SHUTTER AT HIGH SPEED

In the age of megapixels and color spaces we often take the basic components of camera technology for granted. Photographers tend to overlook the ingenuity of the shutter mechanism installed in HC lenses – and yet it is no less of a technical feat than all the other components in the H System.

BY HANNS W. FRIEDRICH
PHOTO: RICHARD DAWSON

Richard Dawson took this picture for GQ magazine using a Hasselblad H3D-39 with the flash set to 1/800 to virtually freeze the spray water

At Hasselblad in Gothenburg/Sweden, Tomas Johansson, the developer in charge of the central shutter mechanism, cranks a test unit, sets it off and watches it fire away for minutes at incredible speed. "The H camera might not take 20 pictures per second, but that has nothing to do with the shutter," he remarks with a grin. The Swedes are proud of their shutter. It's one of the H System's core components and the 'mechatronical' device is as simple as it is ingenious. H System users enjoy its unsurpassed precision and versatility. Laymen will ask, what's the big deal with a shutter mechanism that shoots only 1/800 second at maximum speed? Even amateur cameras with focal plane shutters – installed in the camera, as opposed to every lens – are known to fire away at 1/8000 second. But, the pros will know. Central shutters have obvious advantages: for example, flash units can be used throughout all shutter speeds – including the 1/800 second setting.

ADVANTAGES OF THE CENTRAL SHUTTER

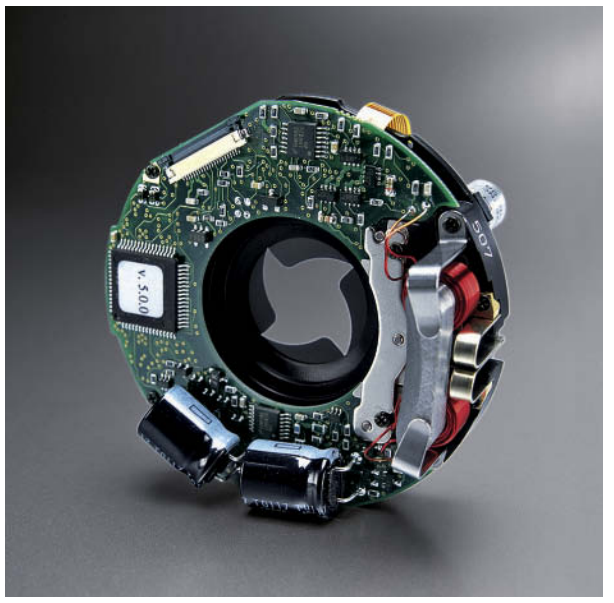
There is, in fact, a whole array of positive assets in the central shutter. It allows for approximately three exposure values more flash sync speed than a focal plane shutter. This means flash photography with almost entirely suppressed ambient light, providing the photographer with absolute control over his lighting. What starts out being beneficial in the studio proves to be downright indispensable in some flash scenarios outdoors.

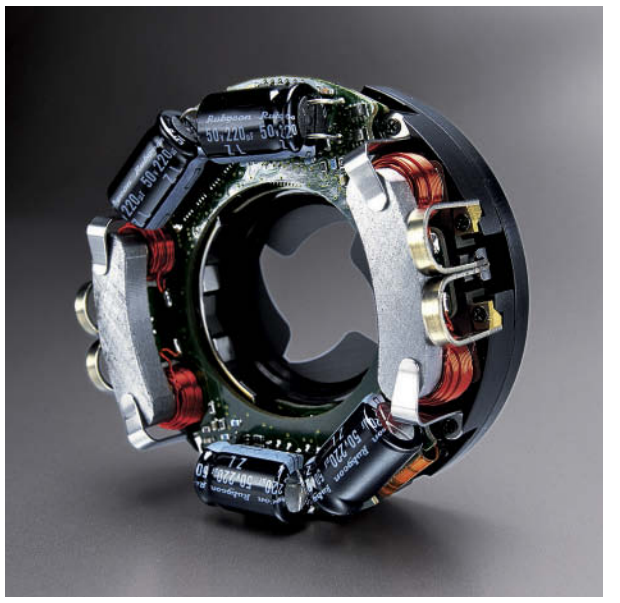
Where the exposure is longer and subjects are moving, available light may lead to an unsharp secondary exposure whith blurry contours. The significantly faster sync speeds of a central shutter, on the other hand, freezes any movement far more effectively while also completely suppressing the influence of the ambient light. The photo on the left illustrates the concept: spray water could never have been frozen as effectively in a well-lit studio with the H3D set to a flash sync speed of 1/125 second.

