

# LENSES FOR CLOSE-UP AND MACRO PHOTOGRAPHY

Including the Exotic Nikkor Industrials

by  
Michael  
Erlewine



Lenses for  
Close-up  
And  
Macro  
Photography

By Michael Erlewine

*This collection of information is respectfully dedicated  
to the lensmen from whom I learned a lot of what I  
know. My sincerest thanks!*

Bjørn Rørslett  
Thom Hogan  
Lloyd Chambers  
Klaus D. Schmitt  
Roland Vink

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## **Lenses That Can Be Used for Close-up Work**

This is a collection of information on lenses related to use in close-up and macro photography, along with several essays I put together on some of the Nikon industrial lenses, often called the "Exotic Nikkors." I do this in my spare times, so the format may be a little rough, but the price is right. Hopefully, some few of you will find this material interesting and we can discuss.

Therefore, what follows is a bunch of lens profiles, most of them macro lenses, but not all of them. Along with the macro lenses are a number of non-macro lenses that we all know. Why list these? Because I am always looking at how any lens can be used for

close-up and macro work, even if it was not made for it.

And following those lenses, as mentioned, is a series of what are known as industrial lenses, lenses used in enlargers, scanners, and high-tech machines, the so-called Exotic Nikkors and others.

There is a companion volume to this book having to do with macro and close-up equipment, and technique to be issued soon. It will be titled "Close-up and Macro Photography." Enjoy.

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August 15, 2014  
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P.S. Thanks to Roland Vink for useful comments, which I have appended with the tag RVink. Visit his very useful site on Nikon gear at:

<http://www.photosynthesis.co.nz/nikon/lenses.html>





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## **Voigtlander 125mm f/2.5 Macro APO-Lanthar**

Focal Length: 125mm

Widest Aperture: f/2.5

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 58mm

Hood: Included, Square

Close Focus Distance: 14.96 inches (38 centimeters)

Reproduction Ratio: 1:1

Focus Throw: 630°

Weight: 28 ounces (794 grams)

Pros: Very fast lens, very sharp lens, 9 blades, close focus, goes 1:1, long focus throw.

Cons: None. Perhaps a little heavy. Build-quality a little fragile, I have heard of several accounts of lenses breaking or needing service after heavy use. Also rather expensive.

I could write a book about this lens, but I will spare you. The CV-125 is, hands down, the best macro lens I own and I use it all the time, even though I have a shelf full of some of the best macro lenses in the world at the ready. It has no major negatives. It is very fast, very sharp, focuses close, reproduced to 1:1, has 9 blades (great bokeh) – the works.

If I want to complain, it is on the heavy side, but I am always happy to carry this piece of glass in the field.

The lens is very difficult to find in the Nikon format and also very expensive, with copies now going for \$2500 or so. Despite all the good qualities, probably

the features that set this lens apart from other fine macro lenses are the fact that it is truly apochromatic (APO) and has such exceptional bokeh (lovely out-of-focus blur in the background).

Of course, IMO, I would add that it has a “magic” quality that words can’t express and a very-long focus throw that makes macros and stacked-photos so very easy. I find it very stable when it comes to handling various types of light in the same frame, like shade with rays of sunlight. This is real workhorse and I have used mine day in and day out for years.

It focuses to 1:1 and lets you get very close in on your subjects. A feature not often mentioned about this lens is that it is also very sharp at mid-range and even at landscape distances. This is the little lens that could and it does. If you ever find one, buy it. You will never be sorry.



## **Zeiss 55mm f/1.4 APO Otus Distagon T\***

Focal Length: 55mm

Widest Aperture: f/1.4

Narrowest Aperture: 16

Aperture Blades: 9

Filter Size: 77mm

Hood: Included

Close Focus Distance: 19.7 inches (.50m)

Reproduction Ratio: 1:7

Focus Throw: ~ 270°

Weight: 2.14 lb (970 g)

Pros: Best APO, Razor-Sharp  
Cons: None. Perhaps a little heavy.

Simply the best lens I have ever used, bar none, and it is not even a close-up or macro lens, and is mere \$3,990.00, but absolutely worth every penny. This lens has a minimum-focus distance of 19.7" (.50m) and a healthy focus-throw. I can get away with adding the Nikon PK-11A 8mm extension tube to it, which shortens the near-focus distance, but at a sacrifice of image quality wide-open. I have to stop the lens down to about f/4 to keep the sharpness, but that is not too bad for bokeh.

So this and the following lens are the two best lenses I have ever found. I use them all the time. More on this and the Zeiss 135mm APO in the companion volume "Close-Up and Macrophotography."



## **Zeiss 135mm f/2 APO Sonnar T\* ZF.2**

Focal Length: 135mm

Widest Aperture: f/2

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 77mm

Hood: Included

Close Focus Distance: 2.62 feet (.80 m) Reproduction

Ratio: 1:4

Focus Throw: ~ 270°

Weight: 2.02 lb (920 g)

Pros: Best APO, Razor-Sharp  
Cons: None. Perhaps a little heavy.

This is not even a close-up or macro lens, but rather a telephoto, but it is so highly-correct (so great) that I use it all the time and crop out the part of the photo I am after. Of course, with the Nikon D810 as a camera I am working with 36MP, so I have a lot to crop from. This is an exquisite lens that costs \$2,122.00, but of course is worth it. I just sold some of the dozens of close-up lenses I never use and bought this one. It is perfect, but is not the easiest to use.

It has a great focus-throw, but a not-so-great minimum close-focus distance of 2.62' (.80m), which is a ways back. Nevertheless, I use it and I use it all the time and am delighted with the results.

From RVink: I agree this is not a macro lens, but with a magnification ratio of 1:4, I do consider this a "close-up" lens. After all, 1:4 is half the magnification of the Zeiss 50/2 and 100/2 macros! This is sufficient for close-ups of larger flowers and insects.

I guess it depends on the interpretation of "close-up" - for me it is the ability to focus closer than normal without going into the "macro" range. The reason the close limit of 0.8m seems "way back there" is due to the relatively long focal length (which also permits a very generous working distance). Compared to other 135mm lenses it is not way back there at all, it's very close! The Nikon AF-S 300/4 falls into the same category with the same magnification at close range but with even greater working distance - 1.45m.





## **Zeiss 50mm f/2 ZF.2 Makro-Planar**

Focal Length: 50mm

Widest Aperture: f/2

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 67mm

Hood: Included

Close Focus Distance: 9.5 inches (24 centimeters)

Reproduction Ratio: 1:2

Focus Throw: 300°

Weight: 18.72 ounces (531 grams)

Pros: Very sharp lens, fast lens, 9 blades, good focus distance, good focus throw.

Cons: No 1:1, heavy-ish.

This is a wonderful little lens, more interesting to me than its big brother the 100mm Makro-Planar. It is very, very sharp and with such a close focus you can treat it like a wide-angle lens and poke it right into the middle of things. It stacks very well and has a luxurious 300 degrees focus throw. It does not reach 1:1, but I don't care because I don't use it for the nitty-gritty ultra-close shots. I treat it, as mentioned above, more as a wide angle lens and reserve it for that.

It has a superb build and if there is any fault at all with this lens (IMO) it is that it may be perhaps too contrasty and not corrected enough for aberration, etc. and not quite subtle enough in color. It is not an

APO lens and that is the only thing I have noticed that I do not love.



## **Micro-Nikkon 45mm f/2.8 PC-E Tilt/Shift**

Focal Length: 45mm

Widest Aperture: f/2.8

Narrowest Aperture: 32

Aperture Blades: 9

Filter Size: 77mm

Hood: HB-43

Close Focus Distance: 10 inches (25 centimeters)

Reproduction Ratio: 1:2

Focus Throw: 120°

Weight: 26 ounces (737 grams)

Pros: Fast lens, 9 blades, very sharp, good close focus.

Cons: Short focus throw, does not go to 1:1, tilt/shift features require a learning curve.

I have all three of the most recent Nikon PC (tilt/shift) lenses, this one plus the 85mm and 24mm PC. While all three are exemplary lenses, I find the 45mm PC the most useful for macro and close-up work. The “PC” stands for perspective control through the tilt and shift features.

The tilt feature allows the lens to tilt (either up and down, or right and left) a total of 8.5 degrees. There are many tutorials on the web for learning to use this feature, but the idea is that in any photo there is one and only one plane of focus. “Tilt” allows the lens to align the plane the lens with that of the image plain. An example might be a field of flowers stretching toward the horizon. Instead of just having the front

flowers in focus, by tilting the lens it can be possible have the whole field in focus.

The shift feature allows the lens to be sifted right or left (or up and down) bringing what normally would be out-of-frame in frame without having to move the camera. Notice that these lenses have large box-like midsections. This allows a lens to have a larger image circle than a normal lens, so that shifting the lens to either side allows more or less of the subject to come into view. At total shift of 11.5 mm to either side is permitted.

In addition the whole lens barrel can be rotated plus or minus 90-degrees by 30-degree increments allowing you to combine the tilt/shift features in various combinations. Sound amazing? It is, but don't run out and buy one unless you really need these features. These lenses are bulky and heavy. Both the tilt and shift features (and especially the tilt feature) have a steep learning curve and are not easy to learn. The focus throw is very smooth but also very short, making it not ideal for close-up focus stacking.

That being said, the Nikon 45mm PC-E lens is a lens I frequently carry with me for wider views than my CV-125 requires. Using this lens I can stick it very close to a flower and capture it and the surrounding space easily. The shift feature allows me to take three photos (left-shift, middle, right-shift) and combine them with a stitching program to produce a seamless mini-panorama. Since all three photos already share a common image circle within the camera, this guarantees a seamless panorama. However, I find that I can only shift (left or right) one-half of the permitted distance without causing some vignetting.

Still, I can produce a three- shot panorama with no special panorama head in a jiffy and they are excellent. I don't feel they are as perfect for stacked three-shot panoramas than using the CV-125 and a pano head, however.





## Nikon Nikkor 24mm PC-E f/3.5

Focal Length: 24mm

Widest Aperture: f/3.5

Narrowest Aperture: 32

Aperture Blades: 9

Filter Size: 77mm

Hood: HB-41

Close Focus Distance: 8.267 inches (21 centimeters)

Reproduction Ratio: 1:2.7

Focus Throw: 90°

Weight: 25.76 ounces (730 grams)

Pros: Sharp lens, 9 blades, tilt/shift, very close focus distance.

Cons: No 1:1, very short focus throw, heavy.

Pros: Fast lens, 9 blades, very sharp, good close focus. Cons: Short focus throw, does not go to 1:1, tilt/shift features require a learning curve.

I have all three of the most recent Nikon PC (tilt/shift) lenses, this one plus the 85mm and 45mm PC. The “PC” stands for perspective control through the tilt and shift features.

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flowers in focus, by tilting the lens it can be possible have the whole field in focus.

The shift feature allows the lens to be sifted right or left (or up and down) bringing what normally would be out-of-frame in frame without having to move the camera. Notice that these lenses have large box-like midsections. This allows a lens to have a larger image circle than a normal lens, so that shifting the lens to either side allows more or less of the subject to come into view. At total shift of 11.5 mm to either side is permitted.

In addition the whole lens barrel can be rotated plus or minus 90-degrees by 30-degree increments allowing you to combine the tilt/shift features in various combinations. Sound amazing? It is, but don't run out and buy one unless you really need these features. These lenses are bulky and heavy. Both the tilt and shift features (and especially the tilt feature) have a steep learning curve and are not easy to learn. The focus throw is very smooth but also very short, making it not ideal for close-up focus stacking.

That being said, the Nikon 24mm PC-E lens is a lens I don't frequently carry with me for wider views than my CV-125 requires. I tend to favor the 45mm PC-E lens. Using the 24mm PC-E lens I can stick it very close to a flower and capture the flower and the surrounding space easily. The shift feature allows me to take three photos (left-shift, middle, right-shift) and combine them with a stitching program to produce a seamless mini-panorama. Since all three photos already share a common image circle within the camera, this guarantees a seamless panorama. However, I find that I can only shift (left or right) one-half of the

permitted distance without causing some vignetting. Still, I can produce a three- shot panorama with no special panorama head in a jiffy and they are excellent. I don't feel they are as perfect for stacked three-shot panoramas than using the CV-125 and a pano head, however.



## **Zeiss 100mm f/2 ZF.2 Makro-Planar**

Focal Length: 100mm

Widest Aperture: f/2

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 67mm

Hood: Included

Close Focus Distance: 16.8 inches (43 centimeters)

Reproduction Ratio: 1:2

Focus Throw: 360°

Weight: 26.5 ounces (751 grams)

Pros: Very sharp lens, Fast lens, good focus throw, 9 blades.

Cons: No 1:1, heavy-ish, near focus could be closer.

