Electronic camera shutters

by DICK LEVINE

Automatic exposures by candlelight, high accuracy and an infinite number of shutter speeds — these are some of the advantages of electronic camera shutters.

During the past 10 years we have seen a strong move in the camera industry toward what is commonly called "electric eye" photography. This development has been welcomed by those who just want to "aim and shoot" and let the camera take care of the technical problems.

It has even been appreciated by many advanced amateur photographers who find it convenient having one less variable to worry about.

Professional photographers, however, have tended to resist camera automation because past automatic cameras have not allowed a choice of preselecting either aperture or shutter speed on the same camera.

Most automatic exposure cameras have made use of a form of aperture control rather than shutter control. This was a logical development from camera-mounted light meters, which were eventually integrated into the camera body. The most common arrangement (see illustration) is either spring powered or operated by the action of pressing the shutter release button.

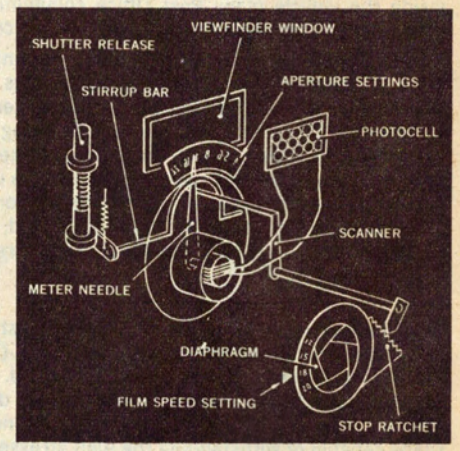
A stirrup bar is used to hold the light meter needle briefly while a scanning lever mechanically senses its position. The diaphragm is then adjusted by a spring and ratchet device to make the aperture agree with the f-stop reading on the meter.

In other words, except for the photocell and meter movement, aperture control systems are mechanically operated. If the photocell is the type which generates its own power, such as a selenium cell, the camera need not have a battery supply. This type has been used most often on fixed-lens cameras. Single lens reflex cameras with interchangeable lenses usually contain the light-dependent resistor (LDR) type photo cell, which has the advantage of smaller size and can be mounted inside the pentaprism housing. LDR systems, however, need an internal battery.

Electromechanical aperture control systems, though complex mechanically, have been refined to the point where they have a high degree of reliability — but they are still somewhat susceptible to damage due to rough handling and sometimes have problems in extremely cold weather.

Another disadvantage is that, since they are adjusting aperture rather than time their usefulness at low light levels is limited by the maximum aperture available on the camera.

The alternative to aperture control is the electronic shutter concept, which is rapidly gaining acceptance by the general public. The pioneers in the electronic shutter field are Polaroid and Yashica. Polaroid has used electronic shutters since the introduction of its first automatic camera in 1963. Polaroid's electronic shutter was built by Yashica, and in 1964, Yashica brought out their own electronic shutter camera.



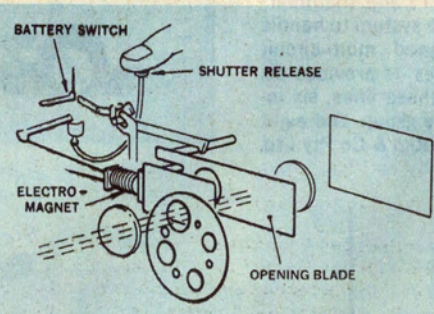
Electromechanical aperture control mechanism.