A focal plane shutter generally uses a vertical slit to expose every pixel or grain line by line, thus covering the image plane at rapid speed. Flash photography requires the first shutter curtain to open entirely before the second can shut the film window. It calls for a 1/60, 1/125 or, at best, 1/250 second shortest flash

SYNOPSIS

- The H System's central lens shutter allows for flash photography at 1/800 sec – the camera's fastest shutter speed. In this area, it outshines the focal plane shutters found in 35mm systems.
- The patented 'mechatronical' shutter built in Sweden causes almost no vibration, uses a minimum amount of movable parts and consumes very little energy.
- Super high-tech materials and a sophisticated control board inside every H lens ensure superlative operation.
- The shutter is very precise and reliable. Its lifespan extends far beyond 100.000 exposures.
- Hasselblad's True Exposure mode guarantees correct exposures independently of the aperture setting.





The H shutter comes in two types: the smaller 20 mm version (left) has one motor; the larger, more sophisticated 28 mm shutter uses two motors for compatibility with telephoto and high-speed lenses

sync speed – all depending on the camera system and type of shutter.

Exposures take as long as the flash sync speed, or longer: i.e., even if the shutter speed is set at 1/2000, it might still take 1/125 second for the shutter to perform. Any movement during this time – whether by the camera or the subject – can lead to visible distortion as is frequently seen in sports images. The central shutter, on the other hand, will have nothing to do with this 'rolling shutter' effect. It sits in the optical center of the lens right behind the aperture. For this reason, it makes no difference that the central shutter cannot open or close with infinite speed. It opens first in the middle and closes last in the middle: the fast, aperture-like opening and closing mechanism has no optical repercussions and doesn't lead to vignetting.

An added bonus of the central shutter is that it causes virtually no vibration. The forces applied by the tiny, ring-shaped shutter blades are neutralized almost entirely. The two curtains of the focal plane shutter, by comparison, spring off in the same direction only to hit resistance and cause camera shake. Normally, any potential shutter vibration cannot be compared with the more violent flap sound of the mirror inside SLR cameras. However, since the H3D will optionally open the mirror long before the shutter fires, the smooth central shutter of H lenses has indisputable advantages.

Over the years, medium-format cameras by Hasselblad have been known to use both central shutters and focal plane shutters. The general inclination, though, has always been toward the central shutter. Users prefer advanced flash compatibility to lighting-fast shutter speed. The 'mechatronical' central shutter was in fact built before the H camera, as the H1 requires lenses with absolutely precise, electronically controllable internal shutters. The mechanical levers in the lens bayonet are thus made redundant.

THE HASSELBLAD CENTRAL SHUTTER

1 The basic principle behind the shutter control system, conceptualized and patented in Sweden, is as simple as it is ingenious: a mechanism transfers the angular movement of a lever onto the shutter blades. The core piece, a powerful, M-shaped spring, would normally keep the lever locked in the center position. It is attached to an anchor held by two fixed neodymium magnets on both sides, i.e., in the open or closed state. When the anchor touches one of the magnets, the magnetic circuit is closed and a large holding force is created that keeps the shutter open or closed more dependably.

However, the moment the connection is cut, the spring yanks the lever back to the opposite side where it is held by the other magnet. To cut the connection on either side, a magnetic field is generated to neutralize the magnetic power and also, for short exposure times, add force to

The central shutter is installed inside the lens, back to back with the aperture. There are no side

the moving system. This is a clever idea that boasts a number of advantages: for one, the shutter will remain open or closed without using any energy whatsoever. Both states are stable and autonomous.