This is a wonderful lens and, like its little brother the 50mm Makro-Planar, it very, very sharp. The build is tough and elegant. I wish its near-focus distance was a little shorter and it does not go to 1:1, which is perhaps its main fault. It is no wonder it has such fanatical followers. As for my use of it, IMO there is a little too much contrast in the output and the colors are not APO and seem to lack some of the subtlety found in APO lenses like the CV-125 APO-Lanthar,

Leica 100mm APO Elmarit R, and the Coastal Optics 60mm APO lens.

That aside, this would be a wonderful lens for anyone.



## Micro-Nikkor 60mm f/2.8 G

Focal Length: 60mm

Widest Aperture: f/2.8

Narrowest Aperture: 32

Aperture Blades: 9

Filter Size: 62mm

Hood: HB-42

Close Focus Distance: 7.28 inches (18 centimeters)

Reproduction Ratio: 1:1

Focus Throw: 120°

Weight: 15 ounces (425 grams)

Pros: Fast lens, 9 blades, close focus, VERY sharp, goes to 1:1.

Cons: Short focus throw.

This is a real workhorse of a macro lens, especially for copy work. I shot over 30,000 concert posters with this lens and it worked better than any other lens I could put my hands on. If I had the Coastal Optics 60mm at the time, perhaps only that would have been a better lens for copy work.

The 60mm Nikon macro is not what the 105mm focal range can provide and most macro photographers want that extra distance between them and their subjects. The 60mm does not provide that and I never use it for that ultra-close work that the 100mm or 200mm macro lenses provide. Instead, 60mm macros are for larger subjects, what I call dioramas or mini-landscapes such as a close-up of a flower and as



much of the bush it is on also in the same frame, and so on.

If you are thinking of macro as the eye of the dragonfly or the bee's knees, this lens is not that. But the more I learn about close-up photography, the more the 60mm focal length is becoming useful to me. This lens is all about context and story. Wider-angle lenses allow us to tell more of a story than do the longer focal lengths.

However, the 120° focus throw is too short and makes focusing a real problem, especially if you want to stack photos. The 1:1 image frame is a real plus and makes this lens very attractive. And it is light and can slip into a pocket.



## Nikon Nikkor 35mm f/1.4 G

Focal Length: 35mm

Widest Aperture: f/1.4

Narrowest Aperture: 16

Aperture Blades: 9

Filter Size: 77mm

Hood: HB-59

Close Focus Distance: 9.85 inches (25 centimeters)

Reproduction Ratio: 0.179x

Focus Throw: 090°

Weight: 21.165 ounces (600 grams)

Pros: Very fast lens, VERY sharp, 9 blades, short focus.

Cons: Short focus throw, no 1:1, heavy-ish.

This quite new and very expensive lens is very, very sharp. And while it may have been designed (only 1 90-degree focus throw) for people photos and as a walking-around lens, it makes a very good wide-angle close-up lens for macro shooters. With a very close near focus (< 10 inches), you can poke this little baby right in the midst of a bunch of flowers and get one very close and see everything else in the vicinity at the same time.

There has been some discussion about auto-focus not being exact on this lens but as a macro shooter that means little to me. I shoot with manual focus anyway. I am sorry the focus throw is so darned short, which makes focus stacking trickier than it otherwise would have been. And of course, as a wide angle it

does not go to 1:1. There are older Nikon wide-angle lenses (35mm and 28mm) that also do a superb job at a much lower cost, so don't ignore those.

IMO this is a magic lens that is very useful for mini-landscapes, dioramas, and the like plus it is great for people and parties at the same time.



## Coastal Optics 60mm f/4.0 APO Macro

Focal Length: 60mm

Widest Aperture: f/4

Narrowest Aperture: 45

Aperture Blades: 7

Filter Size: 52mm

Hood: Does not include a hood. Use Nikon HR-2

Close Focus Distance: 10.4 inches (26 centimeters)

Reproduction Ratio: 1:1.5 (2/3rds original size)

Focus Throw: 210°

Weight: 19 ounces (535 grams)

Pros: Wickedly sharp, short focus distance.

Cons: Slow lens, only 7 blades, short focus throw, does not go to 1:1, hot spot at 1:3.

Aside from being very expensive (\$4500), the CO-60 APO lens is somewhat of a specialized lens. It is designed for use not only in the visual spectrum but also in the infrared and ultra-violet spectrums on either side of the visual spectrum. It was designed for forensic and scientific use. If you were looking for a copy-camera lens in a studio, this would be just about perfect. Lens expert Lloyd Chambers states that the CO-60mm is “a reference lens for other lenses... On a scale of 1 to 5, it is a 5+.”

It does have its problems, foremost among them is the fact that this lens has a prominent hotspot at smaller apertures around magnifications of 1:3. For distances longer than this, there is no problem. However, as a macro photographer the 1:3 range

means I have run into these hotspots many times and they do ruin a photo. Not sure what the thinking is on why such an expensive and perfect lens should have such a glaring fault. Perhaps it is that we should be grateful to have this fantastic lens, warts and all. A workaround is to use the very smallest extension ring to help bypass the hotspot range. Another trick is to use a high-megapixel camera like the Nikon D3x and avoid the hotspot range and then crop out what you are trying to capture, given the extra pixels. I have done both successfully.

Aside from the hotspot I have other issues with this lens, in particular the very short focus throw of around  $210^\circ$  degrees. Compared to  $630^\circ$  on the CV-125,  $210^\circ$  is difficult especially since a focal length of 60mm is wide enough that even the smallest change in the focusing barrel produces a noticeable change. This makes it hard to focus stack with the CO-60mm. Macro lenses benefit from having long focus throws, more so the wider they get.

The other issue that I have encountered, although no one else seems to worry about this, is that when shooting in mixed light such in the shadows of a forest canopy where a shaft of sunlight is cutting through the shade, the CO-60mm appears to be more sensitive to light dynamics. The result is the need to use diffusers carefully to filter the brighter light areas.

That being said, this is a wonderful lens indeed. It comes with no hood, but really needs one. I use the rubber hood, Nikon HR-2 on my copy.





## Voigtlander 58mm f/1.4 Nokton

Focal Length: 58mm

Widest Aperture: f/4

Narrowest Aperture: 16

Aperture Blades: 9

Filter Size: 58mm

Hood: Use Pearstone 58mm snap-on Tulip hood.

Close Focus Distance: 17.76 inches (45 centimeters)

Reproduction Ratio: 1:5.8

Focus Throw: 210°

Weight: 11.29 ounces (320 grams)

Price 2010: \$409 at B&H.

Pros: Very fast lens, very sharp lens, 9 blades.

Cons: Not close focus, no 1:1, 16mm smallest aperture.

This lens is an all-metal construction with a hard-rubber focusing ring. The included lens cap is a pain and should not be used as it requires you to remove the screw-in hood each time you use it. I bought a Nikon 52mm pinch-cap and that solved the problem. I intend to find a rubber 52mm hood and get rid of the original metal dome.

No less an authority than Lloyd Chambers states that this lens is equal to the Zeiss 50mm f/1.4 Makro-Planar and better than the “Holy Grail” of Nikons, the legendary Noct- Nikkor 58mm/f.1.2. This is saying a lot. Test results by others show this lens not great wide open but very strong from f/4 or f/5.6 and even stronger at f/8 and fine at f/11. This is unusual and

makes the Nokton perfect for close-up nature photography. It is also one of the least-expensive top quality lenses available today.

From RVink: "Better than the 'holy grail' of Nikons, the legendary Noct-Nikkor 58mm f/1.2".

I think it depends on what is meant by "better". The Voightlander has less field curvature so the corners are rendered sharper for landscapes etc, but I don't think this lens has the melting-soft bokeh of the Noct. The Noct is also better corrected for coma due to the aspheric front elements so it renders point sources (night time shots) better. However, for general use perhaps the Nocton does appear sharper, and it's certainly cheaper, but for portraits and night shots I would prefer the Noct (if I could afford one!)



## **Nikon Nikkor 24mm-70mm AF-S f/2.8 G ED**

Focal Length: 24mm-70mm

Widest Aperture: f/2.8

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 77mm

Hood: HB-40

Close Focus Distance: 14.96 inches (38 centimeters)

Reproduction Ratio: 1:3.7

Focus Throw: 90°

Weight: 31.68 ounces (898 grams)

Pros: Fast lens, sharp lens, close focus distance, 9 blades.

Cons: No 1:1, very short focus throw, heavy.

This is not a macro lens or even a close-up lens, but at the wide end it can do in a pinch for close-up mini-landscape shots. It is very sharp, fast, but has a very limited focus throw, typical for a lens designed (I guess) for shooting moving targets.



## Nikon Nkikor 16mm f/2.8 Fisheye

Focal Length: 16mm

Widest Aperture: f/2.8

Narrowest Aperture: 22

Aperture Blades: 7

Filter Size: CAP Hood: Built In

Close Focus Distance: 9.84 inches (25 centimeters)

Reproduction Ratio: 1:10

Focus Throw: 60°

Weight: 10.12 ounces (287 grams)

Pros: Fast lens, sharp-ish, good close focus, goes 1:1, 7 blades.

Cons: Very short focus throw, not sharp enough for the finest work.

The Nikon 16mm Fisheye lens is the opposite of a macro lens which oddly enough makes it useful to me in my work as antidote for what I normally do. Instead of getting close, up this rectilinear (framed like any other lens and not a circular fisheye lens) is able to cram almost the entire world into the shot, including my feet and too often the tripod itself.

Thanks to special software in post (I use the built-in feature in Adobe Lightroom) the resulting photos can be more-or- less straightened out to appear as a normal photo, but one maybe on LSD. For myself, I love this lens and it is small enough to jam in a pocket or a bag. With a near focus distance of some 10

inches I can highlight a single flower close-up and have the whole meadow in which it sits looking over its shoulder.

Although this lens is relatively sharp, it is not sharp enough to be totally convincing, but that is not its purpose anyway. I love the 3D or otherworldly sense that this lens offers and I have sought to replicate this effect but with deep focus by using a panoramic head and focus stacking, and with some success. It took my years to succumb to owning this lens, but that was a mistake on my part. The 16mm rectilinear fisheye is a lens I would not part with.

From RVink: Closer focusing can be achieved by removing the rear filter, at the expense of losing infinity focus.





## Leica 100mm Apo Macro Elmarit R Lens f/2.8

Focal Length: 100mm

Widest Aperture: f/2.8

Narrowest Aperture: 22

Aperture Blades: 7

Filter Size: 60mm

Hood: Pull out hood.

Close Focus Distance: 17.71 inches (45 centimeters)

Reproduction Ratio: 1:2/1:1

Focus Throw: 710

Weight: 27 ounces (765 grams)

Pros: Fast lens, 7 blades, reasonable short focus, great focus throw.

Cons: Does not go to 1:1 without help, no automatic aperture (have to open to focus and close to shoot).

This is one of the legendary macro lenses, a true APO (apochromatic) lens. 100mm is a great macro focal length, and the focus throw is a whoppin' 710°, just what a focus- stacker like me is looking for – incremental focus. This lens was never made for the Nikon mount, so if you find one of these and want it on a Nikon, you will have to make the conversion yourself. That is what I did.

Not only is this one of the sharpest macro lenses ever made, but it has an almost movie-like feel to the color, very soft and delicate. It does not go to 1:1, but only

to 1:2, so that is not great, although the accompanying Elpro diopter can be purchased which brings it to 1:1. However, as a rule I don't like close-up adapters, although this is probably the best one I have ever seen. But there is some bad news with this lens on a Nikon Camera.

There is no way that you can enable the ability of this lens on a Nikon to automatically open up when you use the viewfinder and then stop down at the appropriate aperture when the shot is taken. Can't be done because what is needed is a mechanical lever and it just is not present. So, what this means is that for every shot you have to manually turn the aperture ring wide open, focus, and then look to see and turn the aperture to where you want it for the exposure.

This is an acquired taste and the learning curve involves forgetting to stop down and the resultant over-exposure. The net result is that, although this is one of the great lenses, I seldom choose it when I have other lenses that will let me see at the widest aperture in the viewfinder and automatically stop down for the exposure.

This lens is outstanding (a class act) and comes in a little form-fitting leather case that zips up.





## Leica Elpro 1:2-1:1 Close-Up Lens R

Focal Length: 100mm

Widest Aperture: f/2.8

Narrowest Aperture: N/A Aperture Blades: N/A Filter Size: 60mm

Hood: Included

Close Focus Distance: Filter

Reproduction Ratio: 1:2/1:1

Focus Throw: N/A, filter

Weight: 7 ounces (198 grams)

Pros: Works quite well with the 100mm Leica

Cons: Still is an add-on lens to get to 1:1.

This is one of the legendary macro lenses, a true APO (apochromatic) lens. 100mm is a great macro focal length, and the focus throw is a whoppin' 710°, just what a focus- stacker like me is looking for – incremental focus. This lens was never made for the Nikon mount, so if you find one of these and want it on a Nikon, you will have to make the conversion yourself. That is what I did.

