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SERVICING ELECTRONIC FLASH

There has long been a distinction between camera-repair and electronic-flash technicians — camera-repair technicians don't work on electronic flash and vice versa. But the trend toward building electronic-flash units into cameras may erase that distinction.

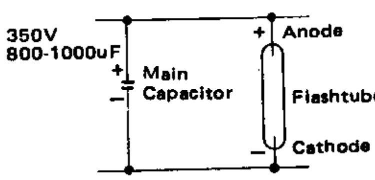


Figure 1. Flash Capacitor and Xenon Flashtube in Parallel

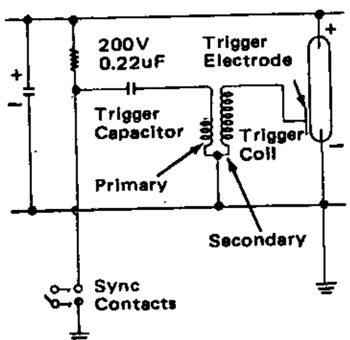


Figure 2. Flash Circuit with Trigger Coil and Sync Contacts

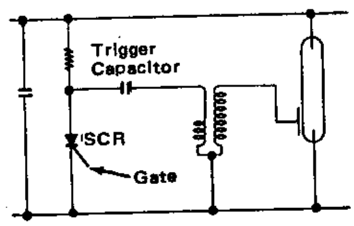


Figure 3. Low-Voltage Trigger Circuit As Used in the Vivitar 285

Fortunately, you don't have to be an electronics technician to work on a built-in flash unit. The built-in unit uses a basic, manual design which provides acceptable exposure over a limited distance range. An accessory flash unit using such a simple design may not be considered economical to repair – the parts costs may exceed the value of the unit. However, building the flash unit into the camera changes the situation. The camera cost may justify repairing the flash.

A simple flash unit consists of little more than a large capacitor connected in parallel with a xenon flashtube, Figure 1. The capacitor, normally called the "main capacitor", charges to a little over 300V in most units. When the main capacitor discharges through the flashtube, the large current surge causes the xenon gas to glow. Now the flashtube emits a brief, intense burst of light.

In Figure 1, though, the main capacitor can't discharge through the flashtube. The xenon gas in the flashtube acts as in insulator, holding the voltage on the main capacitor. To allow the main capacitor to discharge, it is first necessary to ionize the xenon gas. Once ionized, the zenon gas becomes a conductor with very little resistance.

The trigger circuit ionizes the gas by giving the flashtube a high-voltage pulse. Figure 2 shows a typical design. The secondary of the trigger coil connects to the trigger electrode of the flashtube, a metal contact near the cathode end. The primary of the trigger coil connects to the trigger capacitor.

When you turn on the flash unit, the trigger capacitor charges to 200 - 300V. But that voltage isn't enough to ionize the flashtube. The trigger coil, a step-up transformer, must increase the voltage to around 4,000 to 6,000 volts.

Closing the shutter's sync contacts allows the trigger capacitor to discharge through the primary of the trigger coil. The increasing current through the primary induces a voltage in the secondary, a stepped-up voltage that appears at the trigger electrode. Now the xenon gas ionizes, and the main capacitor discharges through the flashtube.

The design in Figure 2 is a "high-voltage trigger". If you measure the voltage across the sync contacts with the flash charged, you will get over 200V – the voltage across the trigger capacitor. With a hot-shoe unit, the high voltage appears between the contact at the bottom of the accessory-shoe base and the ground contact at the side. A high-voltage trigger eventually causes wear and tear on the shutter's sync contacts; the sync contacts have to carry the full current from the trigger capacitor.

Most hot-shoe units now use low-voltage triggers. If you measure the voltage across the hot shoe or across the flashcord connector, you will typically read around 4 to 8V. Figure 3 shows the low-voltage trigger used in the Vivitar 285. A silicon-controlled rectifier (SCR) is connected in series with the trigger capacitor. Normally, the SCR acts as an open switch. However, when a positive voltage is applied to the gate, the SCR turns on and acts as a closed switch. Turning on the SCR allows the trigger capacitor to discharge through the primary of the trigger coil.

Closing the shutter's sync contacts applies positive voltage to the SCR gate. The sync contacts carry only the low gate current. All the current from the trigger capacitor flows through the SCR.