As a whole, it's a motor-less shutter solution that uses very little energy. With the majority of shutter speeds, the magnetic-field-enhanced 'push' described above is only really needed to help compensate the nominal friction caused by the shutter. The spring inside the shutter mechanism is what ensures that the blades are fired open at high speed and then brought to a gentle halt on the other side, ensuring that they do not collide with the stop position at full speed. No, the four shutter blades are handled with care for they consist of carbon fiber laminate and measure 0.08 millimeters – about the width of a human hair. The construction is designed to cause minimal abrasion and work seamlessly.

TWO VERSIONS OF THE SHUTTER

Hasselblad builds the shutter in two sizes: one measures 20 millimeters in diameter, the other 28. The large version is used for high-speed and tele lenses. The larger the shutter, the more difficult to build. For instance the blades of the 20 mm version weigh 0.13 grams and the shutter spring develops a force of about 7 Newton, the equivalent of 700 grams. The large 28 mm shutter, in turn, requires two motors to move the 0.22 gram shutter blades with a speed equal to that of the smaller model. At 35 N and 3.5 kg, the springs call for five times the tractive force, making the 28 mm version far bigger and more sophisticated. An even larger mechanism for even bigger and faster lenses could no longer be manufactured under reliable, economic conditions

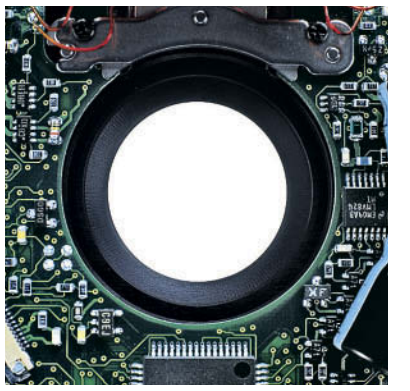
effects from opening the shutter from the middle to the outer sides, first leaving the light through in

– especially not if it is to perform at 1/800 second. However, we would expect no less from the H lenses.

Speeds of 1/500 second and slower use, almost exclusively, the force of the spring to open and close the shutter. The lever moves in tandem with the speed of the powerful coil as it springs freely. The magnetic field will compensate for any mechanical abrasion using a nominal amount of energy. Faster speeds, on the other hand, call for more acceleration. Ultimately, it is the capacity of the shutter blades that constrain the speed. Extreme acceleration could simply cause the laminate to dissolve. The 1/800, however, guarantees long life – even though it already is subject to unimaginable forces which only carbon fibers can withstand.

The shutter control mechanism is far more complex than one would think. Counter impulses – generated by magnetic fields – prevent the blades from bouncing back (and forth!) after opening or closing. The 20 fastest internal speeds, from 1/250 to 1/800 seconds, are each controlled by a reference table, listing the conditions, length and strength of the electro-magnetic impulses. The tables are installed in the shutter's control board and become increasingly sophisticated at faster speeds. Designers went to great lengths to puzzle out these lists with sophisticated measuring tools and high-speed cameras. The extreme precision they obtain is then made real when every shutter is gauged and calibrated individually in the factory.

2 The electronic control mechanism warrants exposure speeds with superior accuracy. It's highly beneficial in specialized fields like aerial photography where it guarantees 100 percent synchronized exposures using various lenses. It also enables True Exposure. Here, an electronic control considers that the shutter



the middle. The light-weight, high-speed blades guarantee precise exposure speed at 1/800 sec

– which opens in a circular fashion from center to edges – clears a small aperture faster than a wide-open one. Since the introduction of the H1, the photographer no longer has to correct the exposure – something even most experienced photographers would overlook – when the aperture is small.

3 Hasselblad makes no compromises when it comes to the accuracy of the shutter. Internally, the Swedes adhere to far stricter standards than what is dictated by the ISO for medium-format cameras. The amount of fine-tuning invested by Hasselblad engineers, combined with the superior electronic control options, ensures that all shutter speeds remain within the tightest of tolerance margins – barely one-tenth of an exposure value – even though the company's internal norm would

allow as much as three-tenths, and the ISO even four-tenths discrepancy. In theory, the ISO tolerance norm stocks enough reserves to transform the standard 1/800 into a prestigious 1/1000 second. Mechanically, nothing would even have to change. However, this would go against the Hasselblad philosophy. As it is, the HC lens simply ensures exact exposure speed while keeping sufficient tolerance levels for backup. And it proves to be very reliable and accurate in the field, where consecutive exposures all stay precise within 0.02 exposure values.

