



Getting Started with Your Converted Infrared or Full-Spectrum Camera

by Rob Shea

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First Edition

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<https://www.robsheaphotography.com>

<https://blog.robsheaphotography.com>

<https://www.youtube.com/c/RobSheaPhotography>

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Introduction

Welcome to the hidden world of infrared photography! This book is designed for new infrared photographers who have converted a camera to infrared or full-spectrum. This book covers the styles of infrared photography, using external filters, selecting lenses, settings for shooting with your converted camera, and how to process your infrared images. Infrared photography can be challenging and rewarding. This book will help to get you started. When you are ready for more, there are links to blog articles and videos covering more advanced topics.

Short Intro to Infrared Photography: https://youtu.be/8k_vOSs8-lc

Long Intro to Infrared Photography with Q&A: <https://590.red/intro>



590 nanometer (nm) infrared image

Styles of Infrared Photography

Here are some of the distinct styles of infrared photography.

Traditional Infrared

Traditional infrared photography is shot with a 720 nanometer (nm) high-pass filter. This filter blocks light with wavelengths of light below 720nm, including most visible light and ultraviolet light. It allows infrared light and a small amount of red light to pass to the sensor. Traditional infrared images are commonly characterized by blue skies and white foliage.



Infrared image with 720nm filter



Infrared image with 720nm filter

Black and White Infrared

Any image shot with an infrared or full-spectrum camera can be processed as black and white.



Infrared image with 590nm filter converted to black and white



Infrared image with 590nm filter converted to black and white

Deep Infrared

Deep infrared images capture only infrared light. These images use an infrared filter that only allows light above 750nm to pass, commonly an 830nm or 850nm filter. They are processed as black and white.



Infrared image with 850nm filter



Infrared image with 850nm filter

Color Infrared

Color infrared images capture infrared light and some visible light, allowing them to be processed like traditional infrared images, but with more colorful results. Color infrared images can only be captured with a converted camera and an infrared filter from about 470nm to 665nm.



Infrared image with 590nm filter



Infrared image with 590nm filter

Full-Spectrum

Full-spectrum images capture all of the wavelengths of light that your sensor can detect, including visible light, ultraviolet light, and infrared light. Ultraviolet light adds a violet cast to the image, while infrared adds a red cast to the image. Full-spectrum images can only be captured on a full-spectrum converted camera.



Full-Spectrum image



Full-Spectrum image

Chrome

The Chrome style emulates the look of *Kodak Aerochrome* infrared film. Chrome filters are dual-pass, capturing red and infrared light in the high pass and blue light in a second pass. Chrome images can only be captured on a full-spectrum converted camera with an external chrome filter.



Chrome infrared image



Chrome infrared image

Ultraviolet

Ultraviolet images capture only ultraviolet light. Ultraviolet light can reveal skin pigmentation not visible to the naked eye. While technically not “infrared”, ultraviolet photography uses converted cameras and filters just like infrared photography. Ultraviolet images can only be captured with a full-spectrum converted camera and a low-pass ultraviolet filter.



Ultraviolet portrait



Ultraviolet portrait

External Filters for Infrared Photography

External lens filters can be used with your converted camera to achieve a variety of infrared styles. Here are some general guidelines to follow for external lens filters.



The same scene with three different infrared filters: 590nm, 720nm, 850nm.

On Full-Spectrum Converted Cameras

The primary benefit of full-spectrum converted cameras is that they can be combined with external lens filters to produce any style of infrared photography. The downside is that you will need an external filter to shoot any style except full-spectrum.

- Traditional Infrared - Add a 720nm filter.
- Deep Infrared - Add a 750nm or greater filter.
- Color Infrared - Add a 470nm, 590nm, or 665nm filter.
- Chrome - Add a Chrome filter.
- Ultraviolet - Add an ultraviolet low-pass filter.
- Full-Spectrum - No filter required.
- Visible light - Add a Hot Mirror filter to block UV/IR light and capture a visible light image.
- Black and White - Use any of the above combinations can process as black and white.

On 590nm Color Infrared Converted Cameras

Cameras converted with a 590nm internal filter can shoot a variety of styles including traditional, deep infrared, color, and black and white. They can use filters with higher-numbered cut-offs, but not lower. The same applies to cameras converted to 470nm or 665nm, they can use higher-numbered filters, but not lower.

- Traditional Infrared - Add a 720nm filter.
- Deep Infrared - Add a 750nm or greater filter.
- Color Infrared - No filter required for 590nm. Add a 665nm filter for less color. Filters with a cutoff lower than 590nm cannot be used.
- Black and White - Use any of the above combinations can process as black and white.

Chrome, ultraviolet, full-spectrum, and hot mirror external lens filters will not work properly on a 590nm converted camera as light below 590nm will be blocked by the internal filter.

On 720nm Traditional Infrared Converted Cameras

Cameras converted with a 720nm internal filter can shoot traditional infrared, deep infrared, and black and white styles. They can use higher-numbered filters, but not lower.

- Traditional Infrared - No external filter required.
- Deep Infrared - Add a 750nm or greater filter.
- Black and White - Use any of the above combinations can process as black and white.

Color, chrome, ultraviolet, full-spectrum, and hot mirror external lens filters will not work properly on a 720nm converted camera as light below 720nm will be blocked by the internal filter.

External Filter Recommendations

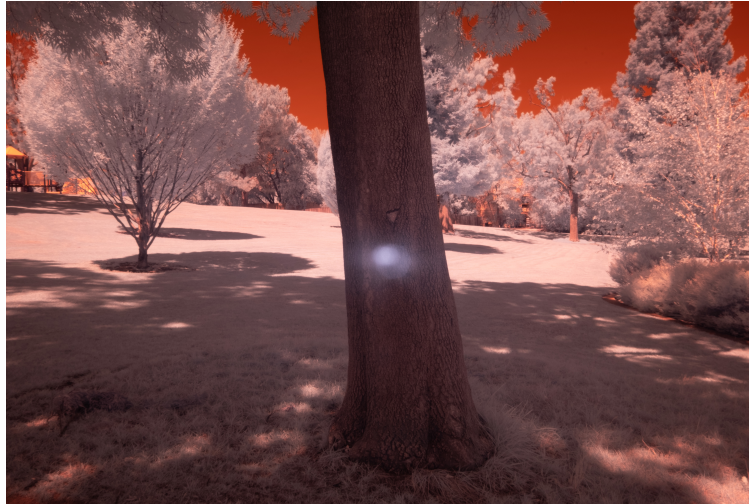
Filter quality matters. I recommend using quality filters from top brands such as *B+W*, *Hoya*, *Kolari Vision*, *LifePixel*, or *Tiffen*. Avoid low-quality filters or “variable” cut-off filters.

Filters can be expensive. If you haven't decided what style you wish to shoot, you may wish to try a variety of low-cost filters to determine your favorite styles, then purchase higher quality filters of your favorite style.

Review of Neewer Infrared lens filter kit: <https://youtu.be/shw2rdEkGMY>

Lenses for Infrared Photography

Lens selection can be tricky with infrared photography. That's because about half of all lenses display hot spots in infrared images. Hot spots are overexposed circles that appear in the center of the image. While these can be fixed in processing, the effect is complicated with overlapping hot spots of various sizes impacting exposure and color. It's best to avoid shooting infrared images with lenses that display hot spots.



Infrared image with hot spots

Hot Spot Factors

Before researching or testing your lenses, it's helpful to understand some common factors relating to hot spots.

- Prime lenses tend to be less impacted by hot spots than zoom lenses. Zoom lenses are a marvel of science and convenience, but require some internal complexity to work properly. This complexity tends to increase the likelihood and severity of hot spots. Prime lenses tend to have few hot spots as a result.
- Vintage lenses, used with 35mm SLR film cameras, tend to be less impacted by hot spots than modern lenses. This is likely due to the modern coatings and more complex optical formulas in newer lenses. Vintage lenses have fewer hot spots as a result. Vintage lenses can be easily paired with mirrorless cameras using inexpensive adapters.
- On some lenses, lower f-stop numbers (wider apertures) will produce mild or no hot spots. Higher f-stop numbers (narrower apertures) will produce hot spots or more severe hot spots. While you will have more flexibility in settings with lenses that offer no hot spots at any aperture, you may find certain lenses are useful so long as you remain below the f-stop where hot spots are visible.

Vintage Lenses

Infrared with vintage Canon FD 24mm f/2.8: https://youtu.be/BA_IzuiHN5Y

Infrared Photography with vintage Nikon 24mm: <https://youtu.be/nSV3fjBXSo8>

Infrared with Vintage Budget Prime Lenses: <https://youtu.be/PAw6xaVKdVk>

Testing for Hot Spots

Before embarking on any photo trips, be sure to test your lenses for hot spots in infrared. Here are the steps for testing your lens in infrared on your converted camera. For consistency, use a tripod.