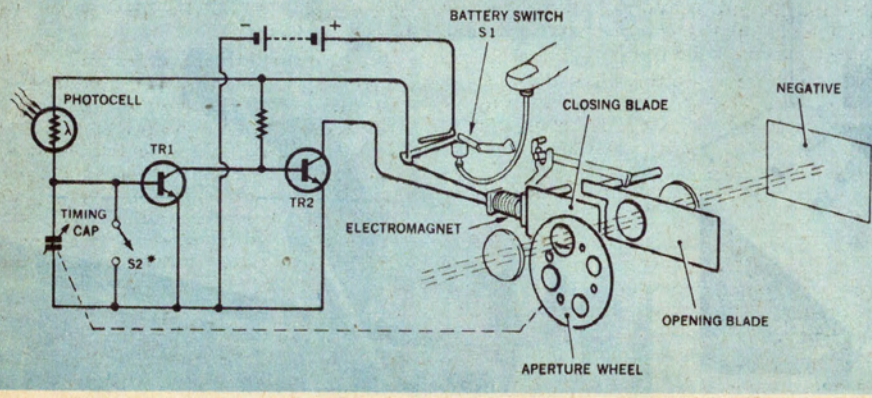
Though the cameras were very different, both used a similar shutter control concept. Both cameras use a timing capacitor which starts charging when the shutter release is pressed, and both control the shutter action with an electromagnet.

As you can see in the accompanying illustration, the Polaroid shutter is a simple device, using only two transistors, a photocell, and a few minor components.

Its sequence of operation, which can take place in a little as 1/1200 of a second, is as follows: When the shutter is cocked, both blades are mechanically pulled to one side of the light path. Part of the opening blade remains between the lens elements to prevent light reaching the negative. When the shutter release is pressed to take a photograph, battery switch (S1) closes and activates. TR2. The base of TR2 is forward

Sketch at right shows the Polaroid shutter mechanism just prior to pressing the shutter release. Drawing below shows the closing blade being held by the electro-magnet while the timing capacitor charges.





Colorpak 80 is a low priced Polaroid colour camera with an electronic shutter.

biased by the resistor, current flows in its collector circuit, and the electromagnet is energised.

The opening blade is released mechanically and snaps across to permit light to reach the negative through a large hole in the blade. The closing shutter is also mechanically released, but cannot move because it is restrained by the electromagnet. At the same time as the blades are released, timing switch S2 opens, permitting the timing capacitor to start charging.

When the timing capacitor has charged to a level sufficient to bias TR1 into conduction, TR1 effectively "steals" the forward bias from TR2, causing TR2 to stop conducting. With TR2 turned off, there is no current through the electromagnet and the closing blade is released to complete the exposure.

The timing capacitor's rate of charge will be determined by two things: the amount of light striking the photocell during its charge cycle, and its total capacitance. There are several timing capacitors and these are switched in and out out of circuit in various combinations by a switch mechanically coupled to the aperture wheel.

It is interesting to speculate as to why Polaroid designers decided in favour of a solid state shutter control as long ago as 1963, when other camera manufacturers were almost unanimously choosing aperture controls which were mechanically coupled to light meters. Polaroid designers were in a rather unique postion, however, in that they had only four film speeds to contend with, so they could dispense with the diaphragm-type aperture control.

Also, one of those film speeds was 3000ASA, meaning that with a bright scene and the f-stop set at its minimum of f42, the shutter had to close in 1/1200 of a second. So they were faced with having to provide a fast, accurate shutter in any case, and their design proved to be much simpler mechanically than a diaphragm system.

Currently available Polaroid models that contain the electronic shutter are the four cameras in the Automatic 300 Land series, ranging in price from $75 to $185, and the new Colorpak 80 camera which sells for less than $30.

Another interesting feature of Polaroid's top-of-the-line Automatic 350 model (shown on our cover) is the inclusion of an all-electronic timer with an audible "beep" signal to notify the user that the exposed film has been developed.

As with the shutter mechanism, the "beeper" circuit uses a capacitor as a timing device. The timing required is set by means of a dial on the back of the camera which controls a variable resistor in series with the timing capacitor.

The action of removing the exposed picture from the camera momentarily closes a two-pole normally open switch. One set of contacts temporarily shorts out the timing capacitor to get rid of any residual charge; the other set activates a circuit which turns on a small indicator lamp.