LIVE SPAN BEYOND 100,000 EXPOSURES

Shutter designer Tomas Johansson hasn't given up his dream of a 'real' 1/1000 second. "All it should take is a bit of extra fine-tuning and modifying. The 1/1000 is on my agenda," he says. However, the speed issue is rarely even raised by users. There appear to be plenty of other areas that can be improved first – but the shutter mechanism keeps evolving.

The 1/800 second, on the other hand, gives the shutter a markedly long life span. The exact number of exposures is rather open, though it is always likely to extend beyond 100,000 shots. Johansson points toward a shutter that had fired more than 250,000 exposures. Afterwards it continued to perform within the acceptable tolerance margins and, in addition, displayed no wear and tear as it was being disassembled. Since the burden of exposures is distributed across all H lenses, the contingency risk to the shutter is minimal and occurs only rarely. The engineers will then inspect the cause of the defect and use their insights to make improvements.

The shutter and the aperture are mounted back to back. They form the exposure unit, the heart of every HC lens. Hasselblad manufactures both the aperture and the shutter in Gothenburg. Mechanically, the aperture is kept simpler than the shutter. The developers decided to build the new version to greater precision than the previous unit, which had been supplied by a third party. The superior shape is obvious. "When something requires re-modification we always make sure we do it the Hasselblad way," Johansson says.

In addition to the mechanical components, the exposure unit has a circuit board that is also used for the autofocus motor. What immediately stands out on the electronic control board are the large capacitors. Similar to a flash unit, they gather the energy to generate the magnetic field. In the 28 mm shutter, the exposure unit is comparatively large and it is difficult to incorporate into the construction. However, the optical department are happy to work with the two, differently sized shutters. The smaller version slots right in without a fuss, while the larger gives birth to high-speed lenses such as the HC 100mm f/2.2. Here, the depth of field at open aperture is spectacularly low, while the speed leaves little room for improvement.

HC lenses are assembled at their partner company Fujinon. The exposure unit itself, being the complex and highly critical component for the correct functioning of the lens, is made in Gothenburg and sent to Japan as a complete unit. All parts are assembled with extreme care; physical dimensions have to be correct and the control lever attached to the blades with utmost precision. The tolerance margins for the various components are abysmal while the demands on the material very high. The workers involved in assembly all possess exceptional dexterity as tasks can be rather finicky. The blades are mounted using a critical, tiny drop of grease; not enough would result in premature wear and tear; too much oil could end up on the lens. The aperture and shutter are meticulously checked and calibrated before leaving as a finished component on the long journey to Japan only to then return to Sweden as the heart piece of an HC lens.