Not only is this one of the sharpest macro lenses ever made, but it has an almost movie-like feel to the color, very soft and delicate. It does not get to 1:1, but only to 1:2, so that is not great, although the accompanying Elpro diopter can be purchased which brings it to 1:1. However, as a rule I don't like close-up adapters, although this is probably the best one I have ever seen. But there is some bad news with this lens on a Nikon Camera.

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This lens is outstanding (a class act) and comes in a little form-fitting leather case that zips up.



## Micro-Nikkor 105mm f/2.8 VR Lens

Focal Length: 105mm

Widest Aperture: f/2.8

Narrowest Aperture: 32

Aperture Blades: 9

Filter Size: 62mm

Hood: HB-38

Close Focus Distance: 12.36 inches (31 centimeters)

Reproduction Ratio: 1:1

Focus Throw: 270°

Weight: 27.84 ounces (789 grams)

Pros: Sharp lens, 9 blades, good near focus, ample focus throw, VR, gets to 1:1.

Cons: Could be sharper, a little heavy.

This is the current version of the classic Nikon 105mm Micro-Nikkor but is much bulkier, heavier, and more expensive than pulling an earlier model off Ebay. I would stick with the earlier models since (believe it or not) they are sharper, at least for very close work.

There is one and only one reason I still own this lens and that is for hand-held chase-the-butterfly photography. For the most part I am always on a tripod, but for some subjects I need to sneak up on them and follow their movements. The addition of the VR in this version works quite well and makes it the best lens for this kind of job.



The VR 105mm lens also is relatively fast and goes to the 1:1 reproduction ratio without the addition of extension tubes or close-up lenses. This alone is a big plus. In fact, if I sit down and add up all the qualities needed for a good macro lens, the Nikon 105mm VR is always near the top. It is fast, goes to 1:1, focuses close, has 9 blades for good bokeh, and has a reasonable focus throw. All these added together suggest that this might be the best all-around macro lens for beginners.

#### OLDER 105mm Micro-Nikkors

There were a number of older 105mm macros. Here are the specs for the version before the VR release. All of these earlier 105mm macros are good basic macro lenses and worth picking up if the price is right.

Lens: Micro-Nikkor 105mm f/2.8 V

Widest Aperture: f/2.8

Narrowest Aperture: 32

Aperture Blades: 9

Filter Size: 52mm-62mm

Hood: HS-7

Focus Throw: 180°

Weight: 19.75 ounces (560 grams)

Pros: Sharp lens, 9 blades, good near focus

Cons: Could be sharper, a little heavy, marginal focus throw.



## Nikon Nikkor 85mm f/1.4 G

Focal Length: 85mm

Widest Aperture: f/1.4

Narrowest Aperture: 16

Aperture Blades: 9

Filter Size: 77mm

Hood: N/A

Close Focus Distance: 36 inches (91 centimeters)

Reproduction Ratio: 1:8.3

Focus Throw: 90°

Weight: 20.98 ounces (595 grams)

Pros: Very fast lens, VERY sharp, 9 blades.

Cons: long focus distance, no 1:1, very short focus throw, heavy-ish.

I mention this and the new “D” version of the classic 85mm f/1.4 not because I use it often but because it is a sharp lens that many professional photographers already have in their kit. I use it once in a while for extremely low-light occasions for shooting mid-sized bushes, plants, etc. Actually, more of the time now in low-light situations I am now using the D3s and pushing the ISO, so I list it here just to keep it in mind.



## **Micro-Nikkor 70mm-180mm AF f/4.5-5.6 D**

Focal Length: 70mm-180mm

Widest Aperture: f/4.5-5.6

Narrowest Aperture: 32-40

Aperture Blades: 9

Filter Size: 62mm

Hood: HB-14,HN-23

Close Focus Distance: 19.42 inches (49 centimeters)

Reproduction Ratio: 1:32/1:3.2

Focus Throw: 180°

Weight: 35 ounces (992 grams)

Pros: Zoom macro lens, 9 blades, reasonable focus throw.

Cons: VERY slow lens, long near focus, does not get close to 1:1, heavy.

The 70-180mm Micro-Nikkor is a nice idea, a macro lens that zooms. I used this lens almost exclusively for almost two years, so I really know it inside and out. It is nice to zoom around, to pull out or focus in to adjust a shot without having to move the tripod. All this is fine. But I never do much macro or close-up work at 70mm. Most to all is done at the other end of the focus range, around 180mm and when down there the f-stop for this lens is f/5.6 which (simply put) is too damned dim for my eyes in the viewfinder. I like the early morning light of dawn or the twilight to shoot and I find there is not enough light to see to focus with this lens, especially if I want to stack photos. The viewfinder is dark at f/5.6 except in bright light. Why bother?

I will say that there is a “magic” with this lens that I do love. Somehow the images have an almost film look to them which I like. And the lens is sharp enough, but not tack sharp and the resulting photos tend to be too dark or heavy/contrast-y in some sense not present in my Zeiss or Voigtlander lenses. And it weight almost two pounds!

If you work in bright light a lot, you might consider this lens. Otherwise, you are better off with a lens that will go 1:1 and is faster like the Nikon 105mm Micro-Nikkors.

From RVink: "...around 180mm where this lens is f/5.6 which is too darned dim for my eyes in the viewfinder" True, but it is worth noting the aperture does not get slower as you focus closer, unlike most other macro lenses. Most macros such as the Nikon 60/2.8, 105/2.8 and 200/4, the aperture drops to f/5 or f/5.6 at close range, so are not really faster in the macro range.

It achieves this trick by reducing the focal length at close range instead. The result is the working distance is rather short. It is not a replacement for the 200 Micro where the greater working distance and smaller angle of view is desirable. It's also not a replacement for the 105's greater magnification, especially when the 105 is used with teleconverters, extension or combinations to achieve reproduction ratios greater than 1:1. However the ability to zoom makes it an extremely flexible lens.



## Micro-Nikkor 200m AF f/4 ED-IF Macro

Focal Length: 200mm

Widest Aperture: f/4

Narrowest Aperture: 32

Aperture Blades: 9

Filter Size: 62mm

Hood: HN-30, HN-23, HN-30

Close Focus Distance: 19.68 inches (50 centimeters)

Reproduction Ratio: 1:1

Focus Throw: 300°

Weight: 41.6 ounces (1179 grams)

Pros: Very sharp lens, gets to 1:1, good focus throw, 10 inches from front of lens, rotating collar.

Cons: Slow lens, heavy, not great bokeh.

This is probably Nikon's sharpest macro lens and also its heaviest (over two pounds), so it really can only be used effectively on a solid tripod. This lens is well built, very sharp, and the focus throw is a healthy 300 degrees, which is good for focus stacking. My only complaint is that the f/4 wide aperture dims my viewfinder too much for really low light work, and it is heavy!

According to Canon users this Micro-Nikkor 200mm lens bests even the classic Canon 180mm f/3.5 L USM. This lens can also be used for normal landscape photography as can any macro lens. Not



all macros are sharp for distance shots, but this lens is, so it has a dual purpose, macro and landscape.

This is an auto-focus lens, but it is quite slow and no good macro shooter I have met ever uses auto-focus except perhaps to jump to the general ballpark area for the shot. This lens has internal focusing, so there is no change in the lens length while focusing. The tripod collar rotates 90-degrees so you can switch from horizontal to vertical (or back) in a moment, which is a real plus.

However it does get to 1:1 and is as sharp as you could want (a classic), so it is the favorite of many Nikon macro shooters. I have one but use it seldom as the Voigtlander 125mm APO is better in all ways I care about.

Lens expert Björn Rørslett points out that if you use the 6T close-up lens to extend the reproduction ratio, it should be mounted in reverse on this lens to obtain maximum corner sharpness. The lens collar that comes with this lens is weak and easily is broken. Instead, I use a lens collar from Kirk Enterprises (part # NC-300) which avoids that problem.



## Nikkor 35-70mm AF Zoom f/2.8 D Lens

Focal Length: 35mm-70mm

Widest Aperture: f/2.8

Narrowest Aperture: 22

Aperture Blades: 7

Filter Size: 62mm

Hood: HB-1

Close Focus Distance: 14 inches (36 centimeters)

Reproduction Ratio: 1:4.3

Focus Throw: 360°

Weight: 23.43 ounces (664 grams)

Price 2011: Approximately \$300 on Ebay.

Pros: Fast lens, sharp lens, 7 blades, close focus distance, good focus throw.

Cons: No 1:1, heavy.

This was for years one of Nikon's best and sharpest lenses. This is not a dedicated macro lens, but has a macro mode which lets you get to around 14 inches (24 inches is as close as the non-macro mode allows). The macro mode is a little softer than the standard mode. Although the lens is an early auto-focus lens, in macro mode it defaults to manual focus, which is what macro shooters need anyway.

I list this lens because I had it early on and it is a kind of lens for all seasons, even if it is an old-ish lens by this point. It has those ancient pull-out tubes, which are not my favorite. Still, some of you just starting out and on a budget could pick up a copy that will do portraits, landscapes, and even a little macro. There is no question it is a sharp lens. It has a solid build.





## **Nikon Nikkor 135mm AF DC f/2**

Focal Length: 135mm

Widest Aperture: f/2

Narrowest Aperture: 16

Aperture Blades: 9

Filter Size: 72mm

Hood: BUILT-IN

Close Focus Distance: 3.6089 ' (1.0999 meters)

Reproduction Ratio: 1:7.1

Focus Throw: 130°

Weight: 30.68 ounces (870 grams)

Pros: Fast lens, sharp lens, 9 blades.

Cons: Long focus distance, no 1:1, very short focus throw, heavy.

This is not a macro or a really a close-up lens, but rather a portrait lens that features a de-focus control that allows you to selectively blur the background. It is useful only for mini- landscapes, plants, bushes, and so on. 105DC (39.37 inches)



## **Nikon Nikkor 85mm f/1.4 D**

Focal Length: 85mm

Widest Aperture: f/1.4

Narrowest Aperture: 16

Aperture Blades: 9

Filter Size: 77mm

Hood: HN-31

Close Focus Distance: 33.46 inches (85 centimeters)

Reproduction Ratio: 1.9.09

Focus Throw: 90°

Weight: 19.4 ounces (550 grams)

Pros: Very fast lens, very sharp, 9 blades

Cons: No close distance, no 1:1, heavy, short focus throw.





## **Nikon Nikkor 135mm AF DC f/2**

Focal Length: 135mm

Widest Aperture: f/2

Narrowest Aperture: 16

Aperture Blades: 9

Filter Size: 72mm

Hood: BUILT-IN

Close Focus Distance: 3.6089 ' (1.0999 meters)

Reproduction Ratio: 1:7.1

Focus Throw: 130°

Weight: 30.68 ounces (870 grams)

Pros: Fast lens, sharp lens, 9 blades.

Cons: Long focus distance, no 1:1, very short focus throw, heavy.

This is not a macro or a really a close-up lens, but rather a portrait lens that features a de-focus control that allows you to selectively blur the background. It is useful only for mini- landscapes, plants, bushes, and so on. 105DC (39.37 inches)



## Nikon Nikkor 85mm f/1.4 D

Focal Length: 85mm

Widest Aperture: f/1.4

Narrowest Aperture: 16

Aperture Blades: 9

Filter Size: 77mm

Hood: HN-31

Close Focus Distance: 33.46 inches (85 centimeters)

Reproduction Ratio: 1.9.09

Focus Throw: 90°

Weight: 19.4 ounces (550 grams)

Pros: Very fast lens, very sharp, 9 blades

Cons: No close distance, no 1:1, heavy, short focus throw.

I mention this and the new “G” version of the classic 85mm f/1.4 not because I use it often but because it is a sharp lens that many professional photographers already have in their kit. I use it once in a while for extremely low-light occasions for shooting mid-sized bushes, plants, etc. Actually, more of the time now in low-light situations I am now using the D3s and pushing the ISO, so I list it here just to keep it in mind.



## Nikon Nikkor 300mm AF-S f/4 ED

Focal Length: 300mm

Widest Aperture: f/4

Narrowest Aperture: 32

Aperture Blades: 9

Filter Size: 77mm

Hood: Built-in

Close Focus Distance: 4.75721 ' (1.4499 meters)

Reproduction Ratio: 1:3.7

Focus Throw: 180°

Weight: 50.79 ounces (1437 grams)

Pros: Sharp lens, 9 blades, short focus distance for a telephoto.

Cons: No 1:1, short focus throw, heavy (of course).