When the capacitor is fully charged, circuits are activated which turn on the "beeper" transducer and turn off the lamp, indicating the development is complete. The lamp driver circuit and the "beeper" circuits are combined on a single IC device.

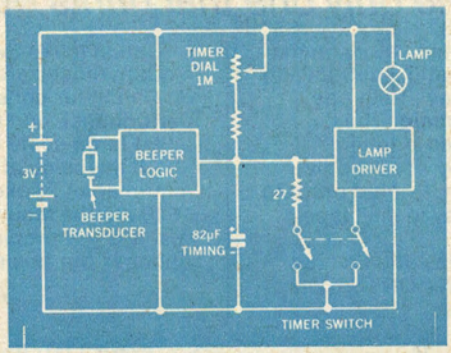
Yashica's first electronic shutter model to be sold in Australia was the Electro 35, which was introduced here in 1966. It was initially advertised as the camera with an "electronic brain", a description which caused it to sell very slowly at first because the general public was afraid it was too complicated and might be costly to repair.

Only after an extensive campaign to convince the public that an electronic shutter camera was simple to operate and more robust than an automatic aperture camera, did buyers begin to accept the concept. But what really caught the public's fancy was the discovery that perfectly timed exposures can be taken indoors without flash — even by candlelight. And the depth-of-field can be adjusted, even at low light levels, because small apertures can be compensated for by shutter speeds as slow as two or three seconds.

In addition to the Electro 35, which has a between-the-lens shutter, Yashica has recently introduced an advanced 35mm single lens reflex camera with a metal focal plane shutter and a wide range of high speed interchangeable lenses.

They have combined the electronic shutter circuits of the Electro 35 with a unique electronic exposure readout system to create a semi-automatic camera which retains the versatility of a manual camera, but is virtually automatic due to the ease with which the exposure can be read and programmed into the shutter circuit.

This model, called the Yashica TL Electro-X, is ideal for indoor still life photography because the scene can be viewed exactly as it will appear on film, and



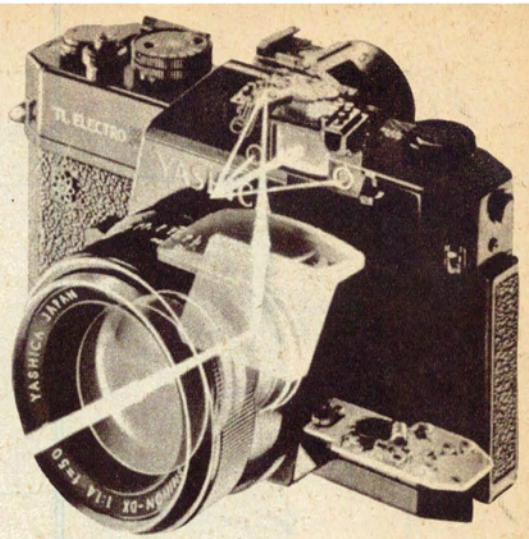
Functional block diagram of Polaroid's "beeper" circuit.

depth-of-field adjustments can be made through the stopped-down diaphragm. Since the CdS photocells are behind the lens and the exposure readout system operates when the diaphragm is stopped down to the selected f-stop, extremely accurate shutter speeds can be achieved.

The electronic shutter will operate at any speed between 1/1000 second and 2 seconds. If, for example, lighting and depth-of-field requirements dictate a shutter speed of 1/103.6 second, that is exactly the speed at which you would set the shutter dial.

Obviously one couldn't read a light meter to that degree of accuracy, so the camera provides exposure readout in the form of lighted red arrows just beneath the viewing screen.

If the exposure is too low for the film speed and aperture being used, the arrow



Yashica TL Electro-X.

pointing to the left comes on, indicating the correct direction to turn the shutter dial to compensate. For an overexposure condition, the right-pointing arrow comes on. When both arrows are off, the exposure is correct. The camera can be brought to the correct exposure by adjusting either aperture or shutter speed, meaning that either parameter can be preselected to suit conditions.