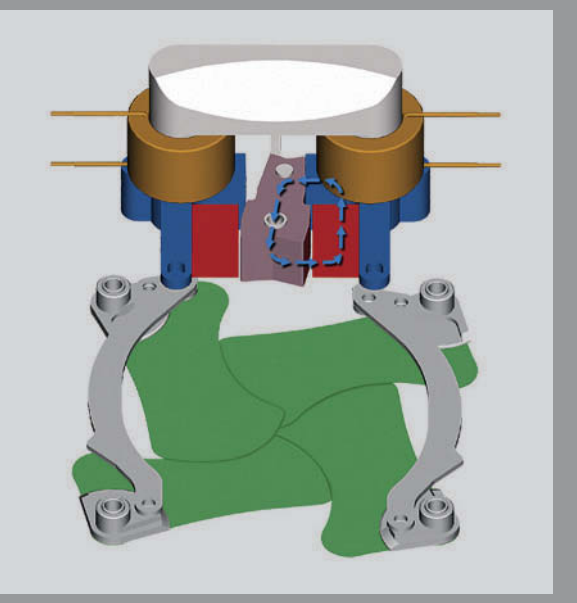
CONCLUSION

Those who believe the shutter to be a simple component wherin a few blades open and close, can remain true to their conviction. In a sense, they are right: the central shutter is as reliable as it is frugal, does exactly what is expected of it and asks nothing more of the photographer than to press the exposure button. The fact that, internally, a number of ingenious controls and magnetic fields are employed to combat mechanical vibration and automatically correct the shutter speed in relation to the set aperture, that the materials can be pushed to the absolute limit and that many clever minds needed many clever ideas and attempts until everything finally works, doesn't have to concern the Hasselblad photographer. He can concentrate on taking pictures and simply rely on his gear.

For further information please visit www.hasselblad.com

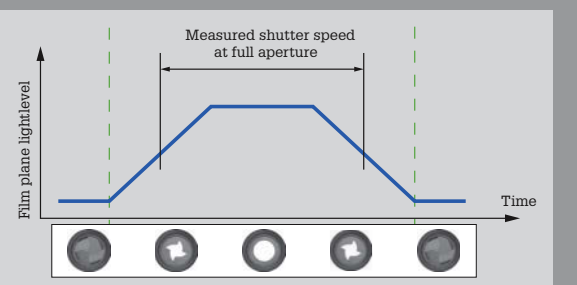
CENTRAL SHUTTERS – AT A GLANCE

1 THIS IS HOW THE PATENTED HASSELBLAD CENTRAL SHUTTER WORKS

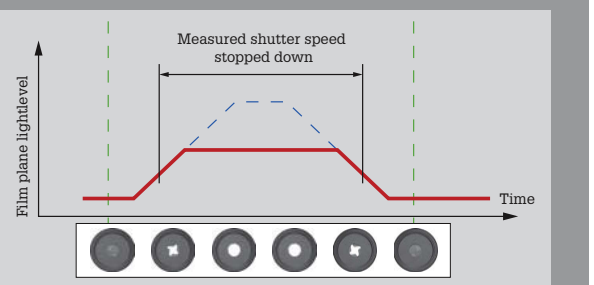


The shutter system is based on a lever attached to a moving anchor. The movement of the lever is transferred onto the shutter blades, while the M-shaped spring tries to pull the lever to the centre position. On both ends, the anchor is held by fixed magnets. The combined force of the magnets is slightly stronger than the force of the spring, ensuring that the shutter is automatically held in either the open or the closed position. To open the shutter, a magnetic field is generated with the help of coils, cancelling the retention force. For fast shutter speeds the coils also add driving force to make the anchor move faster. In other cases, all that's needed is a miniscule electric signal

2 TRUE EXPOSURE



The shutter is similar to the aperture diaphragms in centre of the lens and opens and closes in a similar way. However, despite all efforts, the speed of the blades remains limited. If the aperture is small, the light opening is cleared a little earlier and closed a little later than when the aperture is wide open. With the introduction of the H1, Hasselblad's True Exposure has become an



integral component of the camera system, designed to compensate for deviations. In shorter exposures, the timing for the opening and closing of the shutter is adapted so that the exposure speed is exact and independent of the aperture setting. Extremely fast exposures are compensated for with a marginal adjustment to the aperture, in order to keep the generated exposure independent of aperture setting. Only the fastest shutter speed combined with the smallest aperture setting could result in slightly flawed exposures, but fortunately this is a combination that rarely occurs

3 ELECTRONIC CONTROL FOR GREATER ACCURACY

Thanks to the mechanical design and electronic control system, Hasselblad's centralized shutters are extremely accurate in performance. The ISO norm (outer curve) would, at a shutter speed of 1/125 second, even allow for an 0.4 aperture stop deviation up or down. Hasselblad themselves only allow a tolerance of 0.3 values, and then only with speeds upwards of 1/250 second. The listed values stem from the shutter of an HC 80mm f/2.8. As we can see, any deviations remain under 0.1 aperture values and are thus irrelevant in practice. If Hasselblad were to transform 1/800 second into 1/1000 second, the lenses would still perform within the ISO norm, but it wouldn't be an honest solution