Vivitar Series 1®

70-210mm f2.8-f4.0
Macro 1:2.5x

The Evolution of Excellence

The introduction of the Vivitar Series 1 70-210mm f/3.5 lens in 1972 was hailed as a breakthrough in lens design that would set new standards for the industry. This was the first three-to-one telephoto zoom lens that combined macro capability with the resolution characteristics of a fine fixed focal length lens. The 70-210mm f/3.5 enhanced contrast, resolution and overall image quality by correcting aberrations at close focus and optimizing performance in the normal zoom range.

This lens did, in fact, represent a solution to an incredibly complex set of design problems. But to the designers, the 70-210mm f/3.5 was only the first step in an evolutionary process that would incorporate the latest technology to further improve optical quality, while at the same time making the lens lighter, smaller, faster and more versatile.

The culmination of this rigorous effort is the new Vivitar Series 1 70-210mm f/2.8-4.0 lens which offers higher contrast imagery, mechanical stability, continuous macro focusing, a reproduction ratio of 1:2.5 and a fast f/2.8 maximum aperture.

The Evolutionary Process

Prior to the introduction of the first Vivitar Series 1 70-210mm f/3.5 lens, zoom lenses suffered from severely limited image quality and were not available with macro focusing.

These early telephoto zooms had long barrels where the front vertex-to-image distance was greater than the focal length at the telephoto position. Moreover, lens designs often suffered from the incorrect assumption that higher index of refraction materials is needed in positive lens elements to reduce aberrations. And the now-common method of evaluating lens performance called Modulation Transfer Function (MTF) was not generally available to designers of early zoom lenses and results were too often dependent on subjective evaluation.

As a result, most zoom lenses had distortion in the four to five percent region, with resolution limited by chromatic aberration and astigmatism.

Designers of the Vivitar Series 1 70-210mm f/3.5 lens relied on sophisticated computer programs to evaluate the multitude of variables confronting them. Even the glass types were varied by computer, a feat only recently accomplished by some zoom lens design programs.

The high performance level of this lens was also enhanced by the use of repeated MTF calculations which demonstrated the ability of the lens to reproduce an image within specific limitations. Optical designers used the deviations on their MTF curves to predict and improve the resolution and contrast characteristics of the lens.

The 70-210mm f/3.5 was unique not only because of its short barrel length, f/3.5 aperture, high quality and performance, but because it incorporated a macro mode which set the trend for almost all zoom lenses to follow. The usefulness of macro (4:1 or less magnification) had not been previously established. The enthusiasm of photographers for this feature clearly indicated that high quality macro that is easy to use was a step in the right direction.

Further Refinements

It would seem that telephoto zoom lens design problems were now solved. However, inexpensive and compact cameras were at this time (1976-1977) quickly becoming the largest segment of the SLR owners market. This created a need for smaller lenses at a reduced cost. Photographers also demanded an easier, more flexible macro system; one which would eliminate switches for the macro mode and provide a more comfortable working distance.

The solution to these design objectives was facilitated by further refinements in lens evaluation procedures, coupled with a growing sophistication of computer design

Introducing the New Series 1 70-210mm f/2.8-4.0

programs. The result was the next stage in the evolution of the 70-210mm lens: a lighter, more compact (almost one inch shorter and eight ounces lighter) lens.

Macro focusing was taken one step further as well. The new design incorporated continuous macro focusing, meaning the photographer could zoom throughout the focal range into macro without using a switch. With this lens, one could also zoom within the macro range for composition flexibility. And the lens allowed an extended working distance in macro for easier lighting, the ability to eliminate more of the background, and to help reach hard-to-get places.

In addition to these optical benefits of the new design, an improved mechanical configuration offered several positive benefits as well. One of these is the greater stability of element centration which contributes to superior image quality. Resolution and contrast were further improved by an efficient baffle system minimizing internal reflections.

From a serious users point of view, the optimum telephoto zoom lens design should have all the characteristics of the fixed focal length lenses it replaces, in addition to the advantages of convenience and continuous focal length change.