The readout circuit and the shutter circuit are integrated so that as the shutter speed dial is adjusted to balance the readout comparator circuit, the resistance in series with the shutter timing capacitor is also varied. (see illustration). The Polaroid shutter circuit, you will remember, varied the capacitance of the timing capacitor to adjust shutter speed; this is the major difference between the two circuits.

The Yashica shutter circuit is slightly more complex in that it has three transistors rather than two in its timing circuit, and has an extra switch and protective resistor which make up a special circuit for use in the "bulb" position of the shutter dial.

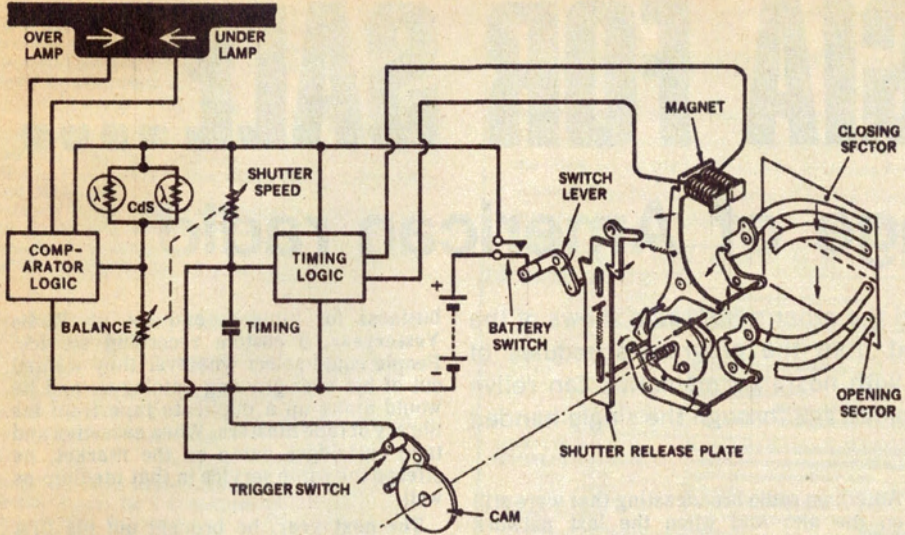
Its comparator circuit balances the current through the pair of CdS photocells (LDRs connected in parallel) against the current through a variable resistor which shares a common shaft with the shutter speed variable resistor.

Having two LDRs in parallel improves the accuracy of the light readout system because the current flowing through the two is averaged and each of the LDRs is positioned to "see" a different area of the picture.

The TL Electro-X is mechanically unique too, in that it has a focal plane shutter which moves vertically across the image area from top to bottom.

Because the shutter sectors travel over a shorter distance with a vertical run (by a factor of 3 to 2), the shutter can open and close faster. The shutter opens fully for any exposure under 1/125 second, as compared to 1/30 to 1/50 second for most focal plane shutters. Use of electronics for shutter timing control eliminates the need for a governor and many of the gears, springs and levers normally associated with focal plane shutters.

The principle of operation is very similar to that of the Polaroid shutter, though it is more complex. When the shutter release plate moves downward, both sectors are



Functional diagram of Electro-X shutter shows how it is integrated with the electronic exposure readout system.

mechanically released and the bottom one is pulled downward by spring action. At the same time, the battery switch closes to energise the circuits and the trigger switch opens to permit the timing capacitor to begin charging.

At the end of the time period, governed by the setting of the shutter speed variable resistor in series with the timing capacitor, the magnet is de-energised and the top sector moves down.

The TL Electro-X also contains a third electronic circuit in the form of a one transistor battery condition checker which lights a lamp to indicate the battery level is sufficient to operate the electronics.

Readers wanting additional information about the cameras described in this article can get it by means of the Reader Information Service coupons on page 128.