What is a 300mm lens doing in the same context as macro and close-up lenses? This very sharp telephoto lens is here for one purpose and that is for use with the Nikon D3x and that only thanks to the fact that it has relatively the shortest near distance of any good-sized telephoto lens, a little under five feet. Attach the Nikon 300mm f/4 lens on a D3x and you can pick off frogs in the middle of a pond and, because the resulting photo has so many megapixels, crop out the frog from the center of the image and still have enough pixels to make a decent photo out of your crop.

In addition, if you put the Nikon AF-S TC-20E-III 2x Teleconverter on any full-frame Nikon you can get right up close and take decent macro photos. No

doubt that the Nikon 300mm needs plenty of light for your viewfinder, it won't be too useful in dim light.





## **Nikon Nikkor 70mm-200mm AF VR II f/2.8 GII AFS ED-IF**

Focal Length: 70mm-200mm

Widest Aperture: f/2.8

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 77mm

Hood: HB-48, HN-28

Close Focus Distance: 4.59317 feet (1.3999 meters)

Reproduction Ratio: 1:8.3

Focus Throw: 90°

Weight: 51.79 ounces (1468 grams).

Pros: fast lens, sharp, VR, 9 blades.

Cons: Not close focus, very short focus throw, no 1:1, heavy.

This very sharp, fast, and ever-so-popular telephoto lens is something most professional photographers have in their bag and already own. Attach the Nikon 200mm VR II on a D3x and you can pick off frogs in the middle of a pond and, because the resulting photo has so many megapixels, crop out the frog from the center of the image and still have enough pixels to make a decent photo out of your crop.

In addition, if you put the Nikon AF-S TC-20E-III 2x Teleconverter on any full-frame Nikon you can get right up close and take decent macro photos.



## Voigtlander 180mm APO f/4

Focal Length: 180mm

Widest Aperture: f/4

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 49mm

Hood: Square, included.

Close Focus Distance: 47.24 inches (120 centimeters) Reproduction Ratio: 1:2

Focus Throw: 290°

Weight: 17 ounces (485 grams)

Pros: Sharp lens, 9 blades, reasonable focus throw.

Cons: No close focus, slow lens, heavy-ish.

This is not a macro lens and not really a close-up lens either, so let's say it is a semi-close-up lens. This is lovely little lens looks like a miniature version of its big brother the Voigtlander 125m APO-Lanthar. And like is brother, the 180mm is also APO and very sharp. However, this lens is difficult to find and is no longer manufactured. Like the CV- 125, this lens has an outer metal shell and a relatively long (and very smooth) focus ring. The lens is sharp by f/5.6 and also still strong at f/8.

For nature photography it gives you plenty of distance (you have no choice), so shots of butterflies on flowers and plants of all kinds are what it is best for. It is light compared to the CV-125. I have not used it for landscapes or infinity shooting, so I can't speak to that. It took me years to find a copy of this lens, so good luck!





## Micro-Nikkor 85mm f/2.8 PC Tilt/Shift Lens

Focal Length: 85mm

Widest Aperture: f/2.8

Narrowest Aperture: 32

Aperture Blades: 9

Filter Size: 77mm

Hood: HB-22

Close Focus Distance: 15.35 inches (39 centimeters)

Reproduction Ratio: 1:2

Focus Throw: 120°

Weight: 22.4 ounces (635 grams)

Pros: Fast lens, 9 blades, sharp lens.

Cons: Near focus a little long, does not get to 1:1, very short focus throw.

I have all three of the most recent Nikon PC (tilt/shift) lenses, this one plus the 85mm and 24mm PC. While all three are exemplary lenses, I find the 45mm PC the most useful for macro and close-up work. The “PC” stands for perspective control through the tilt and shift features.

The tilt feature allows the lens to tilt (either up and down, or right and left) a total of 8.5 degrees. There are many tutorials on the web for learning to use this feature, but the idea is that in any photo there is one and only one plane of focus. “Tilt” allows the lens to align the plane the lens with that of the image plain. An example might be a field of flowers stretching toward the horizon. Instead of just having the front flowers in focus, by tilting the lens it can be possible have the whole field in focus.

The shift feature allows the lens to be sifted right or left (or up and down) bringing what normally would be out-of-frame in frame without having to move the camera. Notice that these lenses have large box-like midsections. This allows a lens to have a larger image circle than a normal lens, so that shifting the lens to either side allows more or less of the subject to come into view. At total shift of 11.5 mm to either side is permitted.

In addition the whole lens barrel can be rotated plus or minus 90-degrees by 30-degree increments allowing you to combine the tilt/shift features in various combinations. Sound amazing? It is, but don't run out and buy one unless you really need these features. These lenses are bulky and heavy. Both the tilt and shift features (and especially the tilt feature) have a steep learning curve and are not easy to learn. The focus throw is very smooth but also very short, making it not ideal for close-up focus stacking.

Using this lens I can stick it very close to a flower and capture it and the surrounding space easily. The shift feature allows me to take three photos (left-shift, middle, right-shift) and combine them with a stitching program to produce a seamless mini-panorama. Since all three photos already share a common image circle within the camera, this guarantees a seamless panorama. However, I find that I can only shift (left or right) one-half of the permitted distance without causing some vignetting. Still, I can produce a three-shot panorama with no special panorama head in a jiffy and they are excellent. I don't feel they are as perfect for stacked three-shot panoramas than using the CV-125 and a pano head, however.

This is a wonderful lens that is indeed very sharp and may interest some of you. That being said, the Nikon 85mmPC-E lens is a lens I don't frequently carry with me because I have a number of fine macro lenses in the 90-125mm focal range. Tilt and shift are not things I tend to do close-up although they can be useful on occasion. If I am shooting landscape or even mini-landscape I generally go wider than 85 degrees.





## **Voigtlander 90mm f/3.5 SL-II APO-Lanthar**

Focal Length: 125mm

Widest Aperture: f/2.5

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 58mm

Hood: Include, small hood.

Close Focus Distance: 19.68 inches (50 centimeters),  
12.6 inches (32 centimeters)

Reproduction Ratio: 1:3.5/1:1.8

Focus Throw: 270°

Weight: 11.29 ounces (320 grams)

Pros: Very sharp lens, APO, 9 blades, close focus  
only with close-up lens, ample focus throw.

Cons: Slow lens.

This little gem is probably the least-expensive top quality APO lens on the market for the value you get. This is an all-metal lens that is built like a tank. It is smallish and includes a close-up filter that screws into the hood of the lens. This is an odd-shaped lens compared to most lenses, but the sharpness and clarity are right up there with the best of lenses and here is APO at a price anyone can afford. The SL-II version (most recent) of this lens is fully metered to Nikon bodies. It is a manual focus lens.

The little 39mm hood adaptor allows you to screw in the small close-up lens which has its own tiny lens cap. Otherwise you can bag the close-up and hood and treat this as any 52mm lens. Just get yourself a 52mm rubber lens cap like the Nikon HR-2 (and

pinch-type lens cap) and presto!, you have a normal-looking lens.

If you yearn for the APO coloring you find in the Voigtlander CV-125 and Leica 100mm APO Elmarit, which are four or five times more expensive, then here is a lens that can get you there. It is a little slow and requires a close-up lens (so does the Leica) to get you to 1:1.



## **Nikon Nikkor 105mm AI-S f/2.5 (built-in hood)**

Focal Length: 105mm

Widest Aperture: f/2.5

Narrowest Aperture: 22

Aperture Blades: 7

Filter Size: 52mm

Hood: HN-8, HS-4

Close Focus Distance: 3.2808' (0.999 meters)

Reproduction Ratio: 1:7.7

Focus Throw: 140°

Weight: 15.34 ounces (435 grams)

Pros: Fast lens, very sharp, 7 blades.

Cons: Long focus, short focus throw, no 1:1, heavy.

This lens was very popular years ago and there are many still available on Ebay at reasonable prices.

This is not a macro lens but just a very, very sharp 105mm manual focus lens that you can easily find. It is useful for mini-landscapes, bushes, etc. – anything about three feet from wherever you are.



## **Kiron (Lester A. Dine) 100mm f/2.8 Macro**

Focal Length: 100mm

Widest Aperture: f/2.8

Narrowest Aperture: 32

Aperture Blades: 8

Filter Size: 52mm

Hood: Pull out hood.

Close Focus Distance: 17.4 inches (44 centimeters)

Reproduction Ratio: 1:1

Focus Throw: 390°

Weight: 22 ounces (623.7 grams)

Pros: fast lens, Sharp, 8 blades, reasonable close focus, good focus throw, goes to 1:1.

Cons: None.

This lens produced by Kiron (Lester A. Dine) is a sharp lens and worth looking at especially if you are on a budget. There are many different lenses (both in 100mm and 105mm) that are essentially the same lens. They have also been issued not only under the Kiron and Lester A. Dine label, but also by Vivitar. I have seen them on Ebay for \$250. This lens does go to 1:1 (which is rare!) and has a very good focus throw. It was originally marketed mostly to dentists. The same lens has been advertised as a f/2.5 when sold by Elcar and as a f/2.8 when sold by Cosina, Panagor, Soligor, Vivitar, Kiron, and sold to dentists as the Lester A. Dine. The results with this lens are sharp and this lens should be on your short list if you want a solid macro lens and don't want to lay out the big bucks. It will do the job. You should be able to find one if you look for a while.





## **Micro-Nikkor 55mm P Auto 55mm f/3.5 (672490)**

Focal Length: 55mm

Widest Aperture: f/3.5

Narrowest Aperture: 32

Aperture Blades: 6

Filter Size: 52mm

Hood: HN-3

Close Focus Distance: 9.488 inches (24 centimeters)

Reproduction Ratio: 1:2

Focus Throw: 300°

Weight: 8.28 ounces (235 grams)

Pros: Close focus, long focus throw, very sharp.

Cons: 6 Blades, does not go to 1:1, slow lens.

This top-quality manual-focus macro lens is very sharp, at least at close distances and is not recommended for landscape or distance shooting. There were two versions, one with a compensating diagram (marked "P") and one without (no "P" suffix). The "P" version is the one to get. There are a number of Nikon 55mm f/3.5 versions of this micro and some care has to be taken to find the correct lot. One way is to make sure the serial number of the lens is between 600001 and 728347. One good way to find this lens is to check KEH.com. They usually have a number of copies and at a reasonable price. This might be the sharpest macro lens for the least money available. It is all manual.

Lens expert Björn Rørslett suggest that the correct lens has a "chrome barrel, magnification factors

printed in light blue, and hill-and-dale focusing and aperture collars." See his site for more details:  
<http://www.naturfotograf.com>

From RVink: There are two main versions here. The first is the "compensating" version. It has a metal focus ring and serial numbers from 188101 - 273153. It is designed for cameras \*without\* TTL metering. As long as the lens is stopped down to f/5 or smaller, the lens will compensate for light lost due to extension by opening up the aperture (obviously it cannot work with the lens wide open because the aperture cannot open up further). The advantage of this mechanism is that the aperture, and therefore the exposure remain constant regardless of the focus distance/magnification. However it causes problems on cameras with TTL metering because they already compensate for the light loss due to extension, so you need to manually counter-compensate otherwise overexposure will result. According to Bjorn this lens is better corrected for macro focusing, but is not so good at greater distances.

It was replaced by the non-compensating Micro-Nikkor-P version (shown in your article). This is designed for cameras with TTL metering, which auto-compensate for light lost due to extension. It has a diamond rubber grip and serial numbers from 600001 upwards. According to Bjorn, the optics are better corrected for general shooting, with a slight loss of performance at close range. However, the technical drawings I have seen don't show any difference, and the manuals of all versions state that best performance is achieved at 1:10 magnification, so I'm not sure if the optics changed or not.

The Micro-Nikkor-P is single coated, it was replaced by the multicoated P.C version, then by the late pre-AI "K" version with modern styling, then by the AI. All have the same optics so one can consider lenses beyond the 600001 - 728347 range you quoted. I would recommend the AI version (940001 and up) simply because it is multicoated and compatible with modern cameras.



## Micro-Nikkor 105mm P f/4 Macro Bellows Lens

Focal Length: 105mm

Widest Aperture: f/4

Narrowest Aperture: 32

Aperture Blades: 12

Filter Size: 52mm

Hood: None.

Close Focus Distance: N/A Reproduction Ratio: N/A

Focus Throw: N/A

Weight: 8.113 ounces (300 grams)

Pros: 12 blades, light

Cons: Slow lens.

I learned how to use this lens from Björn Rørslett and <http://www.naturfotograf.com>. Of course it works great on a bellows for studio work, but that is not how Rørslett uses it. Instead, he mounts this lens (not-reversed) on its sibling 105mm f/4 (which is the identical lens to this bellows version) but in a standard lens tube with focus ring, etc. The two lenses are coupled using the Nikon K3 ring. Through this amazing combination, Rørslett claims that no light is lost and the two lenses equal a 50 mm f/2 lens.

This lens combination is very effective for ultra-close macro shots although focus takes patience and there is very little distance between the end of the lens and your subjects.



