

All you need to know about extension tubes

Before buying a set of [extension tubes](#), I have done my homework but I did not find so easily the information I was looking for. This article intends to answer the questions unresolved before I decided to buy them despite some grey zones.

The main questions were the following:

- *What can we expect from them?*
- *Who are the manufacturers and why chose one rather another?*
- *Advantages and constraints of extension tubes,*
- *Compared with teleconverters,*
- *Real life feedback.*

On a side note, I am using a Nikon DSLR D7000 (APS-C / DX) but should you have a DSLR from any other brand, the rationale would stay the same.

Which improvements can we expect from extension tubes?

Let me use again and apply the excellent formulas of [an article written in French](#), but don't remember these formulas are actually not exactly valid for a system made of several lenses, but for only one, so they are only an approximation. However, I tested them and compared the results with the manufacturer's specifications, and they work relatively well :

R = Reproduction ratio

I = length of the extension tube in mm

F = Lens' focal

C = closest focusing distance of the lens

D = Focusing distance with a tube

When you focus the lens with the extension tube at its maximum distance (infinity):

$$\mathbf{R = I / F}$$

E.g. with a 200 mm lens and a 36 mm extension tube (maximum length of the biggest tube of a classic set of 3 tubes), the reproduction ratio is equal to .18 (not terrific).

How close you can focus now thanks to extension tube when you lens is actually positioned as infinite focus:

$$\mathbf{D = F \times (1 + 1/R)}$$

In the same example than above, instead of infinite, you will actually focus at 1300 mm, so quite close (the distance is calculated from the focal plan, not from the front lens! In this example, it is a 70-200 mm f/2.8, with a minimum focal distance equal to 1400 mm).

Now if you don't focus at the infinite but at the minimum distance available to understand the maximum improvements provided by extension tubes, you need a few more calculation:

First and foremost you need to calculate the real and total length **L** of your system (extension tube + lens) as follow:

$$\mathbf{L = I + (C \times F) / (C - F)}$$

E.g. for my 200 mm, I can focus as close as 1.4 m = 1400 mm. At this distance, with an extension tube of 36 mm we have: $L = 36 + 1400 \times 200 / (1400 - 200) = 270$ mm.

Let's not calculate the reproduction ratio as follow:

$$\mathbf{R = (L-F) / F}$$

In our same example, $R = (270-200)/200 = 0.35$. So thanks to a basic extension tube, we still cannot masquerade quite well a real macro lens with a reproduction ratio equal to 1:1. But much better than the 0.12 reproduction ratio without any extension tube.

Let's now evaluate the minimum focus distance: $D = 200 \times (1+1/0.35) = 770$ mm. You can see that we are far from the supposed 1400 mm, and that this distance is actually quite close.

Some facts about the manufacturers

Apparently that's not a priority for Nikon, and their extension tubes (PK-x) are very obsolete. Actually they barely work with the modern lenses (AF-G), and are only a good match for the older lenses with diaphragm ring (AF-D, AI-S, ...). Other brands (Canon for instance) seem to have more decent ones. If you live in a "major" country (no offense: I live in a small one, Switzerland), [you may have some choice](#). But for the others, it may be limited if not very limited. Kenko is quite well distributed in many western European countries, so I bought their set but from what I have read, you can find other sets less expensive and as good as them. Indeed, most of the sets are very similar: 3 tubes of typically 12-20-36 mm for APS-C or FX (not for medium format or micro 4/3). They are often made in plastic, which means they don't work so well with "heavy" lenses (above typically 700 g). Actually you can use them with heavier lenses, see below, but with precautions and limitations.

Advantages and constraints

Their main advantages are: rather cheap, can let you focus very closely, allow reproduction ratio far above 1:1. The main constraints are: don't forget non macro lenses are not optimized for macro shooting (diffraction and other geometrical default). I could not find real evidence of such defaults, but the theory says images should suffer from them in a way or another. However, with real macro lenses, you don't have this issue anymore. So the theory says they are great with macro lenses! Further more, they are not so flexible as you can't focus very far. Last and not least, most of them are made of plastic (a shame...) and heavy lenses, above 500-700 g are not really the perfect match in theory. That said, I am using them with a 1.5 kg zoom and they work quite well as long as I have one hand grasping the lens, and the other one holding the camera. So it is not a show stopper but could be an issue for reproduction purposes for instance. Another limitation: action macro shooting, where you cannot handle the camera in one hand and the lens with the other.