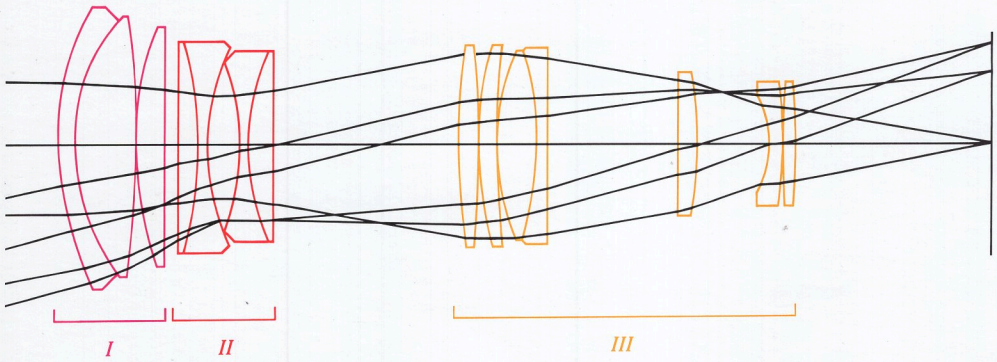
The specifications for the new Vivitar Series 1 70-210mm f/2.8-4.0 lens included the requirements of truer color fidelity, improved contrast and resolution, miniscule distortion, improved macro reproduction ratio, and one last feature inherent to the design philosophy: a fast f/2.8 maximum aperture without sacrificing size or weight.

With these characteristics modeled by an advanced lens design optimization program, it became clear that an altogether new lens type would be needed in order to achieve the desired specifications.

The New Lens Design

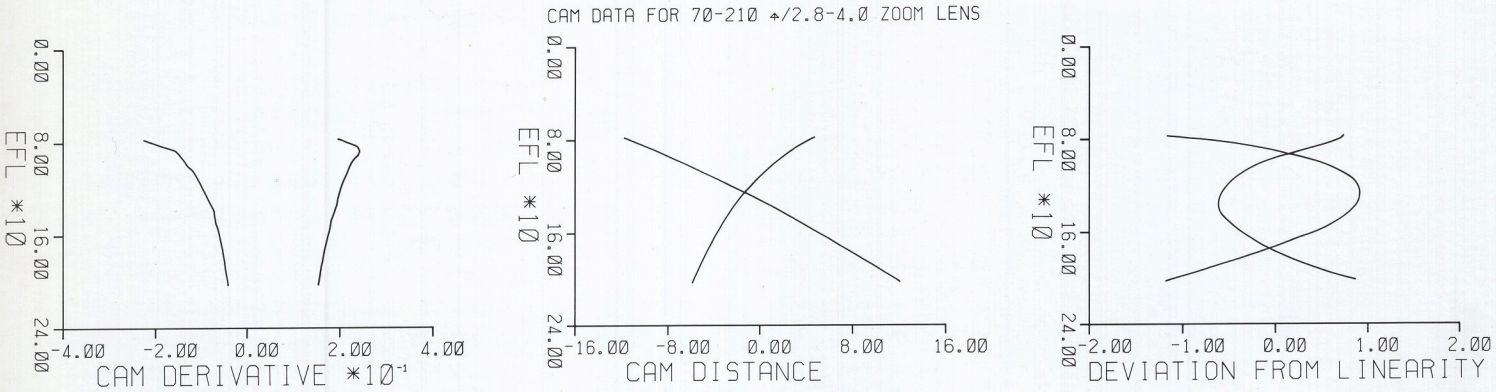
Conventional lens designs minimize lens group powers and maximize zooming group travel. The design of the new Vivitar Series 1 70-210mm f/2.8-4.0 is just the opposite. In this unique configuration the first group is used for focusing and the second and third groups are used for zooming. This design, coupled with lens elements manufactured from rare earth chemical elements, made it possible to attain the higher maximum aperture speed without increasing barrel diameter or filter size.

