



Digital Star Trails Photography

by Duane Cassone



This is a technical paper on Digital Star Trails Photography. The intention of this paper is to provide the photography community with fundamental instructions on shooting star trails with your digital camera. If you're looking for a quick and simple one-page field guide, read or print page 7 and skip all the technical stuff.

I've always been interested in astrophotography and wanted to try my hand at shooting star trails with my digital SLR camera. In October of 2010, I did some research, grabbed my camera, and gave it a shot (no pun intended). I want to share my experiences with others to bring fellow photographers up to speed with shooting star trails with a digital SLR. A couple of very popular photographers, who appear regularly in various publications, have written articles on the topic, but I found their instruction to be incomplete, misleading, and sometimes inaccurate. There are some books written on the topic as well, but I can't see why a book would be necessary....

Digital Camera Primer - Shooting Star Trails (Technical)

Introduction

In the film era, after determining which film was best, one would just point the camera at the sky, open the shutter, and expose for an hour or more. The Earth rotates while the stars stay put and voila! The camera records a “trail” of stars! It’s not as simple with digital, but, in many ways, digital offers more opportunities. With digital, one can control each exposure more so than with film. Film continues to absorb light over time, eventually blowing out the image, but with stacks of many shorter exposures, you can keep the sky darker. Digital offers White Balance choices, while film does not. Fiddling with the first few frames, such as light painting a foreground object or leaving some frames out for a *leading star*, can be really cool.

Digital camera sensors begin to create *noise* after about 2 to 4 minutes of exposure depending on the camera, sensor, ISO settings and other factors. Therefore, if you plan on capturing long trails with a digital camera you should consider an **intervalometer (next page)**. You can shoot one really long exposure, say 90 minutes, or the extent of your battery, but you risk frying your sensor and blowing out the image. I recently took a 90 minute exposure, accidentally, with my D200. The resulting image was awesome, but it’s possible the cold weather (~30° at 2am) may have saved my sensor from overheating. Also, I noted that the long digital exposure exhibited issues similar to that of film’s reciprocity. After a while, noise was no longer an issue, but the image began to blow out.

The plan is to take many (50 – 350) exposures at ~90 seconds to 2 minutes long and use software to “*stack*” the exposures into 1 image. There are a number of steps to consider, but I’ll start with Power.

Power

Ideal star trails require a very long exposure; 1 – 4 hours. Most digital cameras are going to be challenged with limited battery life, so I looked for something to extend it, affordably. We can’t change batteries in the middle of a shoot for risk of jostling the composition, so we use an alternate and portable source of power. You can shoot with camera battery life alone, but the star trail will be shorter. You can use a 12V to 120V power inverter on the car cigarette lighter and an AC adapter available for your camera, but then you have to be near your car. You can lug a battery and inverter out to a remote location, but that’s a lot of lugging. We like the 5 in 1 power pack unit by Chicago Electric, which is sometimes available through [Harbor Freight \(http://www.harborfreight.com\)](http://www.harborfreight.com) or checkout the Peak PKC0BK 450 Amp Jump Starter product found on Amazon for around \$100. It comes with a built-in inverter and 120V socket which can be used with your camera’s AC adapter. You can find other models for around \$100 to \$150 at most major hardware stores. You can still get decent star trails without the extra battery power, so don’t be discouraged if you don’t get the really long trails. 5, 30, 60, 90, 160 minutes of stacked exposures can make a GREAT image with trails and may be possible with just battery life. The longer you expose, the longer the trail.

Should you choose to shoot on camera battery power only, be sure to pack as many as you can and ensure they’re fully charged before you leave home. Remember, cold weather decreases battery life. Should you choose to use an alternate source of power beyond your batteries, you’ll need to purchase your camera’s AC adapter. Generated power is an option, but generators are often prohibited or can only run on restricted hours. They’re also noisy, heavy, and cumbersome.

Special camera battery packs are available, but they’re usually cost prohibitive.

Intervalometer

This is an advanced remote shutter release. It can be programmed to shoot in intervals such as 1 shot every X minutes for X exposure time. It has a start/stop function as well as a remote shutter button with lock that conveniently counts up to indicate how long your exposure is running. There are several options available; Nikon and Canon make their own. I recommend you stick with the big name brands here. I've tried others, and found them to be insufficient. An intervalometer will make long exposure star trail and time lapse photography possible. You'll discover other uses I won't discuss here... I think they're a must-have in everyone's camera bag.

**Special note on the Nikon MC-36 intervalometer. When setting it, remember to include the exposure time in your interval. For instance, if you want a bunch of 2 minute exposures, you set the LENGTH to 2:00 minutes and the INTERVAL to 2 minutes + 1 second or 2:01. The result will be two minute exposures with a 1 second break between them.*

No Intervalometer?

Some cameras come with a *menu driven* internal intervalometer. However, they're often cumbersome, difficult to understand, and, therefore, not a good choice for setting in the field. If you can't or don't want to purchase one, here's a method you can use to capture the images you need to make a star trails photo: Set your camera for 30 seconds or as long as the camera will go before BULB, put in continuous or burst mode, then lock the cable release down to take a card full of images. No guarantees, but that should do it. This method is an interesting option as it reduces the delay between exposures, which consequently reduces the 'Morse coding' effect. Test before you make the trip out of town.