1. Select a scene in direct sunlight. Ensure that the center of your scene is uncluttered. A broad tree trunk, grass, or pavement are good subjects.
2. Set the ISO to the lowest value on your camera: 50, 100, or 200.
3. Set your shutter to automatic.
4. If using a zoom lens, select the widest (lowest-numbered) focal length in mm.
5. Set the aperture to the lowest f-stop number on your lens.
6. Take a shot.
7. Increase the f-stop by a full stop. (Full stops are 2, 2.8, 4, 5.6, 8, 11, 16, etc.)
8. Take another shot.
9. Repeat steps 7 and 8 until you reach the highest f-stop number for your lens.
10. If testing a zoom lens, switch to a higher number focal length in mm, and repeat steps 5 through 9. For zooms, test 3-4 different focal lengths. For example, with a 70-200mm lens, test 70mm, 100mm, 150mm, and 200mm.
11. If testing various filters, repeat all of the above steps with each.
12. Examine the images on your computer and check for hot spots in the center of the image. If there are no hot spots at any aperture or focal length, you've got a keeper. If the lens has hot spots at all apertures, it's not suited for infrared. If the lens only has hot spots at some focal lengths or some apertures, you may wish to label the lens cap with this information for future reference.

Lens Resources

Since new lenses are regularly added and tested in infrared photography, use online sources to determine if specific lenses have hot spots. Here is a collection of lens resources.

Lenses for Infrared: <https://590.red/lenses>

Vintage Lenses for Infrared: <https://590.red/vintage>

Fixing Hot Spots in Lightroom and Photoshop: <https://590.red/hot>

Settings for Shooting Infrared Photography

Infrared light is strongest in direct sunlight. Scenes with direct sunlight during the day will produce the most contrast in your infrared images. Scenes shot closer to sunset or sunrise, in overcast conditions, or shade will offer less infrared light, require longer exposures, and result in less contrast.

Foliage, skies, clouds, and architecture are popular subjects for infrared photography.

Focus

Infrared light focuses on a different plane than visible light. Using lens markings and focus systems that are calibrated for visible light will produce images that are out of focus in infrared. Live view focusing with the rear screen of your camera is not impacted by different focus planes.

Optical Viewfinder Focusing

Optical viewfinder focusing systems, such as on most DSLRs, are calibrated for visible light. If you wish to use the optical viewfinder for focusing, you will need to have had the calibration set to a specific lens when your camera is converted. You are limited to using only this lens with the optical viewfinder for focusing. Using the optical viewfinder with other lenses could result in missed focus.

Live View Focusing

The live view screen on your mirrorless camera, or DSLR in live view mode, will accurately autofocus in infrared. Camera features such as focus peaking and digital focus assist can also help set focus manually.

Aperture

Your lens aperture is used to set exposure and determine the depth of field, or how much of your scene is in focus. Wider apertures with lower f-stop numbers increase the amount of light and decrease the depth of field. Wider apertures are generally more desirable for portraits, with a narrow focus on the subject.

Narrower apertures with higher f-stop numbers decrease the amount of light and increase the depth of field. The highest f-stop numbers (narrowest apertures) on a lens will produce diffraction, a softening of image sharpness due to the physics of light and your sensor's pixel size. Higher f-stop numbers (narrower apertures) are favored by landscape photographers when trying to maximize the depth of field. However, the highest f-stop values might be avoided to avoid the impact of diffraction on sharpness.

This is the same for infrared photography, except with one difference. Higher wavelengths of light, such as infrared, have higher levels of diffraction. The visible impact of diffraction occurs at 1 or 2 f-stops lower than in visible light. For example, you are shooting a landscape in visible light and the highest numbered f-stop you can use without diffraction is $f/11$. With that same camera and lens in infrared, the highest-numbered f-stop you can use without diffraction will be $f/5.6$ or $f/8$. Be aware that the effects of diffraction will soften your images more than in visible light. This is not always a bad thing, just something to be aware of if sharpness is important for a particular image.

Diffraction in Infrared Photography: <https://590.red/dif>

Shutter Speed

Exposure time has the same impact in infrared photography as visible light photography. Choose a shutter speed based on the blur or freezing of motion desired in the image.

ISO

In infrared photography, you are typically shooting in broad daylight with plenty of light. The lowest ISO value for your camera is best and will produce the least amount of noise in the image. You may choose higher ISO values in shade or overcast conditions.

White Balance

Setting a white balance is key for getting the conventional blue-sky look of traditional and color infrared images. A good white balance setting can help separate colors in an image for easier processing. Setting the white balance can be done in-camera or during processing. Let's cover how to set white balance and when is the best time for you.

How to Set White Balance In-Camera

Use your camera's manual for detailed instructions on setting a white balance in-camera. When shooting a subject or aiming at a subject for the white balance, the target depends on the filter and style you are shooting.

- For traditional or color filters, use clouds, white or gray objects, concrete, grass, or foliage.
- For full-spectrum or chrome filters, use clouds, white or gray objects, or concrete.

When to Set White Balance In-Camera

Setting the white balance in-camera is best under any of these conditions.

- You are shooting JPG file format. In raw editors, you will have more control when editing raw files and less control with JPG files. Therefore, when shooting JPG, it's best to set a white balance in-camera.
- When you want to get the closest preview of your final image in-camera. Infrared images typically require post-processing to look good. Setting a white balance in-camera will give you a closer idea, but not an exact representation, of the final result. This can be particularly helpful when shooting with a chrome filter or in full-spectrum.
- You just prefer to set a white balance in-camera.

When to Set White Balance During Processing

Setting the white balance when processing is best when you are shooting in your camera's raw format. Raw file formats capture the data straight from the sensor without color processing. With raw images, you have full control of the white balance settings when processing. This can leave you one less thing to think about when shooting.

Raw or JPG?

Raw images collect the data directly from your sensor without color processing in-camera. Raw images give you the most flexibility for editing. If you have a point-and-shoot camera that doesn't shoot raw, only JPG, be sure to set a white balance in-camera before shooting, whenever you change filters, or when lighting conditions change.

Processing Traditional and Color Infrared Images

In this short guide, I will cover processing traditional and color infrared raw images in Adobe Photoshop. Traditional and color infrared images are the most complicated to process to achieve a blue-sky look. Other styles of infrared can be processed similarly to visible light images. In the [Additional Resources](#) section, I will provide a list of alternative raw editors, including free and non-subscription options.

Traditional infrared (720nm) and color infrared (470nm to 665nm) can both be processed with this method. Here is a raw image shot with a camera converted to a 590nm filter.



Open Raw Image

Open the raw image in Photoshop. This will open the image in Camera Raw, Adobe's raw image processor. By default, the *Adobe Color* profile is applied to the image. Profiles define how the colors from a specific camera are displayed.