Given the formulas explained above, and given a set of extension tube with a total length with its 3 tubes altogether no bigger than typically 68 mm and as most of the lenses don't focus closer than typically 7x their focal lens if not 10x (e.g. a 35 mm f/1.8 DX will focus not closer than 300 mm for a Nikkor), you can't get a reproduction ratio above 1:1 for lenses with focal greater than 75 mm, so not that much.

Extension tubes versus teleconverters

That's really comparing apples and oranges! Teleconverters let you increase the reproduction ratio 1:1 for macro lenses for instance, and you will continue to shoot not so close to your subject. However, you will lost 1 to 2 EV (stops). With extension tubes, you will too lose some EV as you will focus closer but there will be no additional lenses so in theory, even if the lenses are not optimized for macro, you may expected a little bit more quality. More important, the stop loss will not be as significant unless you really want to focus very close. For any reason, the theory let me believe extension tubes work better than teleconverters with Macro lenses, but the real life experience is showing something different (see below). That said, teleconverters are introducing diffraction, especially when focusing at very short distance. I have noticed such defaults in most of the pictures I have taken with them. The amount of diffraction is annoying, even for web publishing. So it is almost a show stopper to me. Theory says I may have similar issues with extension tubes and non macro lenses, I did not notice them so far and further more, these issues don't exist with macro lenses. So to make a long story short: avoid using teleconverters for macro, but buy a set of extension tubes!

Real life feed back

I have tested my Kenko set with:

- Tokina 11-16 mm f/2.8 DX at 16 mm
- Nikkor 35 mm f/1.8 DX
- Nikkor Micro 105 mm f/2.8
- Nikkor 70-200 mm f/2.8 VR II

Note : all the pictures below are not cropped at all. I have shot a magazine (still object) and a spider (transparent back-ground on purpose for the bokeh and to avoid light reduction at very short distance). The spider was not shy at all, which helps me a lot.

AT-X 116 PRO DX AF 11-16mm f/2.8



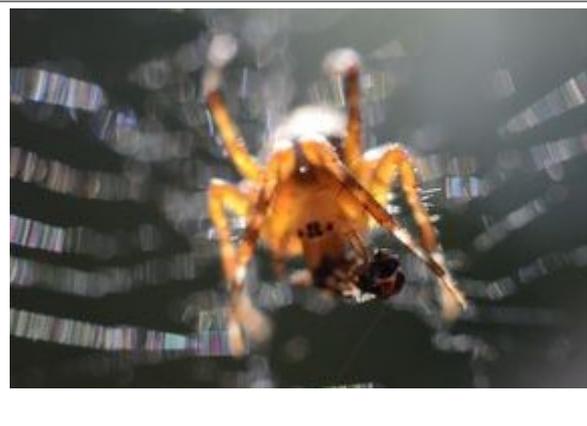
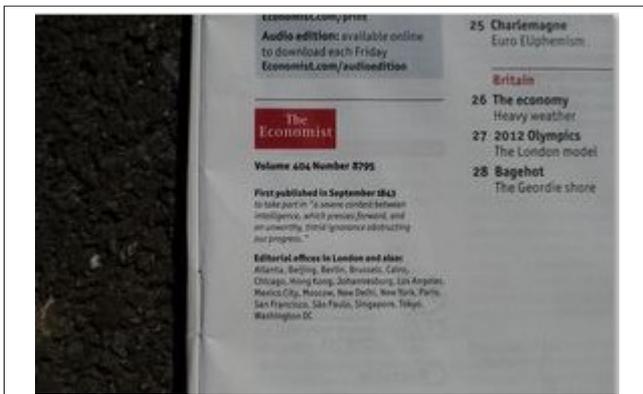
With the Tokina 11-16 at 16mm, I can't focus even at f/22, even by using only the smallest tube of 12 mm, even with a subject really on the front lens itself! That's really too bad. Maybe with a 8 mm tube (Nikon PK 11) but my Tokina does not have a diaphragm ring so forget it. I assume therefore the shortest focal would be around 20 mm. That's really a ball park estimation... It also means if you want to focus very close to a subject

with a wide angle, you need a fish-eye or a very slim tube. For instance, the Nikon DX fish-eye can focus as close as 30 mm from its front lens without any tube. For the a slim tube, the best choice seems to be the Nikon PK-11 of 8 mm but you need an old lens with a diaphragm ring to use it (e.g. 20 mm AF-D). That's of course even truer with a DX (APS-C) sensor.