Both chromatic aberration and distortion have been minimized throughout the entire focal range, and the lens achieves a reproduction ratio of 1:2.5. In short, the new Vivitar 70-210mm f/2.8-4.0 lens fulfills the goal for a zoom lens with superior performance characteristics and the optimum image quality of fine fixed focal length lenses.

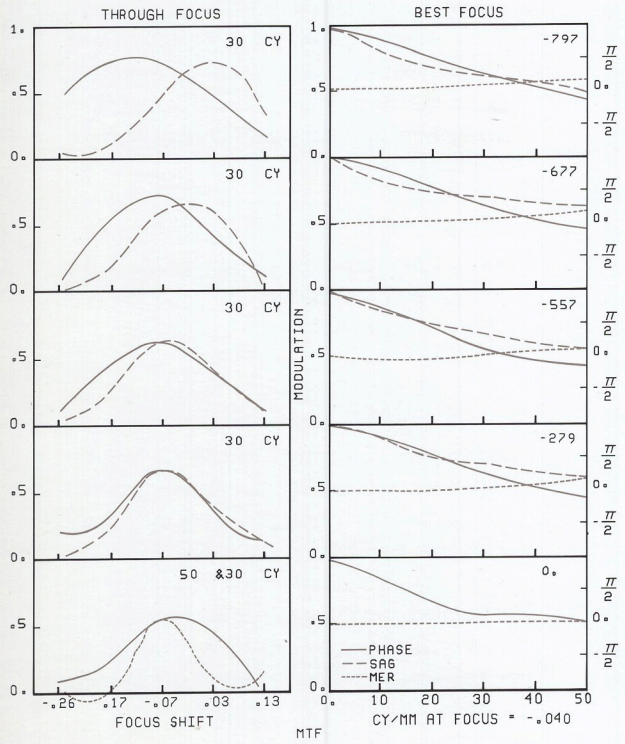


GROUP I: Focusing, focal length 69.4
GROUP II: Compensating, zooming, focal length -26.8
GROUP III: Zooming, focal length 43.3

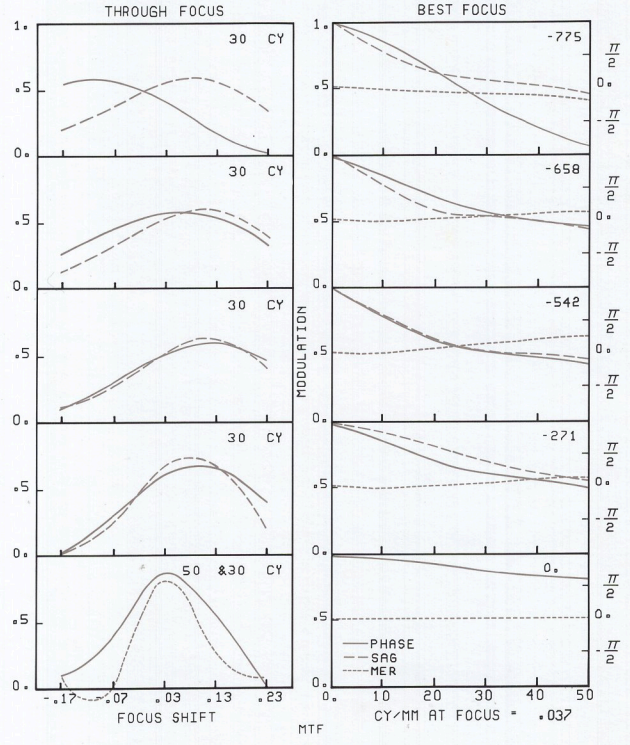
Conventional lens design procedure is to minimize lens group powers and maximize zooming group travel. The new design is just the opposite. The advantage of the extremely short focal length first group is that continuous macro focusing to 1:2.5 can be achieved by one single focusing motion. A very short focal length second group must be use but can move only a short distance. The second group forms a virtual image which is then relayed to the film plane by the third group, an optically stable telephoto-type lens operating at close conjugates. (Patents pending)



Short zoom travel is ideal, if the rate of change is proper. The motions of groups II and III are plotted together with the derivatives of the motions. The motions are monotonic and vary slowly. This means the mechanical design can be such that the weight and travel of groups II and III are balanced. This feature, with the tight tolerances and Delrin® cam grooves, assures absence of "zoom creep" without additional switches.