A 30 second exposure probably requires a slightly higher ISO, so this may only be possible with the higher end cameras offering excellent images at 800 ISO or higher. Test it before you go! This mode works well when there's a little moonlight to help out.

Digital Camera Settings & Picture Checklist

There are many ways you might decide to program your camera for long star trails exposure. Here are some suggestions for starters and other tips. With my Nikon cameras, I like ISO 100 or 200, F2.8 or 3.5, and 60 second exposures, but have successfully captured amazing images with many other settings.

- ✓ Use a sturdy tripod
- ✓ Select a wide angle **lens** preferably in the range of 14 – 24, and up to 50mm
- ✓ Compose your shot.
- ✓ **ISO** - High ISO will collect more stars, but will also pickup more ambient light especially on the horizon.
 - 100-400 for longer exposures (1-2 minutes)
 - 800+ for shorter times (30 seconds to 1 minute)
- ✓ **F-Stop** – Open the lens to f 2.8 or your largest aperture available
- ✓ Set your **focus** on the camera and lens to **manual at infinity**. You can lock the lens in position with painters tape for additional insurance
- ✓ Turn lens **VR off**
- ✓ Turn camera **noise reduction OFF!** Consider Nik® Define to remove any noise from your images instead
- ✓ No **mirror lockup**
- ✓ Turn off **image review**
- ✓ Shoot **RAW** when possible
- ✓ **WB** setting really depends on the camera, but it's best to choose one. If shooting RAW, you can change it in post processing
- ✓ **Remove UV** "skylight" filter as it can produce "ghosting"
- ✓ Set intervalometer with 1 second **intervals** or less if you can

Timing

Star trails should be shot during a new moon, aka “no moon”. Even a sliver of moonlight can infiltrate a star trails long exposure. When using the stacking method, and especially when shooting in a direction with a known commercial flight path, consider starting your longest exposure after 11:30pm when most planes have landed and the sky is darkest. Just set the intervalometer and hit the sack!

Later in the evening, especially at campsites, there are less light intrusions. Less people have a campfire going or lanterns. Also, there are fewer cars on the road.

Orientation, Star Trails Behavior & Shot Selection

1. Long Trails; Stacking 150 to 350 images combined taken at 1 minute exposures using intervalometer and alternate power source. Usually results in 1 or two successful images per camera in a single evening.

**200 stacked exposures, 1 painted frame
60 seconds at f / 28 Nikor 10.5mm, ISO 200
11pm-4am, March 3-4, 2011**



2. Short trails; 1 long exposure around 2 to 10 minutes, some trailing and often more attention to foreground. You can take a lot of these in one evening. *(this image is an example, but not actually from a single exposure)*

**10 stacked exposures, 1 painted frame
120 seconds at f / 2.8 Nikor 20mm, ISO 320
1am July, 29, 2011**



What makes a Star Trail?

As Earth rotates the stars appear to move slowly across the sky. This movement is what we want our cameras to record in the form of a star trail. The longer the exposure time, the longer your trail will be.

In the north sky, from my vantage point in North America, just above the horizon is Polaris (the northern Star). This star, and its southern compliment, appear to remain stationary as we rotate on Earth's axis. All other stars appear to circle around these two stars. Therefore, if you aim north, all stars appear to circle Polaris. At the equator, usually straight up in the sky, are the largest circles, which make for a straighter trail. Aim your camera towards the equator and you get straighter convex and concave trails as the largest circles begin to get smaller and smaller as they near the southern and northern stars.

Stars nearer to Polaris appear to move slower, so for longer trails, you'll need more exposure time. Stars nearer to the equator appear to move more quickly, which is something to consider if you're short on battery life.

Deciding what to shoot?

- ☆ Do you want the circular trails?
- ☆ Do you want straight, streaking trails?
- ☆ Are there clouds?
- ☆ Is there too much ambient light on that horizon?
- ☆ Are there commercial flight paths in that direction?
- ☆ What is your foreground?
- ☆ What lens are you using?

Light Painting & Flashlights

Flashlights & Headlamps

You're going away from the city during a new moon; it's going to be really dark! Headlamps are the preferred light source for getting around as a flashlight can tie up a hand when you need it. In any case, you should **BE ABLE TO FILTER YOUR HEADLAMP AND FLASHLIGHT RED**. Our eyes need to adjust as best possible for the duration of what will be a long night in a dark desert. Having a bright light beamed into your eyes by a fellow photographer just doesn't work.

Light Painting

When shooting in groups or around other photographers; light painting should be a coordinated event in order to avoid contaminating other photographers' shots.

Tungsten flashlights offer the best tone and can be filtered with color gels. LED flashlights emit a subtle blue toned light and make for a great effect as well. Small and large powered, pinpoint and flood flashlights offer different opportunities. Headlamps work too, but the light from them can infiltrate your images if you leave them on while exposing. Make sure to aim your headlamp away from the composition or just shut it off until you're clear. I suggest backlighting and side lighting for foreground objects. Remember that a little goes a long way. Test and check your LCD display first.