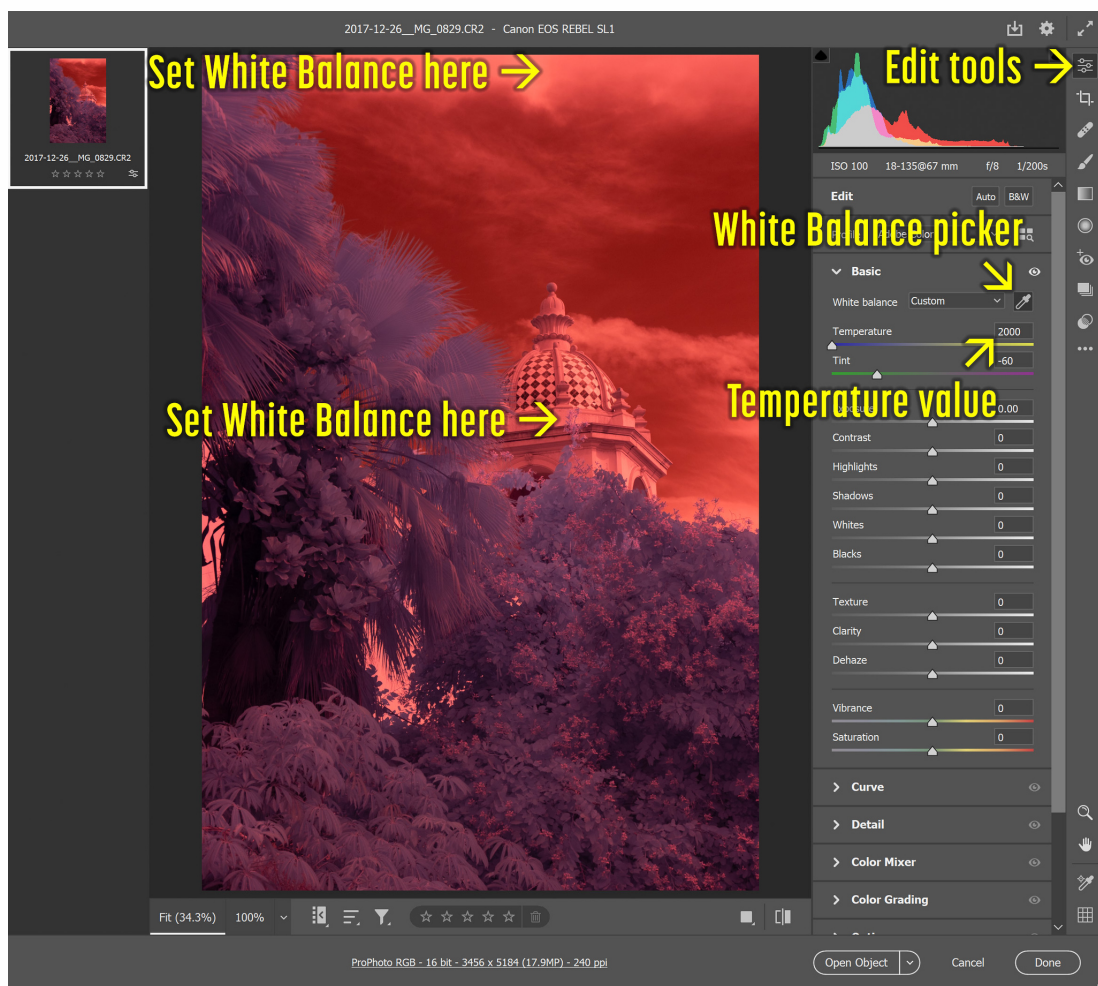


White Balance

In the *Edit* tools, under the *Basic* panel, select the White Balance picker or tap the I key. Use the picker to select a neutral subject in the image. In this image, clouds and the building are good white balance subjects. The white balance should shift slightly. The amount of change will vary depending on your camera sensor and any white balance set in-camera.

If the value of the Temperature slider lands at **exactly** 2,000 or 50,000, then the *Adobe Color* profile does not have enough range for your camera. This is the case for most cameras. You will need a custom profile for your camera. This is addressed in the next step.

If the value of the Temperature slider falls **between** 2,000 and 50,000 after setting a white balance, then you can set a good white balance with the default *Adobe Color* profile. This is rare and will not be the case for most cameras. If so, you can skip creating a custom profile for your camera.



Custom Profile

For many cameras, Adobe provides several profiles with Photoshop, such as *Adobe Color*, *Adobe Monochrome*, *Adobe Landscape*, *Adobe Neutral*, *Adobe Portrait*, *Adobe Standard*, and *Adobe Vivid*. For newer cameras, only *Adobe Color* is provided. Adobe also provides many enhanced profiles grouped under *Artistic*, *B&W*, *Modern*, and *Vintage* profile groups. None of the above profiles are useful for processing **color** infrared images. They may be used for black and white processing. For color infrared images, a custom profile is required.

Custom profiles are created with the *Adobe DNG Profile Editor*. At the time of this writing, the *DNG Profile Editor* is no longer supported. It has not been updated to work with all modern operating systems and is not always available for download from Adobe. An *Infrared Profile Pack* has been created to support infrared photographers who are not able to create a custom profile.

Infrared Profile Pack

Download: <https://590.red/ipp>

If you'd like to learn more about this project, or if your camera is not currently supported and you'd like to have it added, visit <https://590.red/infrared-profile-pack>

Process for creating custom profiles with the *DNG Profile Editor*: <https://590.red/dcp>

Once you have downloaded the pack, unzip the files. Find the matching files for your camera and copy them to the following directory.

Mac Custom Profile Location

Open the Finder. Use the keyboard shortcut `Command + Shift + G` to display the *Go to the folder* dialog. Paste the following path, then hit enter.

```
~/Library/Application Support/Adobe/CameraRaw/CameraProfiles
```

Windows Custom Profile Location

Open Explorer. Paste the following path into the path bar, replacing `{user name}` with your Windows user name, then hit enter.

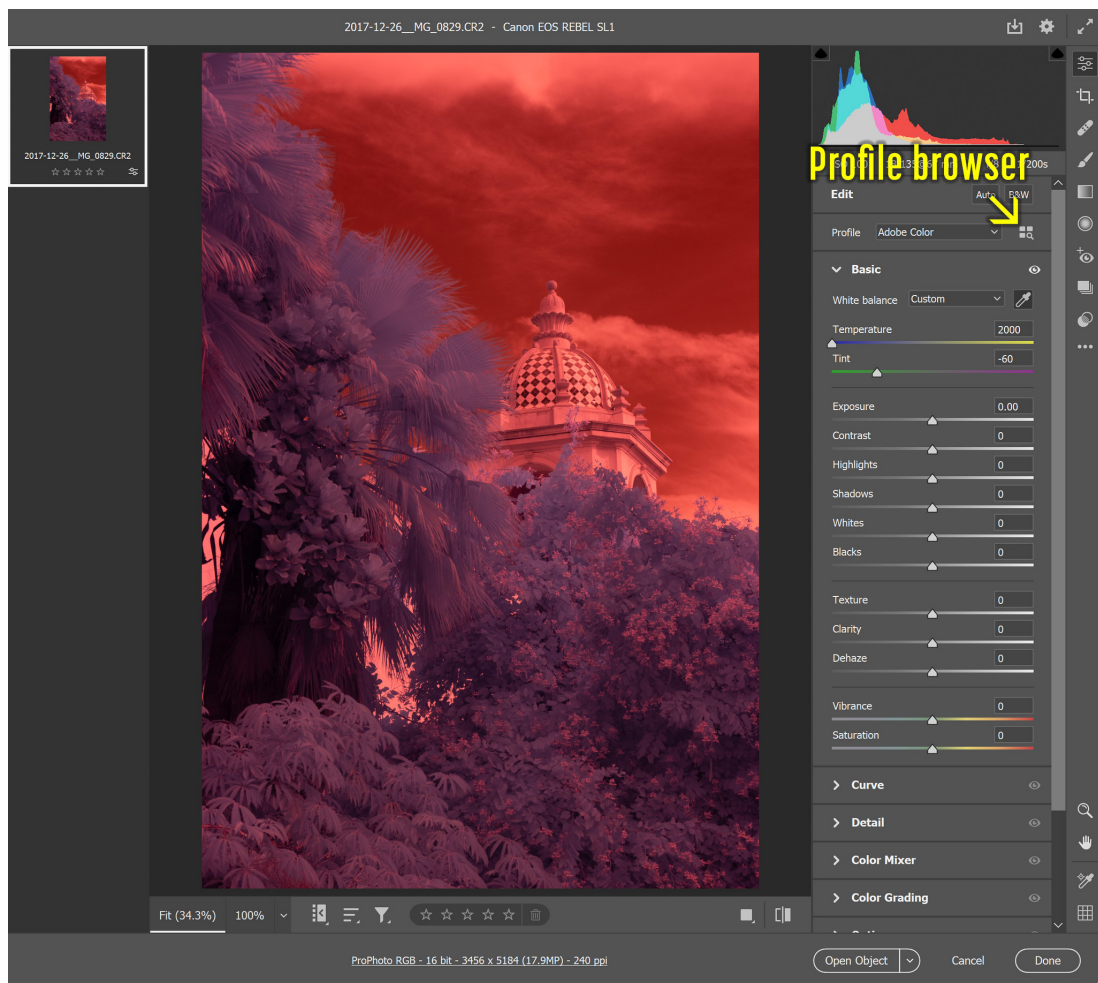
```
C:\Users\{user name}\AppData\Roaming\Adobe\CameraRaw\CameraProfiles
```

Profile Browser

Close and restart Photoshop. Photoshop loads profiles when the program opens. You will need to close and restart Photoshop to use the new profiles.