The unit in Figure 2 still needs some way to charge the main capacitor to around 300V. Since most flash units use batteries, the battery voltage must be raised to the 300V needed across the main capacitor. A stepped-up transformer can provide the higher voltage. But the current from a battery cannot drive a transfromer alone; for the transformer to step up the voltage, the current through the primary must change in value. A changing current through the primary induces a high voltage in the secondary.

The oscillator circuit causes the battery current to change in value. A power transistor connects to the transformer primary as shown in Figure 4. Or the unit may use two transistors in parallel to increase the current capacity. When you close the switch to turn on the unit, base current flows through the base-bias resistor to turn on the power transistor. Now a surge of current flows through the primary, inducing a high voltage in the secondary.

The base of the power transistor also connects to the transformer secondary. As the high voltage appears across the secondary, the forward bias applied to the base drives the transistor into saturation.

Once saturated, the power transistor cannot conduct any more current. As a result, the current through the primary stops changing in value. Now the magnetic field collapses, reversing the polarity across the transformer secondary. The secondary then applies a reverse bias that shuts off the power transistor. When the secondary voltage drops too low to keep the power transistor switched off, the transistor again turns on and conducts current through the primary.

The power transistor thus switches on and off, providing a pulsating DC through the primary (Figure 5). A diode rectifies the pulsating DC to charge the main capacitor. The diode also prevents the main capacitor from discharging when the current changes direction.

As the charge across the main capacitor increases, the frequency of the oscillator also increases. The oscillator accounts for the audible hum when you turn on the flash unit – a hum that gets higher in pitch as the oscillator frequency increases.

Even the simple flash units add one more refinement – a circuit to tell you when the main capacitor has reached a sufficient charge. Typically, a voltage divider (Figure 6) applies part of the main capacitor voltage across a neon ready lamp. When the voltage across Rn in Figure 6 reaches a high enough value, the neon gas glows. The neon ready lamp normally turns on when the main capacitor reaches around 80 percent of its full charge.

A simple built-in unit frequently has no adjustment for the turn-on voltage of the neon ready lamp. The fixed resistance values in the voltage divider determine the main capacitor voltage at which the neon ready lamp turns on. But many units do provide an adjustment – a variable resistor in the voltage divider. To make the adjustment, measure the voltage across the main capacitor as the unit charges. Note the voltage reading when the neon ready lamp turns on. The factory normally specifies the proper voltage.

In the simple units, the oscillator continues to operate even after the main capacitor has reached its full charge. That is why owners often go through batteries so fast. The main capacitor draws a large surge of current when you first turn on the unit. But even with the main capacitor charged, the oscillator may continue to draw 100 to 200mA.

More sophisticated units add battery-saver curcuits. A battery-saver circuit senses the voltage across the main capacitor. When the voltage reaches a certain value, the battery-saver circuit shuts off the oscillator. The battery-saver circuit continues switching the oscillator on and off to hold the main capacitor voltage at the proper value.

Automatic Units

Although the units built into cameras are strictly manual, most accessory units are automatic. The automatic unit uses a light-sensitive sensor – normally a phototransistor – to sense the light reflected from the subject. When the auto circuit determines that the subject has received enough light, it shuts off the flashtube current.

Small units may still use the original automatic design – the quench tube. Here a xenon tube with 1/10 the resistance of the main flashtube (Figure 7) is connected in parallel with the main flashtube. While the main tube is ignited, the quench trigger circuit is fired by the auto circuit and causes the quench tube to conduct. Since electricity takes the path of least resistance, all the energy left in the main capacitor is discharged through

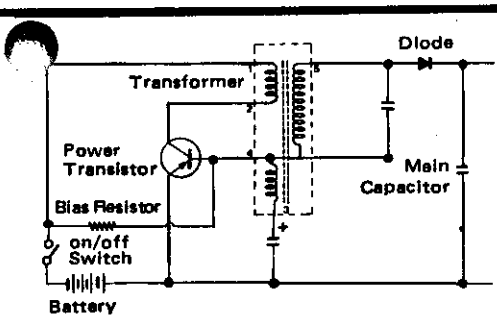


Figure 4. Typical Transistor Oscillator Circuit

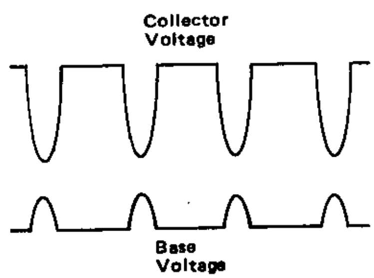


Figure 5. Waveforms of the Pulsating DC Current produced by the Transistor Oscillator Circuit