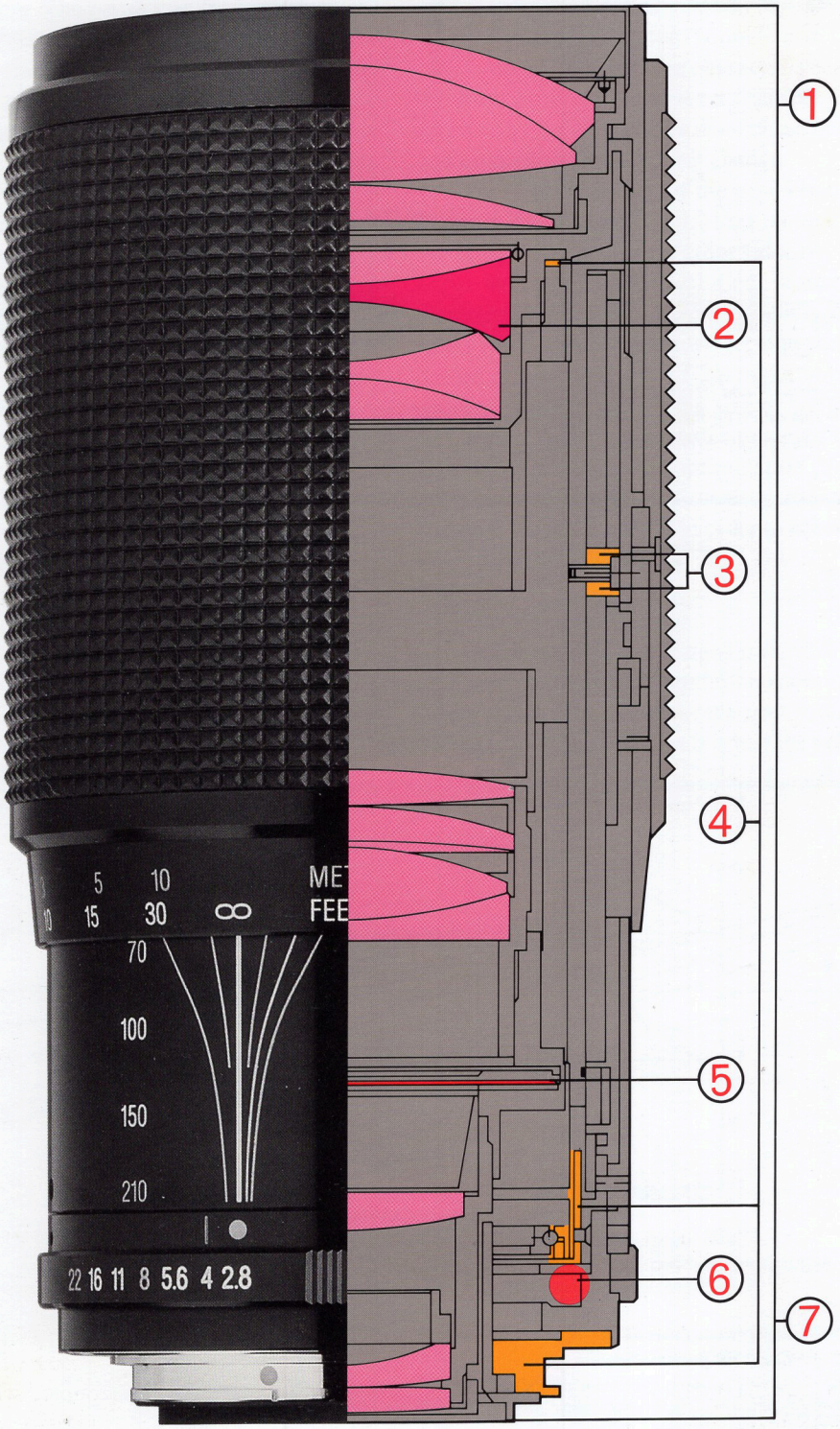
f = 70



f = 200

Literally hundreds of MTF curves were analyzed to determine optimum performance throughout the zoom range, across the image plane and at different object distances, focusing positions and apertures. The peak modulation in both radial and tangential directions lies in the same plane of focus out almost to the very corners. Chromatic aberration at the 210mm position has been minimized. The secondary axial color at 70% aperture is less than .05mm measured transversely and almost no chromatic variation of any aberrations can be detected. The result is a higher contrast picture with truer color fidelity.

The Vivitar 70-210mm f/2.8-4.0 Macro Focusing Zoom Lens



70-210mm f/2.8-4.0 Lens

1. 14 elements in 10 groups. A 1:2.5 reproduction ratio, with continuous macro focusing.

2. This highly sophisticated lens uses tantalum glass to reduce the aberrations to a minimum.

3. A Delrin® roller pressed onto a brass collar moves in a precision cam groove. This assures smooth zooming and focusing throughout the life of the lens.

4. Liberal use of brass, not only insures structural integrity, but also results in more accurately machined internal parts.

5. This new lens employs a 9 blade system for precise aperture control throughout the entire aperture range. Typically, interchangeable lens apertures consist of 6 or fewer blades.

6. The use of up to 184 super quality high carbon chromium ball bearings enhances the overall mechanical operation and durability of the mount.

7. Iris Diaphragm: Moves with the lens group. Its size does not change during zooming, allowing for a simplified mechanical system to provide equally stepped intervals between f/numbers. The optical powers of the groups determine the rate of travel of Groups III, which in turn determines the f/numbers throughout the zoom range. By choosing powers carefully, the lens varies from f/2.8 at the 70mm position to f/4.0 at the 210mm position.