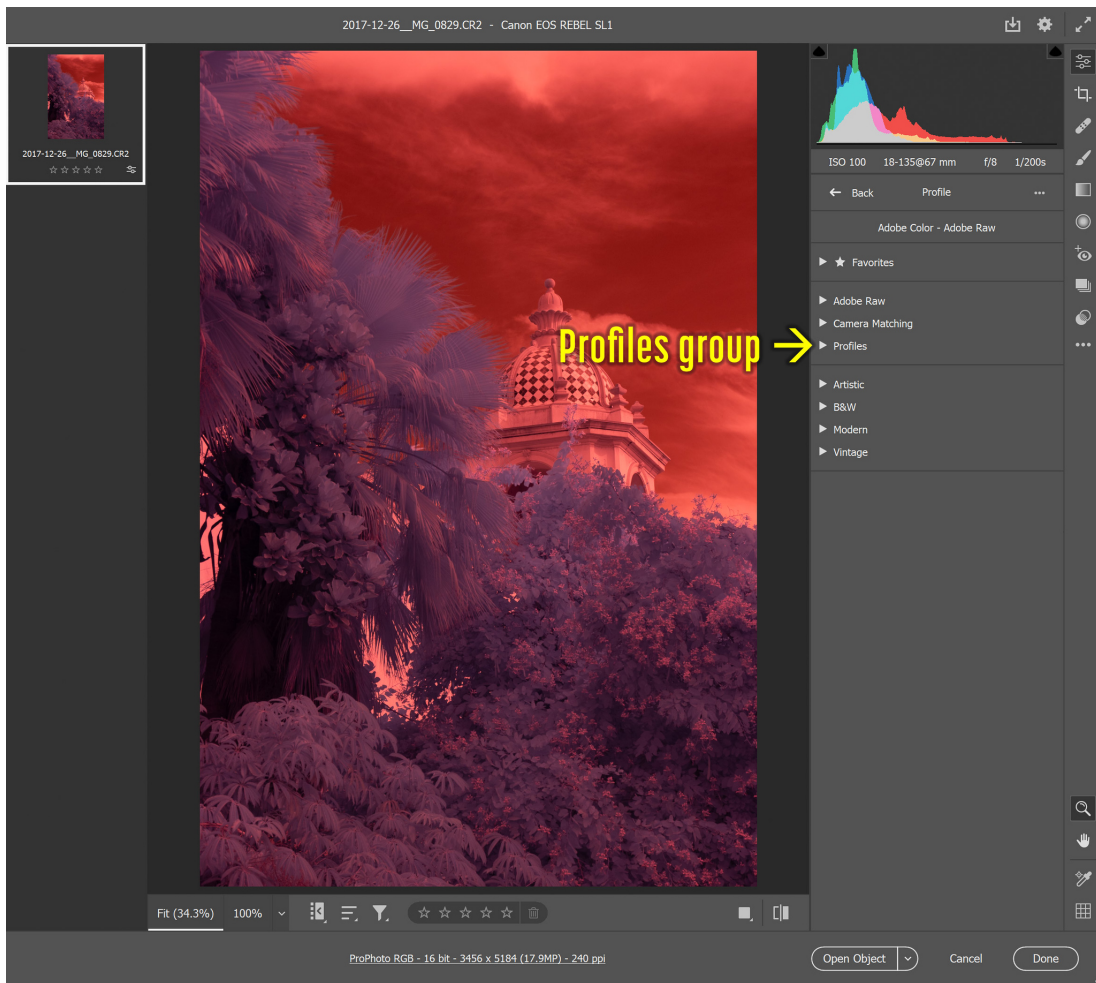
Open your raw image in Photoshop, which will open Camera Raw.

Select the Profile Browser icon to the right of the Favorite profile selector. This will display all available profiles, organized by group.



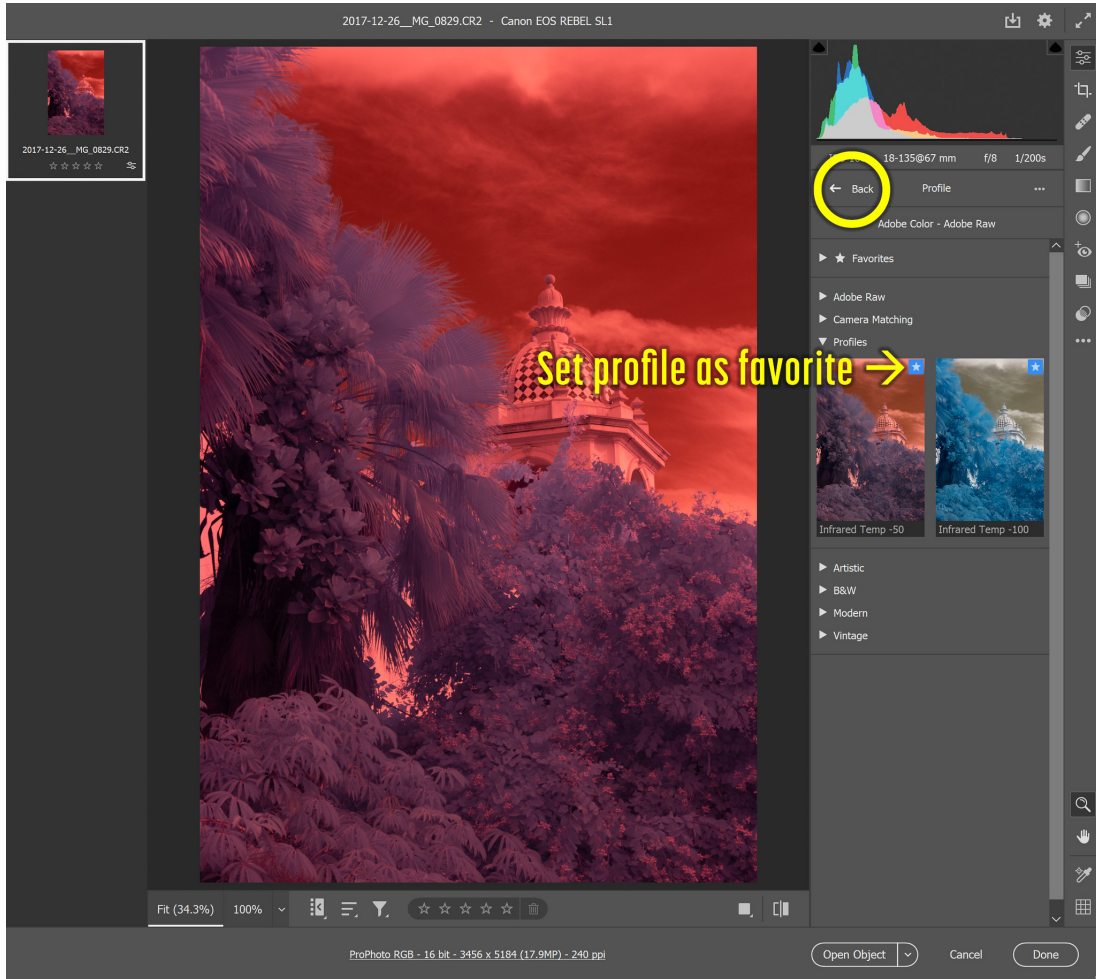
Profiles Group

By default, custom profiles appear in the group named *Profiles*. Expand this group with the triangle left of the *Profiles* group.