Tokina 11-16 mm at 16 mm f/22 with one tube of 12 mm	


 With the Nikkor 35 mm f/1.8, I can really focus close, so close and the reproduction ratio is very interesting. However I don't see the point as a Micro Nikkor 40 mm costs even less than a 35 mm + the set! And is much more versatile. So just forget it ! For those really on a budget, you can still buy used a 55 mm AI-S or a 60 mm AF.

35 mm at closest distance	With the 3 tubes
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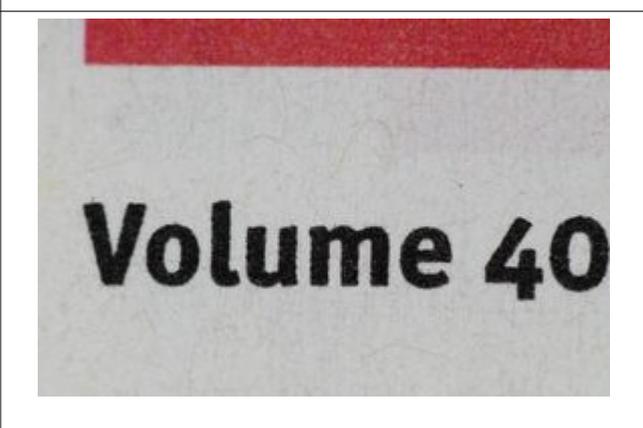


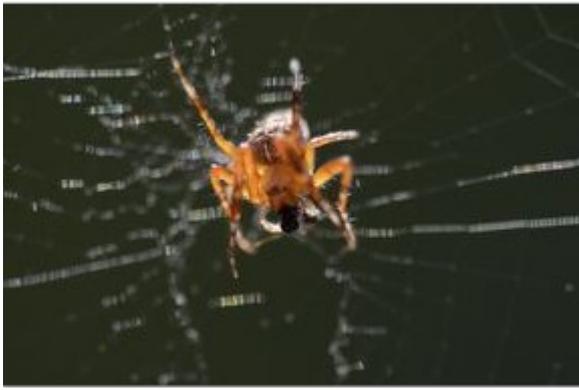
With the Micro Nikkor 105 mm f/2.8, it is a great match. I can focus closer, the improvement are dramatic, like with a teleconverter but without any additional lens and without added diffraction. The theory says I only improve the reproduction ratio to typically 1.2 instead of 1 but the real pictures show a significant advantage for real close macros. As a matter of fact, the reproduction ratio is similar with the tubes than with a x2 teleconverter (TC IIIIE). The focusing distance is closer though. It seems to me to be easier to shoot action. Indeed, the teleconverter cannot replace a real 200 mm macro at f/4 and it is challenging to focus well with a f/5.6 lens. So I would try to get closer thanks to the tube and if not possible, I will use the teleconverter. On a side note, should I can't get closer, I would rather use the 200 mm f/2.8 (see below) and the tubes. Yes not so trivial ! As I will explain in the conclusion, extension tubes are indeed not so versatile, like converters, and the idea they are a good match for beginners look to me obsolete if not totally wrong.