Product Specifications: Series 1 70-210mm f/2.8-4.0

- Vivitar Series 1 quality and performance
- The fastest 70-210mm lens available with 1:2.5 macro focusing
- Smooth, precise one-touch zoom and focus control
- Features Vivitar-pioneered continuous macro focusing permitting the photographer to zoom throughout the entire focal range without switches
- Convenient working distance for more versatility in lighting macro subjects
- Reproduction ratio of 1:2.5 at the 210mm position
- Minimized chromatic aberration and distortion throughout the entire focal range and superior color fidelity, contrast and resolution
- Compact size (measures 5.5″ in length)
- Nine-blade iris system for precise aperture control

Focal Length	70-210mm
Aperture	f/2.8-4.0
Optical Construction	14 elements 10 groups
Angle of Acceptance	34° - 12°
Minimum Focus Distance	1.6M (6.25 ft.) @ 70m 0.8M (2.6 ft.) @ 210m
Max Reproduction Ratio	1:2.5
Length	139mm (5.5″)
Weight	860g (30.3 oz.)
Maximum Barrel Diameter	70mm (2.76″)
Lens Coating	VMC Multicoated
Accessory Size	62mm

Specifications subject to change without notice.

Sources:

"Utilization of Moving Lens Elements for Corruption of Aberrations Resulting from Major Conjugate Changes"

By: Ellis Betensky, *Opcon Associates*

As published in Proceedings of the Society of Photo Optical Instrument Engineers, Vol. 39

"Continuous Close Focusing in Tele-Zoom Lenses"

By: Ellis Betensky, Mel Kreitzer, Jacob Moskovich, *Opcon Associates*

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"The Evolution of the Vivitar 70-210mm Series 1 Lens Design"—A White Paper

By: Ellis Betensky, Mel Kreitzer, Jacob Moskovich, *Opcon Associates.*

Opcon Associates is an independent optical design company that develops consumer optical products exclusively for Vivitar Corporation.

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