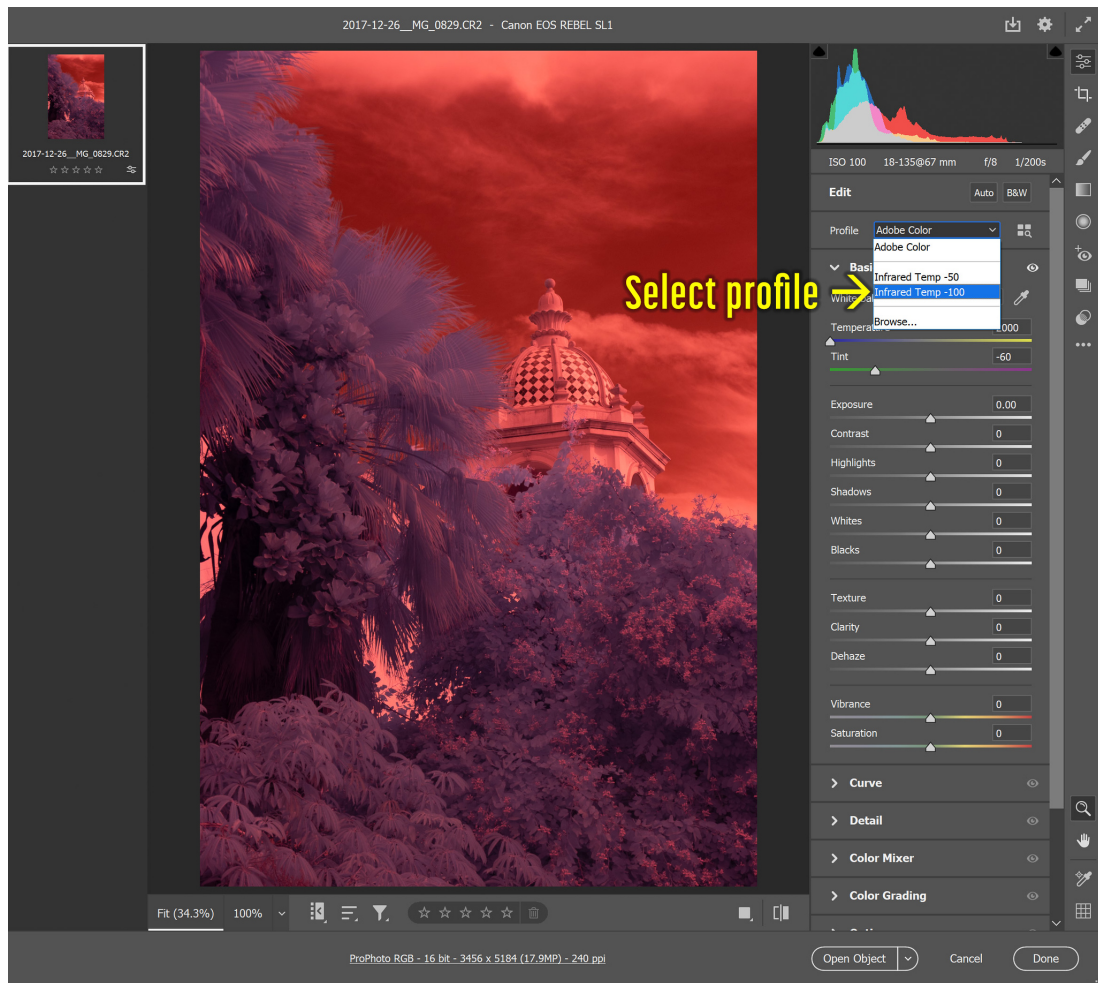
Set Profile Favorites

Set your profiles as favorites by selecting the star in the upper right-hand corner of the profile. If you downloaded profiles from the pack, they will be named *Infrared Temp -50* and *Infrared Temp -100*. Select the Back arrow at the top of the *Profile* panel.



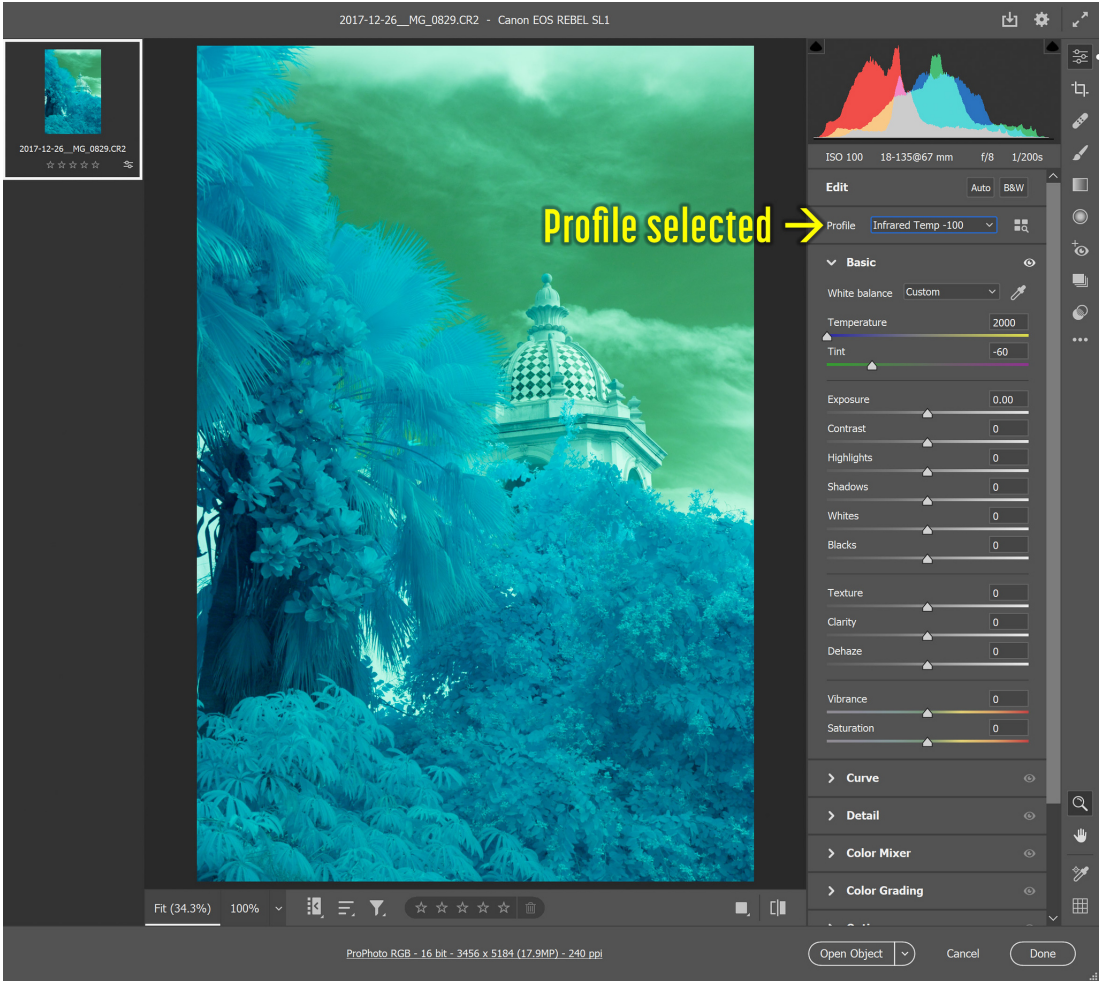
Select Profile

Once favorited, the profiles will appear in the Favorite profile selection box, under *Adobe Color*. Select *Infrared Temp -100*.



Apply Profile

With the custom profile selected, the colors in the image should change dramatically. This is normal.



Set White Balance

Now that you have a custom profile selected, it's time to set your White Balance. In the *Edit* tools, under the *Basic* panel, select the White Balance picker or tap the I key. Use the picker to select a neutral subject in the image. In this image, clouds and the building are good white balance subjects.

With the custom profile selected, the value of the Temperature slider should now fall **between** 2,000 and 50,000. If it does not, try switching to the other custom profile. If you are using the *Infrared Temp -100*, change to the *Infrared Temp -50* or vice versa. Then try to set the white balance again. One of the two profiles should allow you to set a good white balance for a broad range of infrared filters.

Your white-balanced image should now have yellow skies, blue foliage, and white neutrals, such as clouds. With a 720nm filter, the foliage will appear white or a very desaturated blue.

Secrets to White Balance in Infrared Photography: <https://590.red/wb>

Select the *Open*, *Open Object*, or *Open Copy* button to open the image in Photoshop.

