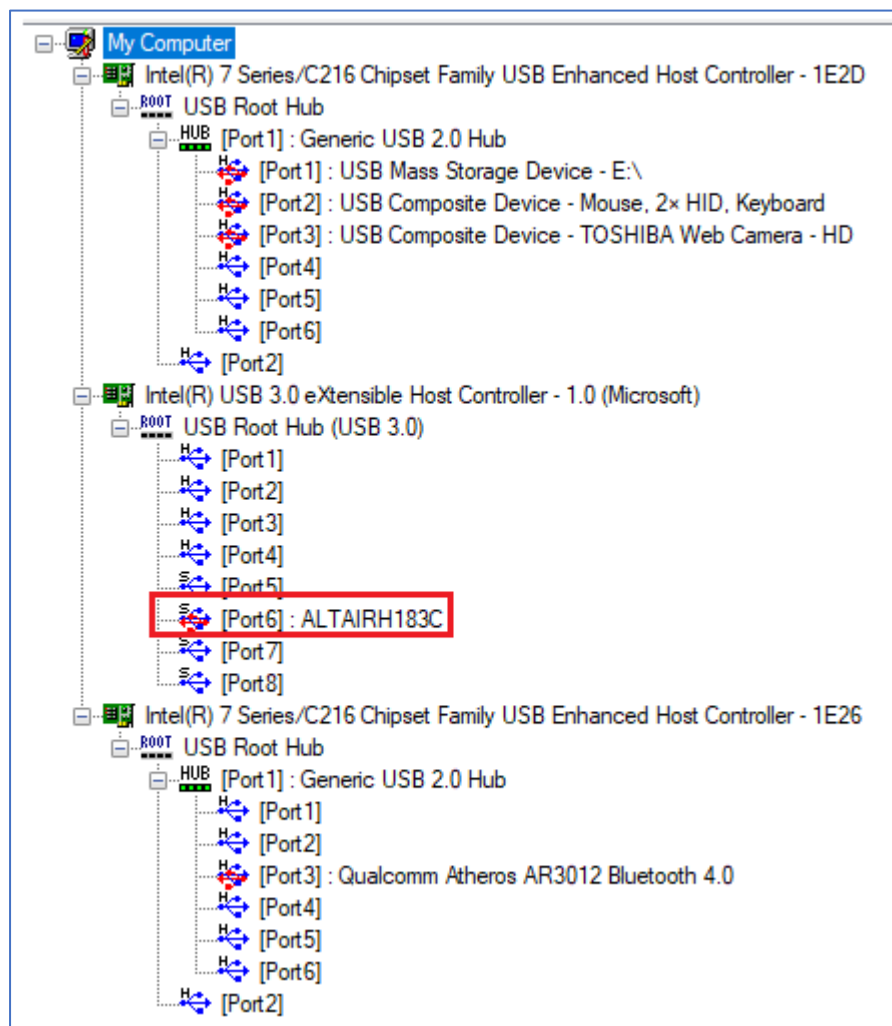
1. Identify the USB speed controls for a camera you have.
2. Identify the minimum and maximum values for the USB controls.
3. Set the Colour Space to RAW8/MONO8 or equivalent.
4. Set the Capture Area to maximum available.
5. Set the exposure to 10ms.
6. Investigate and record the fps and dropped frames for the minimum and maximum values of the camera USB controls.
7. Using the best combination of settings from above draw up a table using different Capture Areas and 8/16-bit Colour Spaces.
8. This information should now provide the best settings for reliable USB operation when carrying out lunar/solar/planetary imaging.

Troubleshooting

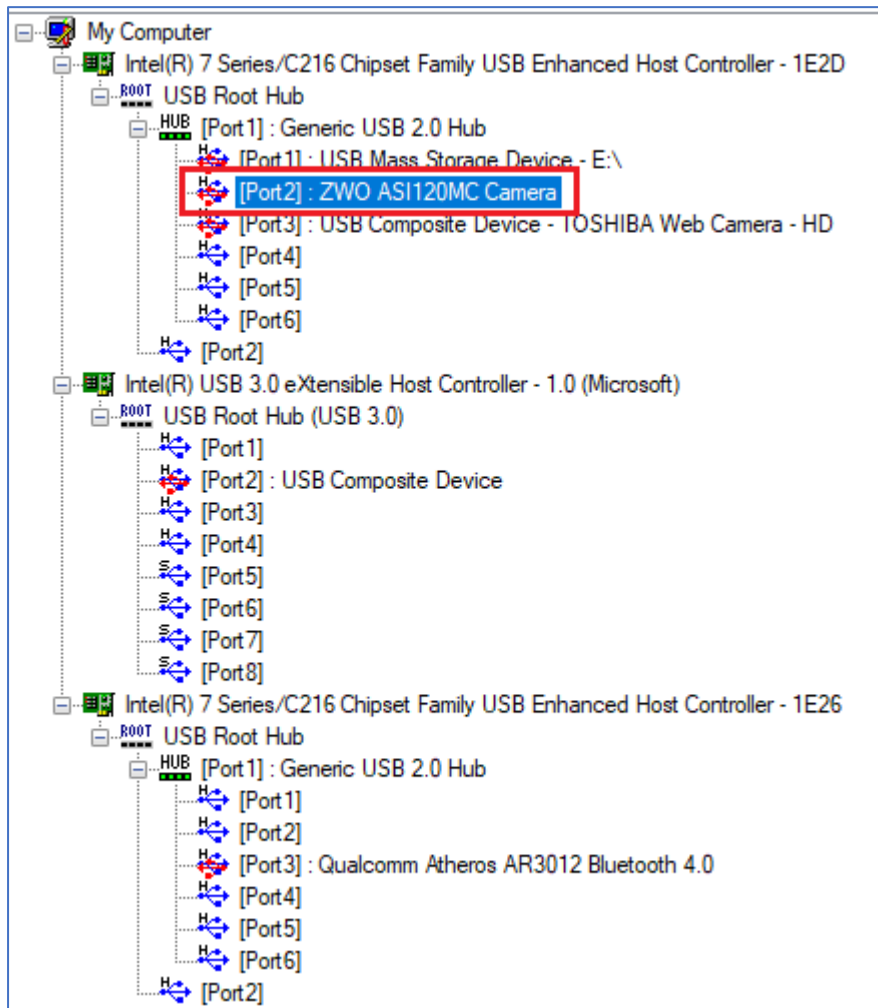
The laptop used for the tests was a Toshiba Satellite Pro C50. The laptop has 1 x USB2 port and 2 x USB3 ports. As can be seen in the diagrams below the USB architecture comprises 2 USB2 Enhanced Host Controllers and 1 USB3 extensible Host Controller.

If difficulties are encountered with USB connectivity, a useful tool to investigate what is happening is USBtreeView which can be downloaded from https://www.uwe-sieber.de/usbtreeview_e.html.

The image below shows an Altair 183C camera connected to a USB3 port. The successful USB3 connection is indicated by the 'S' which is 'SuperSpeed' or USB3.



The image below shows a ZWO ASI120MC camera connected to a USB2 port. The successful USB2 connection is indicated by the 'H' which is 'HighSpeed' or USB2.



If having difficulty with USB connectivity, then submitting an image such as the above will assist when posting to the SharpCap forum.