## Nikon Nikkor 28mm f/2.8

Focal Length: 28mm

Widest Aperture: f/2.8

Narrowest Aperture: f/22

Aperture Blades: 7

Filter Size: 52mm

Hood: HN-2

Close Focus Distance: 0.2m (8")

Reproduction Ratio: 1:3.9

Focus Throw: 170°

Weight: 8.81849 oz. (250 grams)

Pros: Very sharp lens, fast lens, 7 blades, close focus, light.

Cons: No 1:1, very short focus throw.

This is another of Nikon's classic primes. It is still available new and turns up on Ebay used as well. It is fast, wide, has great bokeh, lightweight, and has a close near focus. It has however, an extremely short focus throw so stacking photos must be done with care. However, wide angle lenses don't lend themselves to focus stacking and this is a very handy lens to throw in the bag or stick in a pocket so that you have wide-angle coverage when you need it. I use it for mini- landscapes and any larger-than-macro objects.





## Micro-Nikkor 60mm f/2.8 D Lens

Focal Length: 60mm

Widest Aperture: f/2.8

Narrowest Aperture: 32

Aperture Blades: 7

Filter Size: 62mm

Hood: H2.22

Close Focus Distance: 8.66 inches (22 centimeters)

Reproduction Ratio: 1:1

Focus Throw: 120°

Weight: 15.52 ounces (440 grams)

Pros: Fast lens, 7 blades, close focus, very sharp, goes to 1:1.

Cons: Short focus throw.

This is a real workhorse of a macro lens, especially for copy work. I shot over 30,000 concert posters with this lens and it worked better than any other lens I could put my hands on. If I had the Coastal Optics 60mm at the time, perhaps only that would have been a better lens for copy work.

The 60mm Nikon macro is not what the 105 focal range can provide and most macro photographers want that extra distance between them and their subjects. The 60mm does not provide that and I never use it for that ultra-close work that the 100mm or 200mm macro lenses provide. Instead, 60mm macros are for larger subjects, what I call dioramas or mini-landscapes such as a close-up of a flower and as much of the bush it is on also in the same frame, and so on.

If you are thinking of macro as the eye of the dragonfly or the bee's knees, this lens is not that. But the more I learn about close-up photography, the more the 60mm focal length is becoming useful to me. This lens is all about context and story. Wider-angle lenses allow us to tell more of a story than do the longer focal lengths.

However, the 120° focus throw is too short and makes focusing a real problem, especially if you want to stack photos. The 1:1 image frame is a real plus and makes this lens very attractive. And it is light and can slip into a pocket. That being said, if you don't own one already, get the new Nikon 60mm G version of this lens. I find it much sharper.



## Nikon Nikkor 50mm f/1.8 AIS

Focal Length: 50MM

Widest Aperture: f/1.8

Narrowest Aperture: 22

Aperture Blades: 7

Filter Size: 52mm

Hood: HS-11, HR-1

Close Focus Distance: 17.71 inches (45 centimeters)

Reproduction Ratio: 1:6.6

Focus Throw: 130°

Weight: 5.64 ounces (160 grams)

Pros: Very fast lens, sharp, 7 blades, light

Cons: No close near focus, no 1;1, very short focus throw.

This classic Nikon 50mm f/1.8 lens does not really belong here since it is neither a macro nor a wide-angle lens. However, it is very, very sharp and lightweight as well. If you are shooting mini-landscapes, bushes, gardens, dioramas, there is not reason to ignore this lens, especially if you already have it.

RVink: Not a macro lens, but it can perform quite well on extension tubes.



## Nikon Nikkor 24mm f/2.8

Focal Length: 24mm

Widest Aperture: f/2.8

Narrowest Aperture: f/22

Aperture Blades: 7

Filter Size: 52mm

Hood: HN-1

Close Focus Distance: 12 inches (30 centimeters)

Reproduction Ratio: 1:8.8

Focus Throw: 80°

Weight: 9.52 (270 grams)

Pros: Very sharp lens, fast lens, 7 blades, close focus, light.

Cons: No 1:1, very short focus throw.

This is another of Nikon's classic primes. It is still available new and turns up on Ebay used as well. It is fast, wide, has great bokeh, lightweight, and has a close near focus. It has however, an extremely short focus throw so stacking photos must be done with care. However, wide angle lenses don't lend themselves to focus stacking and this is a very handy lens to throw in the bag or stick in a pocket so that you have wide-angle coverage when you need it. I use it for mini- landscapes and any larger-than-macro objects.



## Voigtlander 40mm Ultron f/2.0 SL II

Focal Length: 40mm

Widest Aperture: f/2

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 52mm

Hood: A dome-shaped aperture ring is included, but it is very shallow. I use a Pearstone 52mm snap-on Tulip hood.

Close Focus Distance: 17.716 inches (45 centimeters), 9.84 inches (25 centimeters) with close-up lens.

Reproduction Ratio: 1:7/1:4

Focus Throw: 160°

Weight: 7 ounces (200 grams) Price 2011: \$409 at B&H.

Pros: Very fast, very sharp lens, 9 blades, light. Close focus with close-up lens.

Cons: No 1:1, short focus throw.

This little pancake lens is solid metal with a hard-rubber focus ring. It is less than one inch (24mm) long. The front element is non-rotational but the lens does extend just a bit while focusing. This is a manual focus lens but it does contain a CPU, so the Nikon matrix metering system works fine with it. There is a traditional aperture ring which you set to automatic aperture.

The lens is sharp wide open and very sharp at f/4 and f/5.6, but this is not APO and does show some chromatic aberration. The lens comes with a separate (and smaller) close-up lens that mounts via a dome-



shaped step-down ring. On this ring sits a tiny lens cap. You may wish to keep the ring and lens cap together and get a standard 52mm rubber hood.

Because of its small size and weight, this lens is easy to carry in a pocket add to your bag. This is a high quality lens at a relatively low price.



## Nikon Nikkor 35mm f/2.8 AI K-Series

Focal Length: 35mm

Widest Aperture: f/2.8

Narrowest Aperture: 22

Aperture Blades: 6

Filter Size: 52mm

Hood: HN-3

Close Focus Distance: 11.811 inches (30 centimeters)

Reproduction Ratio: 1:5.7

Focus Throw: 195°

Weight: 8.302 ounces (235 grams)

Pros: Fast lens, sharp, good close focus, light. Cons: Short focus throw, no 1:1.

35mm is a classic-sized focal length. Here is a fast 35mm lens that can be picked up for very little money. If you don't have a 35, here is one worth picking up.



## **Nikon Nikkor 28mm-105mm 1:35/4.5mm D Zoom**

Lens 62mm

Focal Length: 28mm-105mm

Widest Aperture: f/3.5-4.5

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 62mm

Hood: HB-18, HB-23

Close Focus Distance: 8.66 inches (22 centimeters)

Reproduction Ratio: 1:2

Focus Throw: 45°

Weight: 17 ounces (482 grams)

Pros: Versatile, close focus, 9 blades.

Cons: Slow, short focus throw, 1:2 reproduction ratio

Not a macro lens, but it does have a macro mode and focuses to less than 9 inches. A once-common lens, professionals are finding this lens of higher quality than once thought and are beginning to collect it and add it to their bags. A nice compromise for a zoom.



## Micro-Nikkor 105mm P f/4 Macro Lens

Focal Length: 105mm

Widest Aperture: f/4

Narrowest Aperture: 32

Aperture Blades: 7

Filter Size: 52mm

Hood: HN-8, HS-4

Close Focus Distance: 18.5 inches (47 centimeters)

Reproduction Ratio: 1:2

Focus Throw: 320°

Weight: 17.63 ounces (500 grams)

Pros: Very sharp lens, good focus throw, inexpensive

Cons: Slow lens, long near focus, no 1:1.

This classic lens has the same optics as the 105mm f/4 bellows lens. This is a very sharp lens and quite inexpensive for a quality lens. usually available used on Ebay at all times. It is manual focus and its only drawback is that it is slow (f/4), so viewfinders will not be as well lit if you are photographing in shade, dawn, or dusk. If you have plenty of light, no problem.

From RVink: Same optics are found in the pre-AI, AI and AIS versions (and bellows version). The hoods you mention can be used, but the lenses all have built-in hoods (the AIS is very deep)

The lens gets to 1:2 by itself, and 1:1 can be achieved with the PN-11 extension tube. The PN-11 has a built-in tripod mount, which greatly assist handling and balance when used on a tripod. It's an excellent combination if you can work with the slow aperture - which goes down to f/8 at 1:1!







## **Nikon Nikkor 14mm-24mm AF-S f/2.8 G ED**

Focal Length: 14mm-24mm

Widest Aperture: f/2.8

Narrowest Aperture: 22

Aperture Blades: 9

Filter Size: 77mm

Hood: BUILT-IN

Close Focus Distance: 11.023 inches (28 centimeters) Reproduction Ratio: 1:6.7

Focus Throw: 60°

Weight: 34 ounces (964 grams)

Pros: Fast lens, very sharp lens, close focus distance, 9 blades.

Cons: No 1:1, very short focus throw, heavy, no filters.

This is the lens of choice in my book when it comes to wide- angle zoom lenses and it pretty-much matches any primes in its range. Folks complain about its bulbous lens not taking filters and being unprotected, but that has not bothered me. Could it be that I seldom use filters? However, it might be possible for the plastic lens cap to slip off, so I have added some self-sticking velvet patches to the inside of the cap to make it fit more snugly.

Lens expert Björn Rørslett refers to this lens as “the new reference for wide-angle zoom lenses.” The close-focus distance for this lens is very short so you can pretty much stick this lens right into a flower patch and get a flower and the whole patch. I don’t have to sing the praises of this lens as they are all over the web. Check it out.

Aside from the obvious landscape uses, I use this lens for mini-landscapes, dioramas, and any small scene where I can have something in the foreground in focus and as much of everything else as is possible. Expensive lens.



## **Nikon Nikkor 50mm AF-S f/1.4 D**

Focal Length: 50mm

Widest Aperture: f/1.4

Narrowest Aperture: 16

Aperture Blades: 7

Filter Size: 52mm

Hood: HR-2

Close Focus Distance: 17.71 inches (45 centimeters)

Reproduction Ratio: 1:6.6

Focus Throw: 140°

Weight: 8.1 ounces (230 grams)

Pros: Very fast lens, sharp, 7 blades, light

Cons: No close near focus, no 1;1, very short focus throw.

This classic Nikon 50mm f/1.4 lens does not really belong here since it is neither a macro nor a wide-angle lens. However, it is very, very sharp and lightweight as well. If you are shooting mini-landscapes, bushes, gardens, dioramas, there is not reason to ignore this lens, especially if you already have it.



## **Nikon Nikkor 50mm AF-S f/1.4 G Lens**

Focal Length: 50MM Widest Aperture: f/1.4

Narrowest Aperture: 16

Aperture Blades: 9

Filter Size: 58mm

Hood: HB-47

Close Focus Distance: 17.71 inches (45 centimeters)

Reproduction Ratio: 1:6.6

Focus Throw: 180°

Weight: 9.876 ounces (280 grams)

Pros: Very fast lens, sharp, 9 blades, light

Cons: No close near focus, no 1;1, very short focus throw.

This classic Nikon 50mm f/1.4 lens does not really belong here since it is neither a macro nor a wide-angle lens. However, it is very, very sharp and lightweight as well. If you are shooting mini-landscapes, bushes, gardens, dioramas, there is not reason to ignore this lens, especially if you already have it.





## **Cosina 70mm-210mm f/4.5-f/5.6 Macro Zoom**

Focal Length: 70mm-210mm

Widest Aperture: f/4.5-5.6

Narrowest Aperture: 32

Aperture Blades: 9

Filter Size: 55mm

Hood: Included

Close Focus Distance: 23.62 inches (60 centimeters)

Reproduction Ratio: 1:4

Focus Throw: N/A

Weight: 13 ounces (368.5 grams)

Pros: Cheap, 9 blades

Cons: slowest of the slow aperture, long focus distance, does not go to 1:1, poorly made.

This very cheap lens has appeared in a number of formats and mounts. The copy I have is plastic and barely holds together. It is labeled as a macro lens, but for any practical purpose it is useless. I would not advise buying this lens but have seen it on Ebay for under \$50. It does work, just is not a real macro lens. The lens at 210mm would mean the widest aperture is f/5.6 making the viewfinder (especially at dawn and dusk) very, very dim.

## The Exotic Nikkors and Other Industrial Lenses

This little known (to photographers) genre of lenses is like the proverbial tar baby in Uncle Remus stories, the more you struggle with them, the deeper you are attached to them. Why have we heard so little about them? For one, most of don't attach easily to Nikon DSLRs, but demand one or even a small series of adapters to even mount them. Then there is the little factor that many of them (like some of the Printing Nikkors) originally cost \$12,000 or more per copy, and came in high-end scanners costing hundreds of thousands of dollars.