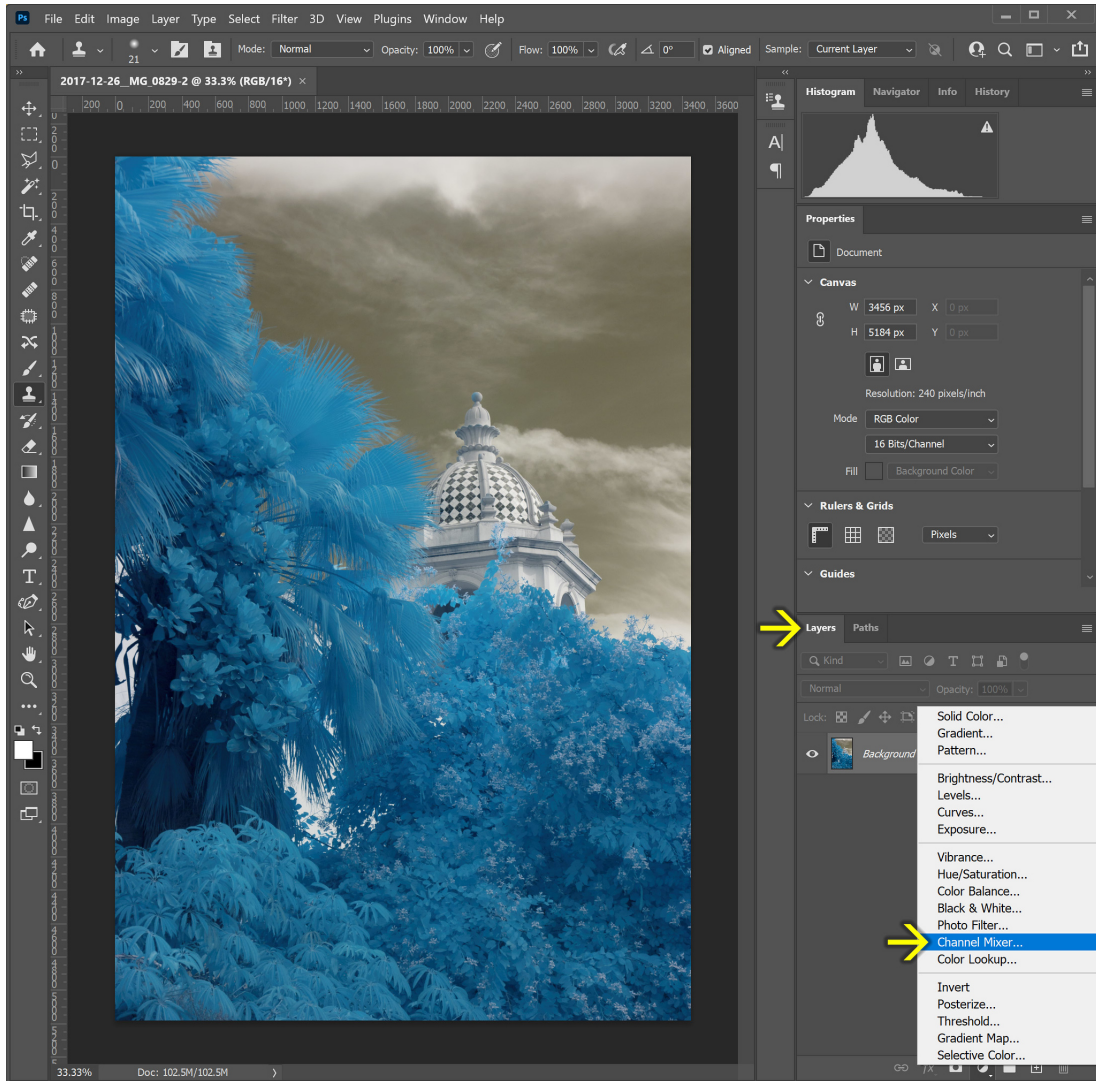


Channel Mixer Adjustment Layer

Open the *Layers* panel. If you don't see it on your screen, under the *Windows* menu, select *Layers*.

At the bottom of the Layers panel, select the icon named *Create new fill or adjustment layer*.

Select *Channel Mixer*.



Infrared Photoshop Actions

Photoshop Actions can be used to automatically apply the Channel Mixer adjustment layer to an image in Photoshop and save you time processing.

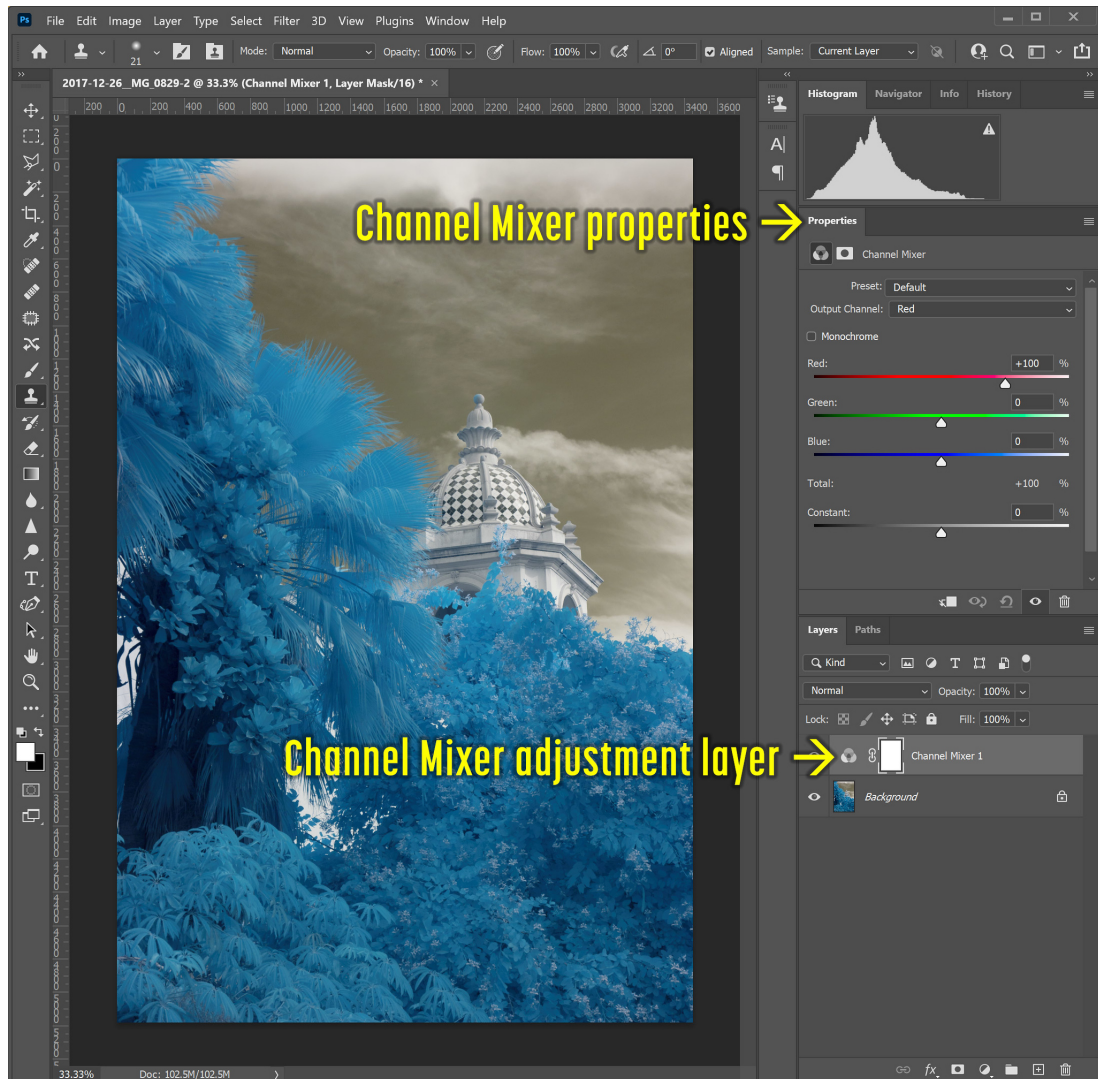
Download: <https://590.red/actions2>

Get more information: <https://590.red/infrared-actions2>

Channel Mixer Adjustment Layer Properties

Select the newly created layer named *Channel Mixer 1*.

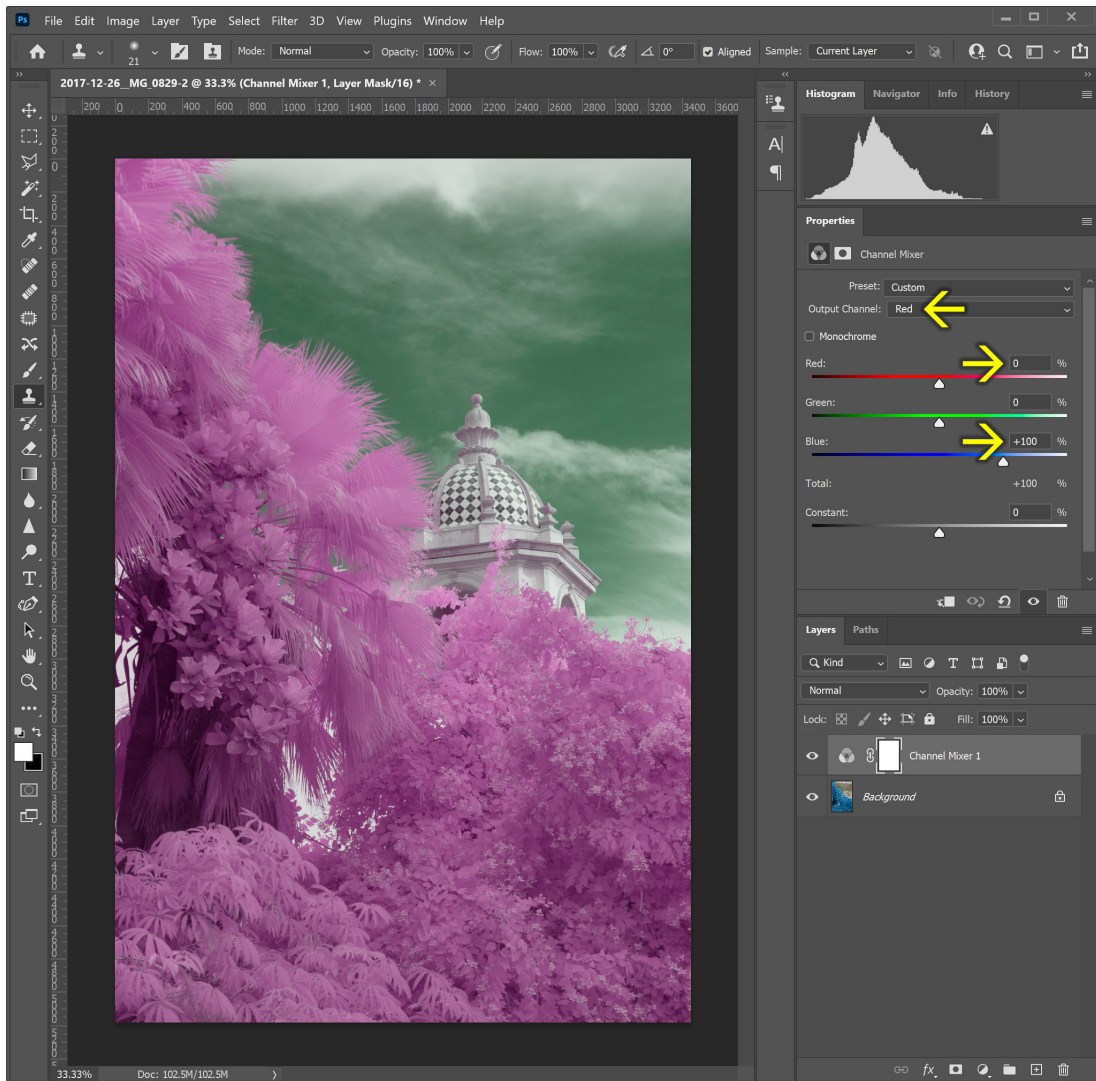
Find the *Properties* panel.