105 mm without tubes at closes focusing distance



105 mm with the 3 tubes at closest focusing distance





105 mm with a teleconverter x2 at closest focusing distance



105 mm with a teleconverter x2 at closest focusing distance and with the 3 tubes

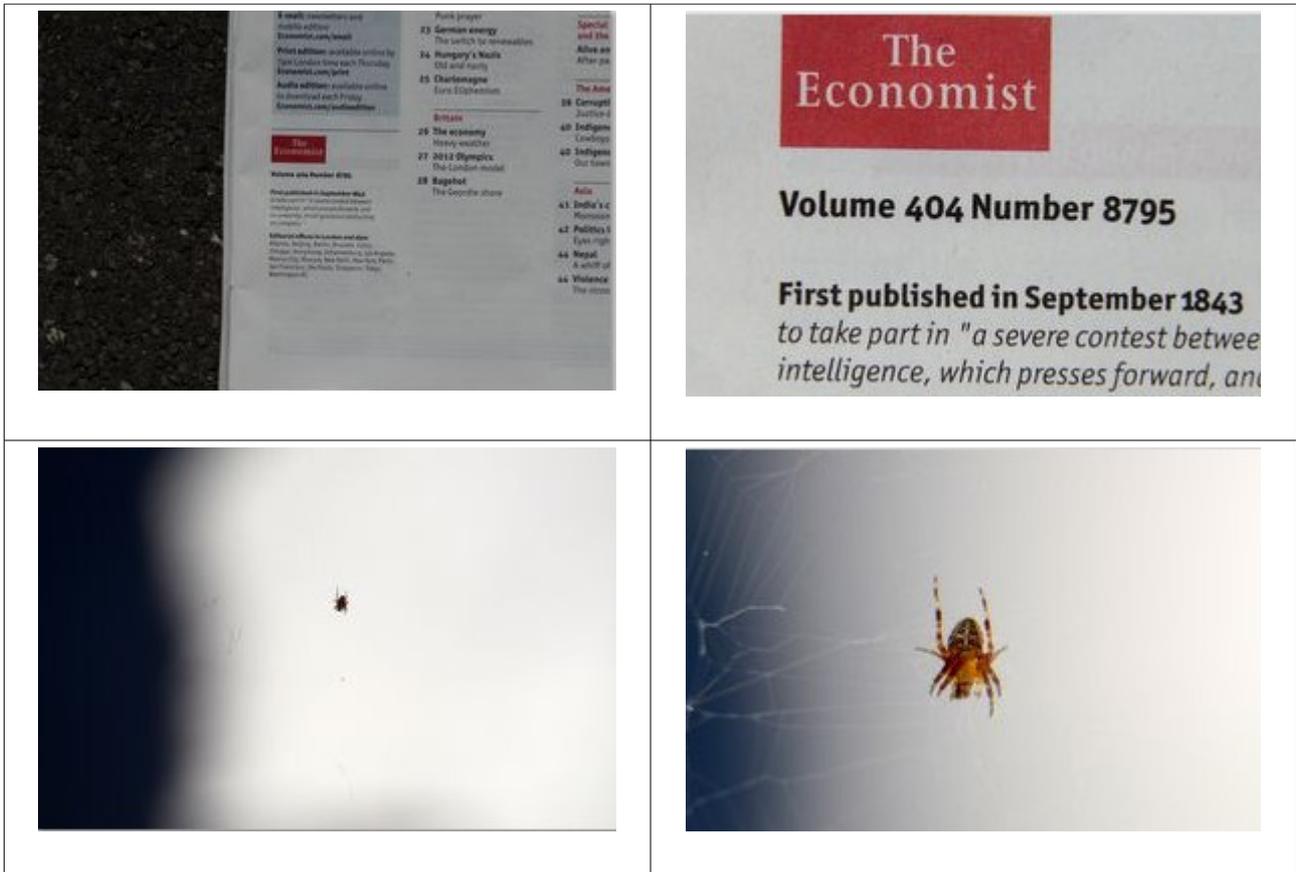


With the 70-200 mm f/2.8, I really like the tubes. In theory, it does not make you lens a real macro one with a reproduction ratio of 1:1 (at 200 mm, the formulas give only a ratio of 0.5). But you can shoot with a bright lens, not so close from your subject and the reproduction ratio is big enough for bugs as big as bees, wasps, butterfly and bost the aperture and the focusing distance make it great for macro... in action. Further more, with only one slim tube (12 mm or 20 mm), you can shoot as close

as 90 cm up to 3 meters, which is interesting for some kind of portraits (kids, pets, ...). On a side note, the reproduction ratio will be bigger with a shorter focal than 200 mm for this zoom (maximum around 140 mm), but I don't really see the point as I have to focus closer. Indeed, I believe it makes sense with such a lens to shoot "far" (around 1 meter), otherwise, just buy a shorter real macro lens, not as expensive, and much more versatile.

70-200 at 200 without the tubes

With the tubes



Conclusion

I disagree about the general belief that extension tubes are a cheap way to get a macro lens. I believe that the newest macro lenses such as the Nikon 40 mm (or ibid from other brands) are a much better options. You can, or you will soon, be able to buy some used, so that's really the best way to start your macro experience, on my humble opinion. I believe that extension tubes are actually quite specific, and very useful with either real macro lens to get even closer, or with fast tele-zoom to shoot macro-action pictures (flying bugs, close portraits, ...). Whereas I don't recommend them for pure reproduction purposes – their plastic cannot guaranty a perfect alignment, they don't cost much. So they are great accessories for anyone who like to shoot close.