For example, the Printing Nikkors were used to scan 35mm color film to make perfect copies. Or they were used to create ultra-fine masks for computer chips. Are they highly corrected, as in "apochromatic?" You bet they are, most have almost no distortion of any kind. Then there is the issue that many of them were made for one and only one aperture or exactly one reproduction ratio, while others are at their best on a rail with about two feet of extension. The list goes on.

And I am only talking here about the ones we know about. There are literally hundreds of models of photographic enlarger lenses that seemingly have never been tested on modern DSLR cameras. Many of them are also highly corrected, so we have only really seen the tip of the iceberg, when it comes to highly-corrected and sharp industrial lenses.

## The Exotic Nikkors

The exotic Macro-Nikkors and other industrial Nikkors don't usually show up on the radar screen of most Nikon users. I ignored them for years. For one, what could I do with them? Many have such a narrow Depth-of-Field (DOF) that a shot taken with these lenses captures the eyebrow of a gnat and the rest is bokeh. Or some of these exotic lenses are designed to only be sharp at a 1:1 magnification ratio, so how many times do I need that? You get the idea. They are indeed "exotic."

I only have a few of these exotic macro lenses and don't intend to buy more unless one of them compels me, which has happened a lot lately. For one, they are very expensive. Many end up on display in a museum or stored in someone's collection where they are never used and seldom even seen. I don't intend to do that.

And when I first encountered them, the photos taken with them, although interesting, did not appeal to me all 'that' much, usually a single shot with literally one point of the photo in striking focus and the rest a blur. At best they were interesting, but more often they appeared IMO to be kind of repetitive. Also, keep in mind that they represent almost the opposite of what I have been doing for years, which is stacking focus. So please forgive my bias here please.

In focus-stacking work, almost everything in the photo can be in focus if I wish, and the tendency of my aperture use (at least in the beginning) is toward the "narrow as possible without succumbing to diffraction." I have literally spent years stacking focus

at the edge of diffraction, so these exotic lenses were about the last thing I wanted to mess with. And I don't like high magnifications, either. Looking at the compound eye of a dead fly on a pin is not my idea of nature photography, no offense intended. Again: just my bias speaking.

But then I saw some photos of flowers by NikonGear.com member Akira, using the CRT Nikkor 55mm f/1.2 lens. Now I liked these shots and the effects that Akira achieved and told him so. This rather bizarre Nikkor lens designed for viewing CRT monitors and even curved to handle those screens caught my fancy. Sure, shots taken with the lens were all blurry except for a single point or plane, a razor-sharp slice of life. But that little slice WAS very, very sharp AND the contrast between it and the general blur was also sharp. I liked the effect.



Now I have to be clear. There is something inside me that for years has strived for sharpness in a lens. And

that something was at odds with another part of me that I can only describe as the “impressionist” in me. The impressionist part of me didn’t give a damn about sharpness but likes to paint in broad colorful strokes. Well, those two parts of me came together in this Nikkor CRT lens, except that I was not happy with that single point/plane of sharpness. Remember, I stack focus.

There was a desire inside me that wanted to paint with sharpness like this Nikkor CRT lens painted with blur. Then somewhere along in here I had what was (for me, mind you) a significant insight. Since I loved the broad strokes of blur of the CRT Nikkor, but was less than satisfied with the pinpoint of sharpness it provided, why not stack the sharpness just enough to create a real plane or section of it that is set off from the background blur or bokeh. Aha!

It was not long before my whole shelf of sharp, sharper, and sharpest lenses, the ones I used to push aperture as high (narrow) as possible were set aside. And in their place, I began to use the complete other end of the lens, the end where it is wide open. By being wide open (and fast!), I was assured of throwing as much of the image as possible into blur, leaving only what I chose to have sharp.

And by stacking sharpness, I moved beyond using these exotic lenses like the Nikkor-CRT with their (for me) small slice of focus, into images with a clear layer or section of sharpness contrasted with a wide areas of bokeh. I could point out by focus stacking layers what I wanted the eye to jump at, and at the same time treat the rest of the image like an impressionistic painting.

In that move, I satisfied two opposite desires within me in a single image. I was really satisfied with the potential of this technique, and it did not take me long to prove this to myself. Thanks to those of you who suffered through my posts!

After all, it is only myself I have been trying to please with my photography all these years. It is only recently that I even began finishing any image beyond minimal adjustments. I had never found what I was looking for. Perhaps now I have, although I am just at the beginning of using this (for me) new medium.

And my interest in lenses changed as well. Instead of thinking of sharpness as pushing apertures higher to the edge of diffraction, I began to yearn for wide-open lenses that blurred everything except for the narrow depth of field which they featured. All I had to do is stack that narrow depth of field, and let the lack of DOF give me a bokeh-covered canvas upon which I could paint some focus. I liked that. I still like it.

### Exotic Lenses

With that insight, suddenly all of the exotic macro lenses that held little interest for me, appeared in a different light. Some of them were very, very sharp, even though that sharpness only appeared in a razor-thin layer. I didn't want lenses that were not fast because they gave me too much DOF and I lost the impressionistic sense of blur that formed the bokeh.

The really fast AND sharp lenses allow me to punctuate the blur of the background with sharply defined focused signatures that complement the bokeh. I like the idea of a piece of the image in focus

and the rest just an impression, like you see in some of the great draughtsman in history: pencil in something clearly and leave the rest as a sketch. This appeals to me somehow, not that I compare myself to these artists.

So, my mantra became: find lenses that were fast wide open AND also sharp. And, as it turns out there is a whole genre or two of lenses that fit this description in the industrial and Macro-Nikkors. However, they are expensive. I am not sure why. Ouch! I can't believe they are that useful except to the extreme micro photographers or to be used as museum specimens. Whatever the reason, they can be hard to find and cost a lot of money. Oh well, time to sell off what I can bear to part with. And I did.

So that is the state of the union of myself and this (new to me) technique. I am at the low end of the learning curve but am very hopeful. I have done enough testing to know that the technique works. All I have to do now is work it.

And of course, now that I have an interest in these very fast and wide and sharp lenses, I see that I am not alone. It did not take me long to find articles that nfoto had written (that oh-so-fierce bear of the north) long ago. Perhaps no one has tried to stack these lenses as much as I intend to, but the footprints are there for me to follow.

I feel that I have, after many years of searching, found something of what I was looking for, scratched an itch, gained some satisfaction, and am coming closer to expressing in photography what I see in my mind.

## Industrial Macro and Close-Up Lens for Stacking

The world of industrial macro and ultra-close-up lenses is especially fascinating to the focus stacker. These very sharp and often highly-corrected lenses, some of which are very fast, can have a very narrow depth-of-field. Most are industrial or process lenses used in scanners, enlargers, copy cameras, and other dedicated tasks.

For example, ultra-sharp industrial lenses are used to project the photomasks on mass-produced silicon wafers from which the final computer chips are made. Other uses include the lenses used in very expensive high-tech color scanners, where in addition to ultra-resolving power, the lens also has to be highly corrected (APO) to handle subtleties of color. Use of these lenses in enlargers and other process photography is worldwide and scores of such lenses exist.

Process lenses with very small apertures do not tend to provide high resolution, so some of these exotic Nikkors tend to be very fast (like  $f/1.0$  and  $f/1.2$ ), and at the same time are very sharp wide open. In fact some industrial Nikkors record diffraction even wide open and certainly do so if stopped down at all. Others have only the single aperture. Many can be stopped down, but not to good effect.

It is important to point out that these industrial lenses differ in quality from the lenses we commonly mount on our DSLRs in that many of them have been produced to a much higher standard of quality than an ordinary camera lens. They can be faster, sharper, and more highly corrected than the F-mount lenses



we are used to buying. And there are many industrial lenses on the used market waiting for people like us to determine how useful they are for our work.

Most industrial lenses do not have a convenient F-mount adapter to fit our DSLRs. Instead, they have RMS (microscope), M39 (Leica), and M42 (Zeiss), and still other non-standard mounts. Some are even threaded for microscope use. Others have tubes and built-in extension that have to be factored into whatever mount we devise. Many shine on bellows or when we mount them on a DSLR with an added helicoid. Fortunately Ebay is full of relatively inexpensive adapters to convert most of these various threads to Nikon F-mounts.



The upshot is that today many of these rare macro lenses function as collector's items, rather than be used for photography. They are also popular among coin collectors and related hobbies where very exact (flat) close-up photos are required. Many of these

lenses, because of their very narrow depth of field, are not attractive to the typical nature photographer. Also, some are so slow as to make focusing through a viewfinder difficult to impossible at low light levels.

Narrow depth-of-field does not deter focus stackers, because we simply stack that narrow depth-of-field as deep as we wish. These exotic industrial lenses can be very fast or very slow. I like the very fast lenses because they tend to give good bokeh, and I can stack as much narrow depth-of-field as I wish.

On the other extreme are the very slow industrial lenses. Their bokeh is not going to be much, but some of them are extremely sharp and/or well color-corrected. Color correction is a big issue. Some of these exotics are true APO (or nearly so), while others have earlier coatings and/or are not color corrected to the degree I would wish.

You are correct if you get the idea that these exotic industrials are an area not well plumbed by focus stackers, but one with great promise. Unfortunately, these lenses are not inexpensive, mostly because they are sought by collectors as copy lenses or just to place in a display case, I guess. The best of the rare industrials make even the Voigtlander 125mm APO-Lanthar look inexpensive by comparison, prices in the range of \$8,000-\$10,000 a copy. Ouch!



However, putting the best-known and most prized industrial lenses aside, there are numerous industrial lenses out there that seemingly (to my knowledge) have never been checked-out and put to use in general macro photography. Ebay is filled with used enlarger lenses and the like. I guess we are waiting from some lens expert to tell us which ones are exceptional, but since they are not expensive, we should check these out for ourselves.

And we focus stackers are kind of on our own as for guidance in these areas. The fact is that although some few photographers comment on them, even fewer seem to use them to any great extent as far as I can see; at least not many photos are out there to view, except of the compound eye of a bee or dragonfly. Most of the discussion I have found for these lenses are by coin collectors or microscope fans. Nature buffs like me seldom talk about them.

Part of my own interest in the exotic Nikkors was the natural result of exploring lenses, but the advent of the Nikon D800E was another really big factor. The

increased resolution of the D800E propelled me to break out of the box of the standard macro lenses and wander into the field of the exotics. And it has been a learning experience.



There is a multitude of enlarger, copier, scanner, and other types of industrial lenses. Many can be had for almost nothing and it is anyone's guess how good they are. These lenses don't go to infinity; they are close-focus-only lenses. And for the most part they don't have a Nikon F-mount, but rather a variety of threads, some very obscure. So finding and using these lenses is no waltz.

These are not walk-around lenses and many require special handling, mounts, have a limited focal range (or just one!), are or are-not color collected, and on and on. In other words, they can be a hassle, but if you are already focus stacking, you are used to taking your time and threading through various hassles.

Why should we use these industrial lenses and how?  
What can they do for us?

The answer is: for several reasons. One of my favorites is bokeh, bokeh, bokeh. Since many of these exotic macro lenses are very, very fast and also very, very sharp, you can be sure that your background is isolated into nice bokeh. Fast lenses bring a very narrow depth-of-field, which is perhaps why they have not been used more by general photographers.

But we focus stackers don't care about a narrow depth-of-field. We can carefully stack that very narrow, yet very sharp, depth-of-field until we have created as much of the subject in focus as we wish, leaving the background nicely blurred. Using these lenses, I like to highlight some very detailed part of the subject to make clear to the viewer that we have that sharpness, and perhaps sharper than they could imagine. And then, I like to let the surrounding background bokeh just run wild and do crazy things not only with blur, but with color. The CRT Nikkor 55mm Oscilloscope lens is very good at producing bokeh with zen-like lumps of color.

And good bokeh and blur is not the end of it. Many, but not all, of these industrial Nikkors are very highly corrected, in fact, true APO lenses, or about as near as we are going to get. So not only are they very sharp, produce fine bokeh, but their color IQ is subtle and fine. So the best industrials are fast, wide, sharp, and APO corrected. It is this color correction that most fascinates me.

To repeat, perhaps the only reason these industrial lenses have not been more utilized until now is that who out there wants great bokeh, fine color, but only a very narrow slice of focus. But with focus stacking, it

is up to us how much of the subject we want in focus. Therefore, I suggest these exotic industrials will only go up in price, not come down, as more of us find out their special qualities and learn to use them. This leaves the uncorrected industrials.

First, they are very few. There are some lenses that are very sharp, but not well corrected or perhaps have earlier single coatings, etc. These lenses are still very useful where refined color is not demanded, or where blocks of color have little micro-contrast and can be controlled in post. Most industrial lenses are, by definition, manufactured to a high standard.