Channel Mixer Red Output Channel

For the Output Channel Red,

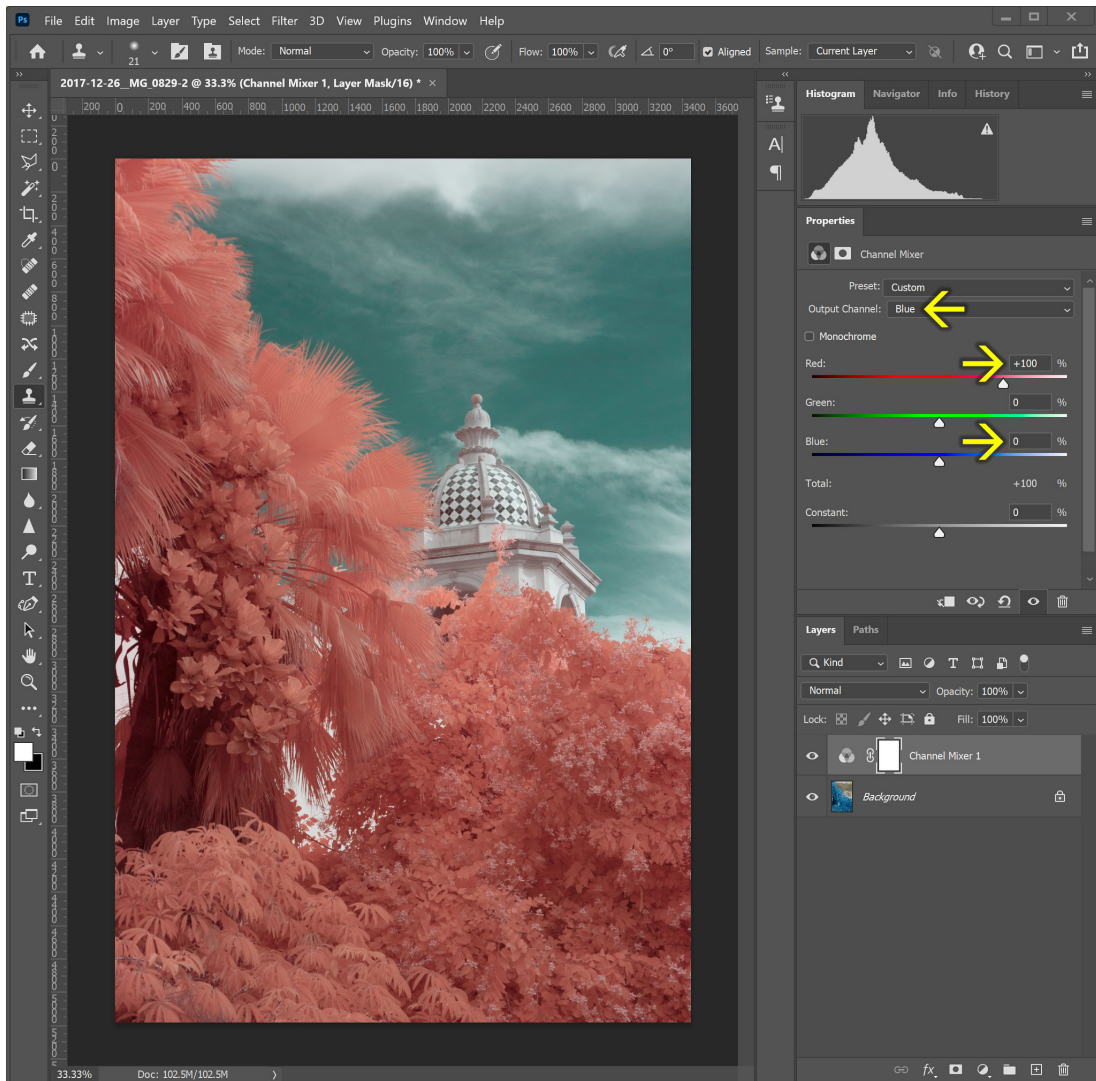
- change Red to 0%
- change Blue to +100%



Channel Mixer Blue Output Channel

Select the Output Channel Blue,

- change Red to +100%
- change Blue to 0%

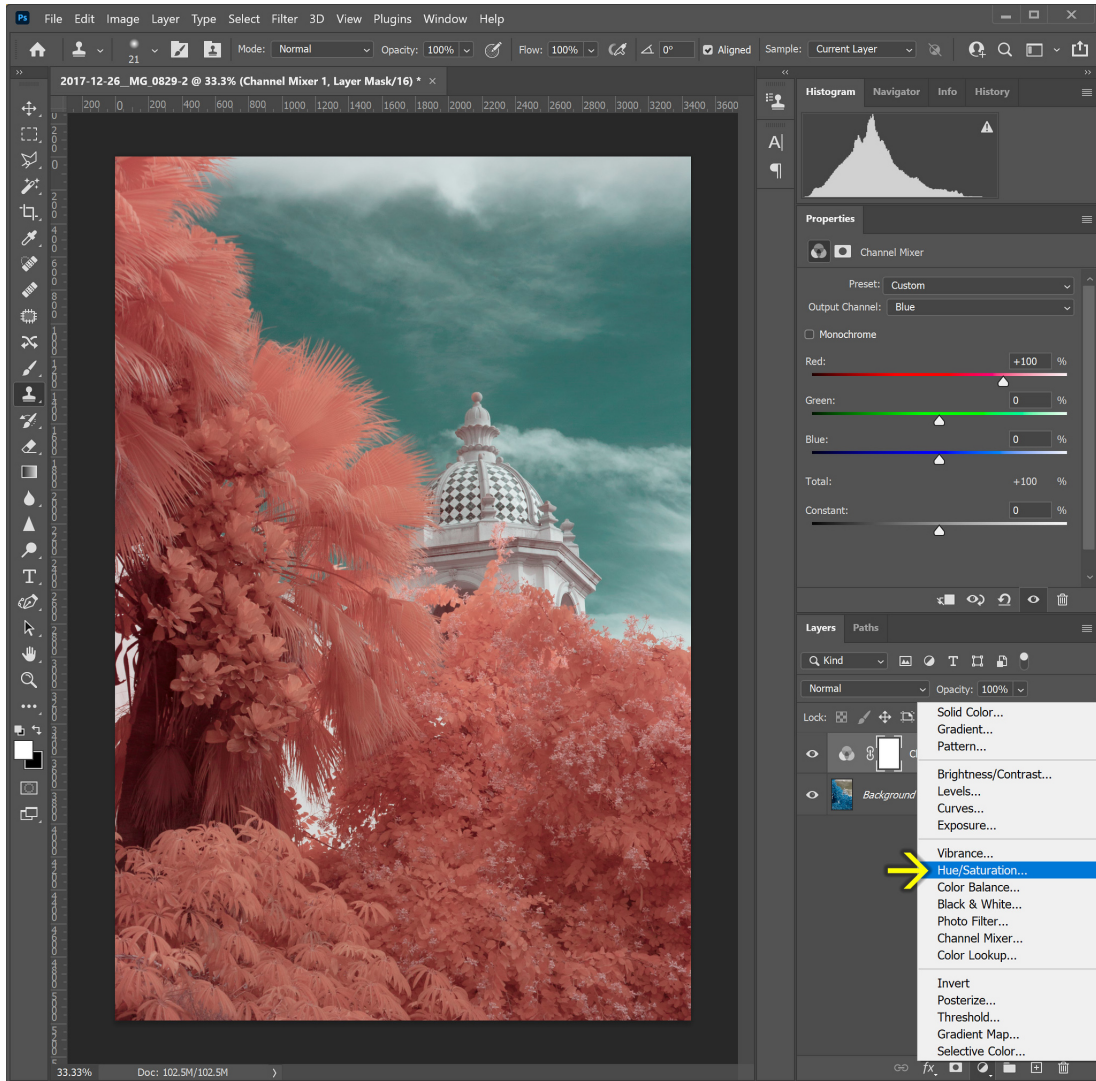


Hue/Saturation Adjustment Layer

If you'd like to tweak the colors to achieve a true blue sky, you can do that with a Hue/Saturation adjustment layer.