For stacked star trails images, I recommend light painting in the first frame or two. When you put it all together, you can decide to include the painted images in your foreground, or not.

Respect Others

All it takes is 1 headlamp or flashlight to ruin a shot for another photographer. Avoid walking through shots by adhering to the predetermined rules of egress such as following lighted or otherwise marked paths, shooting schedules, and limiting your use of flashlights especially those that are not RED filtered. Be sure to use headlamp in its **RED** mode at all times. We use a red filtered headlamp to help our eyes remain dilated as much as possible to see well in the dark when the artificial sources are all off.

Software

When you're ready, you can download the free software to compile your star trails image

Startrails (Windows) - <http://www.startrails.de/html/software.html>

StarStaX (Windows and MAC) - <http://www.markus-enzweiler.de/StarStaX/StarStaX.html>

Russell Browns Script for Adobe Photoshop CS5 and Bridge - <http://russellbrown.com/scripts.html>

Tips for the Digital Darkroom

So as not to *leave you in the dark*, here are some tips for the digital darkroom.

- ☆ If you shot RAW, you will be able to adjust the White Balance settings of your images before stacking them with Achim's software. I use Adobe Lightroom®, which offers features to apply changes to many images at a time.
- ☆ If you light painted in your first few exposures, you can try stacking with and without the painted images to see which looks better!
- ☆ If you leave out the second, third, and fourth exposures from your stack of images (or even the second, third, and fourth to last), your final trails image will have a really cool "leading star" effect.

My Pictures

To see some of my images, visit my personal web page <http://cassonephotography.com> and on Facebook <http://facebook.com/CassonePhotography>

Contact me

I'd love to hear from you. Were you successful? Did my paper help you? Do you have questions? Please, send me an email. I'd love to see the results of your shoot. Shoot me an email anytime duanec@creativephotoacademy.com.

Special Thanks

Special thanks to my father-in-law, John Peterson who's with me every step of the way and who is also a great star trails photographer. See John's work here at <http://petersonspad.com/> Thanks also to my supportive friends, who have been dubbed the "Space Cowboys" for your continued friendship and influence. Mark Comon, of Paul's Photo in Torrance, CA, who is my photography instructor and mentor; <http://creativephotoacademy.com> and <http://paulsphoto.com>. And my late friend and fellow "Space Cowboy", John Bohner - I will think of you every time I shoot the night sky. "*We are all star stuff*" – Carl Sagan

-Duane Cassone



Quick Reference Guide to Digital Star Trails Photography (Simple)

By Duane Cassone

Star trails should be shot during a new moon (no moon). The plan is to take many (50 – 350) exposures at maybe 30 seconds to 4 minutes long and use software to sandwich or combine the many images into 1 image. If you choose to shoot on camera battery power only, be sure to pack fully charged batteries. Remember, cold weather decreases battery life. Should you choose to use an alternate source of power beyond your batteries, you'll need to have your camera's AC adapter and a 120V power source.

(Nikon MC-36) When **using an intervalometer**, remember to include the exposure time in your interval. For instance, if you want a bunch of 2 minute exposures, you set the LENGTH to 2:00 minutes and the INTERVAL to 2 minutes + 1 second or 2:01. The result will be two minute exposures with a 1 second break between them. If you're **not using an intervalometer**, set camera for 30 seconds or as long as the camera will go before BULB, put in burst mode, then lock the cable release down to take a card full of images. A 30 second exposure probably requires a slightly higher ISO, so this may only be possible with the higher end cameras offering excellent images at 800 ISO or higher.

Shot Selection

1. Stacked, long trails i.e. 150 to 350 images combined taken at 1 minute exposures using intervalometer and alternate power source. Usually results in 1 or two final images per camera used in a single evening.
2. One Long Exposure, short trails i.e. usually around 2 minute exposures, some trailing and often more attention to foreground. You can take a lot of these in one evening.

Before you leave

Determine photo goals
Fully charged batteries plus extras
120V Power pack (*Optional*)
AC/Adapter (*Optional*)

Test settings and equipment before photo trip
Headlamp with **RED** light or filter option
Intervalometer (*Optional*)
Painting Flashlights (*Optional*)

Get Ready to Shoot

- Select a wide angle **lens** preferably in the range of 20-35, and up to 50mm
- ISO** - High ISO will collect more stars, but will also pickup more ambient light especially on the horizon.
 - 200 for longer exposures (1 – 4 minutes)
 - 800 for shorter times (30 seconds to 2 minutes)
- F-Stop** – Open the lens all the way, 2.8 or near largest aperture possible
- Set your **focus** on the camera and lens to **manual at infinity** (some choose to tape it down)
- Turn lens **VR off**
- Turn camera **noise reduction OFF!**
- No **mirror lockup**
- Turn off **image review**
- WB** setting depends on the camera. Test in advance, shoot RAW when you can. Pick one for consistent images.
- Remove UV** “skylight” filter as it can produce “ghosting”
- Set intervalometer with 1 second intervals to reduce “Morse coding” or time between frames or set to CH (Continuous High speed mode) and set shutter speed to 30”.