As for myself, I dove in head first and have a small collection of these industrials, including some classics. Have I mastered them? Nope, but at least I got my feet wet and am in the midst of a broad (but not exponential) learning curve. I very much like what I am finding, although much of what I am finding is my own inexperience and lack of technique with this particular group of lenses. This only makes it more fun.

These industrial lenses I consider as a palette that I can hopefully learn to paint with. I am now acquainted with the palette. It is time to be more creative.

Of course, I tend to view my own work as an endless Odyssey through lens-land that has no goal other than the learning process itself. I have never reached that pot-of-gold at the end of the rainbow and, over time, have stopped even considering it. That being said, I have progressed on my journey, which originally was one for greater depth-of-field, greater resolution and sharpness, but which now has morphed into the realization that sharpness ultimately (at least for me) depends on color and color

correction, including other distortion, as in APO lenses.

I'd like to believe that I have all the lenses I could possibly need, but am afraid that every next day brings new ideas to check out, and that, as often as not, this dictates new lenses. And while I try to resist buying any more, the day usually comes when I stop resisting and just buy the darn thing.

I do feel that I have completed my initial testing of the Nikon D800E camera, plus taken at least a brief tour through industrial lenses, and am ready now to settle in for some more creative work.

## Using the Exotic Industrial Nikkors

These exotic industrials are not only rare and expensive, but there is not really that much written about them, at least from close-up and macro nature photographers. Most comments on these lenses takes place on the coin-collector (and related collectables) sites. These guys are serious about testing and using these lenses because they want to properly photograph their coins to show and sell them to other collectors.

One exception to that rule is the Macrolens Collection Database, put together by Klaus D. Schmitt, who is active in macro lenses and IR/UV photography. By the way, there are scads of industrial lenses out there that are never tested or used by photographers, lenses for 3CCD, Projection, scanner, Microhead, TV, and so on. Some of them are advertised only by the number of megapixels (1-2 megapixel, 5 megapixel, 10 megapixel, etc.) they handle. In other words, someday... some photographer will figure out if any of these lenses are also useful for close-up and macro work.

The world of true macro and ultra-close-up lenses is especially fascinating to the focus stacker. These very sharp and often highly-corrected lenses, some of which are very fast, have a very narrow depth-of-field. Most are industrial lenses used in scanners, enlargers, copy cameras, and other dedicated tasks. Some are even threaded for microscope use. The upshot is that these rare macro lenses main function is as collector's items, rather than photography. They are popular among coin collectors and related



hobbies where very exact close-up photos are required. Many, because of their very narrow depth of field, are not attractive to the typical nature photographer. Also, some are so slow as to make focusing through a viewfinder difficult to impossible at low light levels.

Narrow depth-of-field does not deter focus stackers, because we simply stack that narrow depth-of-field as deep as we wish. These exotic industrial lenses can be very fast or very slow. I like the very fast lenses because they tend to give good bokeh, and I stack as much narrow depth-of-field as I wish.

On the other extreme are the very slow industrial lenses. Their bokeh is not going to be something, but some of them are extremely sharp and well color-corrected. Color correction is a big issue. Some of these exotics are true APO (or nearly so), while others have old coatings and are not color corrected to the degree I would wish.

You are correct if you get the idea that these exotic industrials are an area not well plumbed by focus stackers, but one with great promise. Unfortunately, these lenses are not inexpensive, mostly because they are sought by collectors to place in a display case, I guess. The best of the rare industrials make even the Voigtlander 125mm APO-Lanthar look inexpensive by comparison.

And we focus stackers are kind of on our own as for guidance in these areas. The fact is that although some few photographers comment on them, fewer seem to use them to any great extent as far as I can see; at least not many photos are out there. Most of the discussion I have found for these lenses are by

coin collectors or microscope fans. Nature buffs like me seldom use them.

Part of my own interest in the exotic Nikkors was the natural result of exploring lenses, but the advent of the Nikon D800E was another really big factor. The increased resolution of the D800E propelled me to break out of the box of the standard macro lenses and wander into the field of the exotics. And it is a learning experience.

There is a multitude of enlarger, copier, scanner, and other types of industrial lenses. Many can be had for almost nothing and it is anyone's guess how good they are. These lenses don't go to infinity; they are close-focus-only lenses. And for the most part they don't have a Nikon F-mount, but rather a variety of threads, some very obscure. So finding and using these lenses is no waltz.

However, certain industrial lenses have been tested and are prized.

## The Exotic Macro Nikkors: An Update

Coming into it I thought that getting to know this group of very exotic Nikon close-up and macro lenses would be an experience, but I assumed I would get a pretty good handle on it fairly quickly. As it turns out, these lenses are much more versatile than I imagined.

When you factor in different extensions and helicoids, what appears as a simple task becomes much more complex, if not somewhat infinite in possibilities, not that I am complaining.

I am loving these lenses and my faithful Cosina-Voigtlander 125mm f/2.5 APO-Lanthar sits on the shelf gathering dust these days. That ought to tell you something right there, because I love that lens.

As of now I have six of these rare Nikon lenses, and I don't plan on getting any more. Of course I was not planning to get a second one, a third one, and so on. It just kind of happened. Klaus Schmitt is partially to blame. He pointed out the sweet points of these lenses to me, and that was all it took. Here is what I am now using:

Multiphot Macro-Nikkor 19mm f/4.5

Multiphot Macro-Nikkor 65mm f/4.5

Printing Nikkor 95mm f/2.8 1:2

Printing Nikkor 105mm f/2.8 1:1

CRT Nikkor-O 55mm f/1.2 1:2

Repro Nikkor 85mm F/1.0 1:1

I must say that these lenses are challenging, but most of all interesting and fraught with possibilities. I have yet to find any one of them that I don't like, or one that I like above all the others. Each one is so good at what it does. I sure don't want to take the whole set of

them into the field, but I do wish I had them all with me.

The mounts for them alone are something to behold and some of them have mounts that are interchangeable. Also, some of them have extensions and all could take extensions. One even has two helicoids, so the range of magnification is great. And all of these lenses, I imagine, can be placed on a bellows, although I have not had time (or interest) to try that out just yet. There is too much going on with them just the way they are now.

And sharp? These lenses are way sharp. For years I have whined about trying to find some sharp lenses, and I consider the CV-125, the Leica 100mm Elmarit R, and the Coastal Optics 60mm sharp lenses. But these exotic industrial Nikkors are a whole other kind of sharp. I can't really say how sharp, because they are so different that I have not really finished evaluating them. Let's just say they are sharp enough to shut me up, at least for a while. And I am eagerly waiting for my copy of the Nikon D800E.

And at least two of these lenses are way fast,  $f/1.0$  and  $f/1.2$ , a couple are  $f/2.8$ , and the other two are a dim  $f/4.5$ .

I have mentioned this before, but up until now I had no interest in these exotic Nikkors. After all, I could not push them for greater depth of field because they are not built for that. And some of them are so fast that you only get a razor's-edge slice of your subject. Of course, that was a hangover from my years before stacking focus, years when all I could think to do was push aperture high and narrow, and try to battle diffraction.

But of course I now know that you can stack razor-sharp slices of DOF until you accumulate whatever mass of focus you care to have. I missed that concept until recently. And some of these exotic Nikkors are both fast and sharp. And the “fast” quality provide something I can only call “beyond bokeh” as I knew it, more like a complete wipeout of the background, if you wish.

With this technique, you could run the line of sharp focus right up to anywhere you want and just stop cold. Not sure how much I want to do that, but it is nice to be able to do that if I wish.

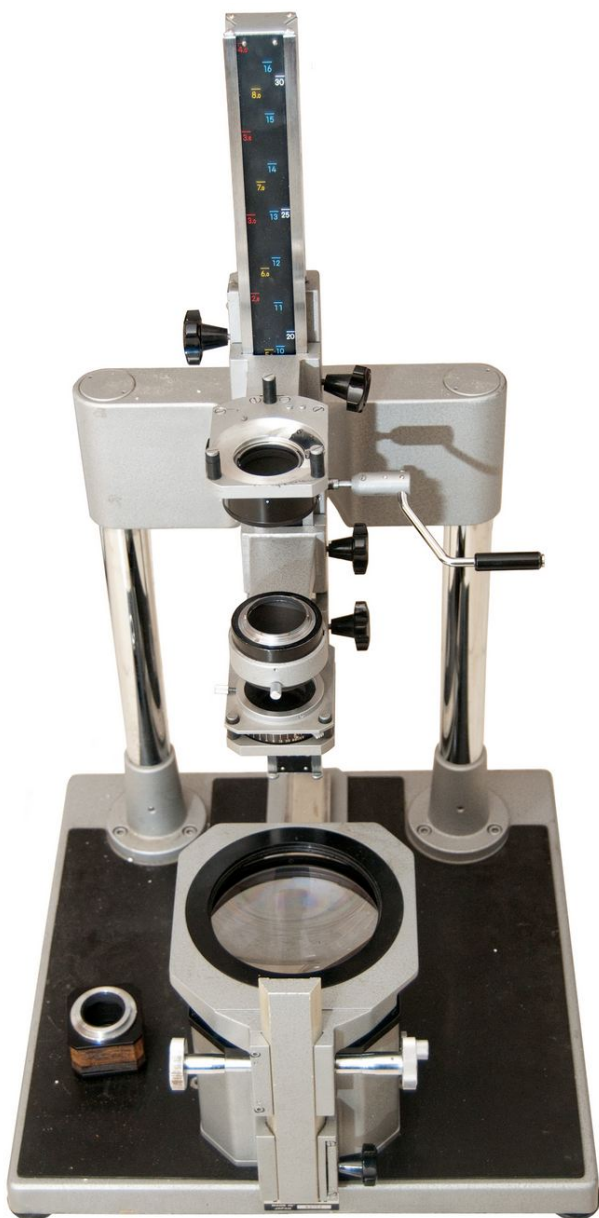
For the most part, I have used these lenses in the studio, mounted on a very solid head (Swiss-Arca C1 Cube) on a very solid tripod (RRS). There is no reason you could not take all this outside on a very calm day, if you did not have to hike too far. Because they tend to require more stacked layers, the least breeze would be a problem, and for at least a couple of these lenses, you need lots of light. In fact, with the two Multiphots I tend to focus using the LCD rather than the viewfinder, because in minimal light (which I like) it is hard to see the subject through the viewfinder. But the CRT Nikkor and Repro Nikkor are just the opposite. They are totally bright in the viewfinder, at least wide open.

I should stop writing about these little puppies because I have posted plenty about them already. I guess I am either just talking to myself or to those few here who are interested in the same approach. To me this is very fascinating stuff.

Here are a couple recent explorations, the first with the Repro 85mm and the second with the Multiphot 65mm. As you can see, very different takes. This is

what is so much fun. I am nowhere near done playing with these things.

## **Some of the Exotic Industrials**



**The Nikon Multiphot Machine**

## **Lens: Macro-Nikkor 19mm, f/2.8, Multiphot**

**Focal Length:** 29mm

**Widest Aperture:** f/2.8

**Narrowest Aperture:** Six rings.

**Aperture Blades:** none

**Filter Size:**

**Hood:**

**Close Focus Distance:**

**Reproduction Ratio:** 15x-40x (20x on barrel)

**Focus Throw:** none

**Color:** Mostly uncorrected.

**Rear Mount:** RMS

**Weight:**

This is one of four lenses designed to be used (i.e. optimum sharpness) on the Multiphot bellows, which is 60 cm, which is much larger than either the Nikon PB-4 or PB-6. The PB-6 with a second bellows extension comes closer, but probably will not interest close-up fans. Those of us who want to use it with less extension are probably not getting the most out of it, but still it can produce remarkable photos. Because the image circle on these lenses was originally designed for 4x5" film, and is roughly 3x that needed to cover a 24x36mm DSLR sensor. Because of this fact, this lens can be used at lower magnifications.

This is a macro not a close-up lens. It can be used on a camera with or without extension, but is happier on a bellows, and really happy on a very long (double) bellows. The lens has little distortion, and requires a tripod for use. It is too high-powered for anything I am interested in shooting. This lens uses a RMS



microscope thread, so an adapter is required to convert to a Nikon F-mount, or to Leica, or Zeiss.



### **Lens: Macro-Nikkor 35mm, f/4.5, Multiphot**

**Focal Length:** 35mm

**Widest Aperture:** f/4.5

**Narrowest Aperture:** Six rings

**Aperture Blades:** none

**Filter Size:** none

**Hood:**

**Close Focus Distance:**

**Reproduction Ratio:** 8x-20x (12x on barrel)

**Focus Throw:** none

**Weight:**

**Color:** Little lateral aberration

**Rear Mount:** RMS

This is one of four lenses designed to be used (i.e. optimum sharpness) on the Multiphot bellows, which is 60 cm, which is much larger than either the Nikon PB-4 or PB-6. The PB-6 with a second bellows extension comes closer, but probably will not interest close-up fans. Those of us who want to use it with less extension are probably not getting the most out of it, but still it can produce remarkable photos. Because the image circle on these lenses was originally designed for 4x5" film, and is roughly 3x that needed to cover a 24x36mm DSLR sensor. Because of this fact, this lens can be used at lower magnifications.