At the bottom of the Layers panel, select the icon named *Create new fill or adjustment layer*.

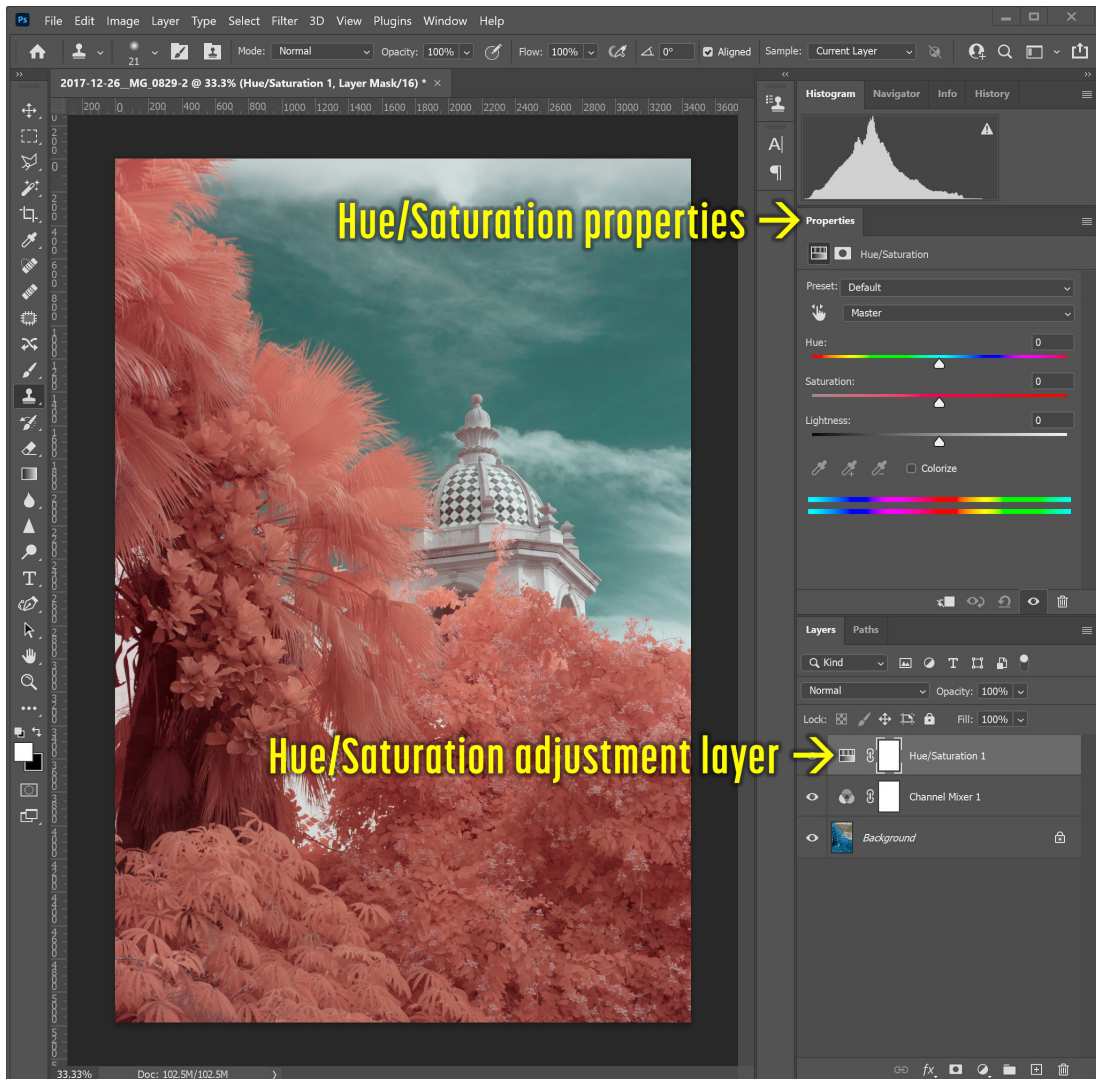
Select *Hue/Saturation*.



Hue/Saturation Adjustment Layer Properties

Select the layer named *Hue/Saturation 1*.

Find the *Properties* panel.



Adjust Hue and/or Saturation

In the *Properties* panel,

- select **Master** to adjust all colors
- select **Cyans** or **Blues** to adjust only the sky

Slide the Hue and/or Saturation sliders until the sky reaches your desired sky blue.



Final Image

Here is the final image after applying a custom profile, setting a white balance, using the channel mixer to swap colors, and adjusting the hue.



What's Next

Color swapping is not the only technique for processing color infrared images. It is a good starting point for learning the basics and beginning your infrared photography journey. There are limitless combinations of subjects, styles, lenses, filters, shooting techniques, and processing techniques. You might find a style you love and master it. You might explore many styles in a quest for learning. The choice is yours.

Enjoy the journey!



590nm infrared image

Additional Resources

Infrared Profile Pack: <https://590.red/infrared-profile-pack>

Lenses for Infrared: <https://590.red/lenses>

Vintage Lenses for Infrared: <https://590.red/vintage>

Five Pitfalls to Infrared Photography: <https://590.red/pit>

How to Fix Hot Spots in Infrared Photos? <https://youtu.be/sD5iJeHcLJE>

Diffraction in Digital Infrared Photography: <https://590.red/dif>

Infrared Editors

Best Editors for Infrared Photos: <https://youtu.be/R3Lz6GQD7Sg>

Adobe Lightroom

Adobe Lightroom can be used in combination with Photoshop. You can select a profile and white balance in Lightroom, swap colors in Photoshop, and then finish the edit in either program. Here is a walkthrough of this process.

<https://youtu.be/1mkB1hEyGus>

Infrared Profile Pack: <https://590.red/infrared-profile-pack>

Best Infrared Workflow for Lightroom, Lightroom Classic, & Lightroom iPad with LUTs: <https://590.red/xmp>

Invert Layer method for editing color Infrared image in Photoshop and Lightroom: <https://youtu.be/WeQbJSj3kGA>

Swap Colors with Local Hue: <https://590.red/bdf>

Color Calibration panel (video): <https://590.red/eu1>

Color Grading for Infrared Photography: <https://590.red/lcg>

Black and White editing (video): <https://590.red/lym>

Black and White edit with Lightroom and SilverEfex Pro (video): <https://590.red/7et>

The Secret to Colors that POP in Infrared Photography: <https://youtu.be/qoZURDAFu1g>

Adobe Lightroom Mobile

How to edit color infrared photos in Lightroom for iPad with Apple Pencil: <https://youtu.be/Lj3wHoDDXmI>

Infrared B&W edit with Lightroom on iPad: <https://youtu.be/reG2hygoovo>

Infrared B&W edit with Lightroom on iPad: <https://youtu.be/vupMbMRb4ms>

Adobe Photoshop

Infrared Profile Pack: <https://590.red/infrared-profile-pack>

Photoshop Actions: <https://590.red/infrared-actions3>

Editing 590nm Infrared image: <https://youtu.be/IrgMYjapoiU>

5 Color Swap Methods for Color Infrared Photography in Photoshop: https://youtu.be/49F9oLl_zw

Editing Infrared in new Photoshop on iPad: <https://youtu.be/w5AnNzLkNcU>

How to add multiple colors to infrared images? <https://590.red/colors>

Adobe Photoshop Elements

How to edit Infrared Photos with Photoshop Elements 2020: <https://youtu.be/iqfUfQfZSxI>

Affinity Photo

Infrared photo edit w/ Affinity Photo: <https://youtu.be/b6nGnoW54gs>

Capture One Pro

How to edit Infrared Photos with Capture One Pro: <https://youtu.be/5yrQisDwp9A>

Darktable (free open source)

Preview of Darktable for editing Infrared photos: <https://youtu.be/lBcLP8ZiX78>

DxO PhotoLab

DxO PhotoLab 4 for Infrared Photography: <https://590.red/dxo>

Exposure x6

Can Exposure X6 edit Infrared Photography? <https://590.red/ex6>

Luminar

Editing Infrared Photos with Luminar 4: <https://youtu.be/rxcovwAplJE>

ON1 Photo RAW

How to edit Infrared Photos with ON1 Photo RAW: <https://youtu.be/RuDSBYpZqiQ>

Pixelmator

Pixelmator Pro for Mac: <https://youtu.be/F5NpoZUXwjQ>

Pixelmator Photo for iPad: <https://youtu.be/5Xk2nIUptDY>

RawTherapee (free open source)

Intro to RawTherapee for Editing Infrared Photography: <https://youtu.be/bJFgcRIDLoE>