This lens, even when fully open, is already recording diffraction. This is a macro not a close-up lens. It can be used on a camera with or without extension, but is happier on a bellows, and really happy on a very long (double) bellows. I have been amazed by its sharpness, but not its color, and it is slow so can be difficult to see through the viewfinder. This lens uses a RMS microscope thread, so an adapter is required to convert to a Nikon F-mount, or to Leica, or Zeiss.



**Lens: Macro-Nikkor 65mm, f/4.5, Multiphot**

**Focal Length:** 65mm

**Widest Aperture:** f/4.5

**Narrowest Aperture:** f/28 (six rings)

**Aperture Blades:** none

**Filter Size:**

**Hood:**

**Close Focus Distance:**

**Reproduction Ratio:** 3.5x-10x (5x on barrel)

**Focus Throw:** none

**Weight:**

**Color:**

**Rear Mount:** M39

This is one of four lenses designed to be used (i.e. optimum sharpness) on the Multiphot bellows, which is 60 cm, which is much larger than either the Nikon PB-4 or PB-6. The PB-6 with a second bellows extension comes closer, but probably will not interest close-up fans. Those of us who want to use it with less extension are probably not getting the most out of it, but still it can produce remarkable photos. Because the image circle on these lenses was originally designed for 4x5" film, and is roughly 3x that needed to cover a 24x36mm DSLR sensor. Because of this fact, this lens can be used at lower magnifications.

The 65 Multiphot is more forgiving than the two smaller ones, but still very much a macro lens. It has a Leica mount so can be adapted to camera and rail using extensions, helicoids, etc., or just mounted on, a bellow, short or long. This too is a very sharp lens, but good for only very, very close (as in macro) work. I like the sharpness, but find the color a little harsh, so I avoid using it if subtle coloring is an issue. It comes with the M39 Leica thread, so needs an adapter for Nikon-F mount. Enrico Savazzi claims it can be stopped down to the 2nd stop.



**Lens: Macro-Nikkor 120mm, f/6.3, Multiphot**

**Focal Length:** 120mm

**Widest Aperture:** f/6.3

**Narrowest Aperture:** seven rings

**Aperture Blades:** none

**Filter Size:**

**Hood:**

**Close Focus Distance:**

**Reproduction Ratio:** 1.2x-4x on barrel

**Focus Throw:** none

**Weight:**

**Color:**

**Rear Mount:** M39

This is one of four lenses designed to be used (i.e. optimum sharpness) on the Multiphot bellows, which is 60 cm, which is much larger than either the Nikon PB-4 or PB-6. The PB-6 with a second bellows extension comes closer, but probably will not interest close-up fans. Those of us who want to use it with less extension are probably not getting the most out of it, but still it can produce remarkable photos. Because the image circle on these lenses was originally designed for 4x5" film, and is roughly 3x that needed to cover a 24x36mm DSLR sensor. Because of this fact, this lens can be used at lower magnifications.

The 120mm Multiphot lens is the most useful lens IMO for close-up work and the only one of the four that is said to be limited by sensor resolution, rather than refraction. Enrico Savazzi claims it can be stopped down to as much as f/11 (the 3rd stop) at 1.3x.

Although these Multiphot lenses are not well color-corrected, I find the 120mm Multiphot a very nice lens to use.

## The Printing Nikkors

There are four Printing Nikkors. These are probably the sharpest, fastest, true APO lenses that you can find, if you can find one. And they are very expensive. They have weird rear mounts that require special adaptors, but they have 52mm front threads and the lenses can be reverse-mounted using the Nikon BR2 adapter, etc. Coin collectors, who are complete fanatics on sharpness, prize them and often have them on the top of their “want lists” to own. That should tell you something.

### Lens: Printing Nikkor 75mm, f/2.8

**Focal Length:** 75mm

**Widest Aperture:** f/2.8

**Narrowest Aperture:** f/11

**Aperture Blades:** 12

**Filter Size:** 43mm

**Hood:**

**Close Focus Distance:** 18.11” at 1/4x

**Reproduction Ratio:** 1/4x

**Focus Throw:** none

**Weight:** 240g

**Color:** 400 ~800nm APO

**Rear Mount:** M45

**Resolution:**

**Image Size:** 16 mm

**Color:** APO

**Rear Mount:** M45





**Lens: Printing Nikkor 95mm, f/2.8**

**Focal Length:** 95mm

**Widest Aperture:** f/2.8

**Narrowest Aperture:** f/11

**Aperture Blades:** 12

**Filter Size:** 43mm

**Hood:**

**Close Focus Distance:** 16.77" at 1/2x

**Reproduction Ratio:** 1/2x

**Focus Throw:** none

**Weight:** 320g

**Color:** 400 ~800nm APO

**Rear Mount:** M45

**Resolution:** 320 lines/nm

**Image Size:** 30mm  
**Rear Mount:** M45



**Lens: Printing Nikkor 105mm, f/2.8**

**Focal Length:** 105mm

**Widest Aperture:** f/2.8

**Narrowest Aperture:** f/11

**Aperture Blades:** 12

**Filter Size:** 43mm

**Hood:**

**Close Focus Distance:** 15.94" at 1x

**Reproduction Ratio:** 1x

**Focus Throw:** none

**Weight:** 360g

**Color:** 400 ~800nm APO

**Rear Mount:** M45

**Resolution:** 240 lines/nm

**Image Size:** 54 mm

**Sharpest Aperture:** f/3.3 to f/4.7

This lens is sharp wide open and can be stopped down to f/5.6 without too much degradation. This lens is designed for 1:1, at which the center and corners are tack sharp. It is a true apochromatic, with virtually no chromatic aberration. Also no distortion or flare. This lens is designed to be used wide open, and does not improve on stopping down.

One way to mount the 105PN is to find a Rodenstock Modular Focus Unit (RMF) kit, which has some accessories to make this happen. The camera-side of the RMF has a Nikon F-mount, which can be used with the Nikon PN-11 extension ring with its rotatable tripod ring, which offers magnification adjustable from 0.7.1 to 1.1.



**Lens:** Printing **Nikkor** 150mm, f/2.8

**Focal Length:** 150mm

**Widest Aperture:** f/2.8

**Narrowest Aperture:** f/11

**Aperture Blades:** none

**Filter Size:** 62mm

**Hood:**

**Close Focus Distance:** 22.5" at 1x

**Reproduction Ratio:** 1x

**Focus Throw:** none

**Weight:** 1,020g

**Color:** 400 ~800nm APO

**Rear Mount:** M70

**Resolution:** 240 lines/nm

**Image Size:** 30mm

**Sharpest Aperture:** f/3.3 to f/5.6

The 150mm Printing Nikkor has front threads that can be attached to the camera, which have M58x0.75 threads. Since the lens is built symmetrically, it does not matter which way the lens is mounted. This lens is heavy and long, so keep that in mind. It wants to be mounted on a bellows, so that you can find the right length for what you are doing.



## **Lens: Micro-Nikkor 55mm, f/1.2 CRT Oscilloscope**

**Focal Length:** 55mm

**Widest Aperture:** f/1.2

**Narrowest Aperture:** f/11

**Aperture Blades:** 12

**Filter Size:**

**Hood:**

**Close Focus Distance:** 417.1mm overall working distance

**Reproduction Ratio:** 1/5x

**Focus Throw:**

**Weight:** 385g

**Color:** Not corrected, 0% vignetting, 1.14% distortion

**Rear Mount:** M39

**Resolution:** 250 lines/mm

**Image Area:** 24x36

Standard wavelength: 400 - 650 milli-micron

The Nikkor "O" (for oscilloscope) or CRT-Nikkor as it is called is perhaps the most "different" lens that I own. This lens was made for monitoring CRTs and has trouble with daylight, which is part of its charm, since all kinds of wonderful color variations can be expected. This is not an APO lens or anything close to it because it has been corrected to render phosphorus colors, and is said to be optimum at  $f/4$  and  $f/5.6$ .

It is listed as having  $f/1.2$ , but remember, all ratings are for a lens at infinity, and this lens is designed for close-up range, so the  $f$ /stop would be more like  $f/1.4$ .

As for bokeh, the CRT-Nikkor is over the top, bokeh on LSD, which I particularly love. The CRT Nikkor can help you get out of the box and become more creative. At least that has been my experience.

I just had to take it out yesterday and shoot a few. Here is one with the Nikon D800E, the CRT Nikkor 55mm  $f/1.2$ , and Zerene Stacker.

This was a lens built to photograph computer monitors CRT, the old ones with a curved face. The lens also has a corresponding curve, and so this is anything but a flat copy lens. In this way it distinguishes itself from almost all other industrial lenses. At  $f/1.2$  it is fast and allows plenty of light in the viewfinder. It has a narrow depth of field at its sharpest and I consider it a specialty lens, although the specialty is very desirable, that of allowing for



sharp resolution in parts of the frame, but a Zen-like blur instead of standard bokeh, that and the ability to make whole areas of color just go wild, well beyond a gradual decline.

It was the use of this lens by another photographer that launched me into my journey into the industrial Nikkors and related process lenses. At least for me, this lens is very much hit or miss, meaning that sometimes the results are miraculous, while at other times, only too average. In other words, this is lens is a little bit difficult to predict or control.



### **Lens: Repro Nikkor 85mm**

**Focal Length:** 85mm

**Widest Aperture:** f/1.0

**Narrowest Aperture:** f/8

**Aperture Blades:**

**Filter Size:** 52mm

**Hood:**

**Close Focus Distance:** 407mm

**Reproduction Ratio:** 0.9x-1.1x

**Focus Throw:**

**Weight:** 2,320g (1 lb., 8 oz)

**Color:** 400-650nm

**Resolution:** 200 lines/mm

**Image Circle:** 43.2mm

**Optimum Resolution:** f/5.6

The Repro Nikkor is long and quite heavy. You have to be very careful that the adapters you use to reach the F-mount are VERY sturdy. This weighty lens wants to fall off, otherwise. It I listed as f/1.0, but commenters seem to suggest it really is more like f/2.0 at 1:1 reproduction ration. The entrance pupils are located quite far behind the lens, so that rays passing through the center of each pupil run pretty-much parallel to the optical axis. Can be used as a relay lens.

I can't speak to that, but I do know it is very bright in the viewfinder, and sharp, sharp. As far as I can tell, this is not an APO corrected lens.

The Repro Nikkor is designed for one thing, 1:1 work in 35mm format. Said to be fully corrected. Vignetting is 0%, Distortion is 0%. There is no field curvature.

These details have been listed for this lens:

Construction: 12 elements in 8 groups  
Picture angle: 14°  
Standard magnification: 1 X  
Working distance: 224mm  
Image area: 24mm x 36mm  
Corr. wavelength range: 400-650nm  
Vignetting: 0 % at f/2.3  
Resolution: 200 lines/mm  
Distortion: 0.0 %  
Aperture scale: 1.0 - 8  
Mount: d = 53mm / p = 0.75mm  
Dimensions diameter: 57.5mm  
Dimensions length: 107mm  
Weight: 640 g



**Lens: Zeiss 74mm S-Planar f/4**

**Focal Length:**

**Widest Aperture:** f/4

**Narrowest Aperture:** 8/11/16/22/32/45/64

**Aperture Blades:**

**Filter Size:**

**Hood:**

**Close Focus Distance:** 276mm

**Reproduction Ratio:** 1:1

**Focus Throw:**

**Weight:**

**Color:**

**Rear Mount:** M32



### **Lens: Rodenstock Scitex-S3 89mm**

**Focal Length:** 89mm

**Widest Aperture:** f/5

**Narrowest Aperture:**

**Aperture Blades:**

**Filter Size:**

**Hood:**

**Close Focus Distance:**

**Reproduction Ratio:**

**Focus Throw:**

**Weight:**

**Color:**

**Mount:** Rear, M39x1

This Rodenstock lens is labeled Scitex, made for the Scitex (later CREO and ultimately bought from Kodak) high-end Supreme/Supreme II scanners), costing about \$45,000, and very high quality.

They have a rear M39x1 thread and must be color corrected because they are used in high-end color reproduction. Also very sharp.



**Lens: EL-Nikkor 105mm f/5.6 APO**

**Focal Length:** 105mm

**Widest Aperture:** f/5.6

**Narrowest Aperture:**

**Aperture Blades:**

**Filter Size:**

**Hood:**

**Close Focus Distance:**

**Reproduction Ratio:** 10x (5x – 20x)

**Focus Throw:**

**Weight:**

**Color:** APO