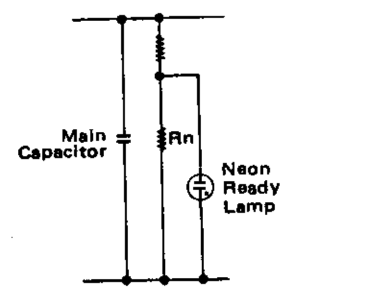


Figure 6. Typical Ready-Light Circuit

Fig

the quenchtube and shunted away from the main flashtube, thus quenching and controlling light output.

There is one drawback to the quench tube design. When the quench tube fires, it wastes the charge remaining in the main capacitor. For the next charging cycle, the main capacitor must start from scratch. That's not much of a drawback with the small units – a small unit usually needs practically all of the capacitor charge, anyway.

Larger units, though, can gain a faster recycle time and a longer battery life by saving the unused charge. In these units, the series thyrister has almost entirely replaced the quench tube. The thyristor is a silicon-controlled rectifier connected in a series with the flashtube. Turning on the SCR allows current to flow through the flashtube; turning off the SCR stops the current flow and maintains the charge remaining on the main capacitor.

When you first turn on the flash unit, the positive turn-on voltage appears at the SCR gate. The SCR is now like a closed switch, ready to conduct when you fire the flash. Turning off the SCR presents more of a problem. Simply removing the gate voltage won't do the job – once triggered on, the SCR continues to conduct with or without the gate bias.

One way to shut off the SCR is to remove the forward bias between the cathode and the anode. The SCR then turns off and remains off – until you restore the forward bias and once again apply a positive signal to the gate. But the flash unit turns off the SCR by applying a reverse bias. Figure 8 shows a typical design.

When you turn off the flash unit, the reverse-bias capacitor charges as indicated. As yet, the series SCR does not see the reverse bias. That is because the second SCR connected in series with the reverse-bias capacitor remains turned off.

The auto circuit shuts off the flash by turning on the second SCR. Now the second SCR becomes a closed switch, connecting the reverse-bias capacitor directly across the series SCR.

Some units use a quench tube rather than the second SCR. Figure 9 shows the design in the Vivitar 283. To turn off the flash, the auto circuit fires the quench tube. The quench tube then conducts, connecting the reverse-bias capacitor across the series SCR.

Most automatic units have indicators to tell you if the subject received enough light on auto operation. In Figure 9, firing the quench tube allows a current flow that turns on another neon lamp; the neon lamp tells you that the subject received proper flash exposure. However, if the subject is too far away, the quench tube does not fire and the neon lamp does not turn on.

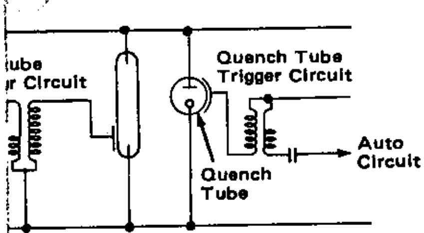
The sensing circuit usually consists of a phototransistor and a capacitor. With a phototransistor, the base lead is open. Light striking the base then provides the forward bias, controlling the current between the emitter and the collector. As the light on the base increases, the collector current increases. The collector current charges a capacitor. When the capacitor reaches a certain charge, it triggers on the second SCR or the quench tube.

Many units gain a variety of f-stop settings by allowing you to change the sensitivity of the phototransistor. Changing the f-stop setting may simply move a different aperture size in front of the base opening. Decreasing the sensitivity of the phototransistor allows you to use a smaller f-stop. The phototransistor must then see more light – or see light for a longer period of time – before it shuts off the flash.

Repairs and Troubleshooting

Many of the current hot shoe flash units have become very sophisticated electronically.

When you replace major components, you should check the adjustments and set them according to factory specifications. Most automatic units have at least two adjustments – one that sets the battery-saver, and a second that controls the flash output on auto. Ultimate, however, factory service manuals and schematics are your troubleshooting allies in both tracking down unusual malfunctions and providing the necessary information to set factory specifications.



e 7. Typical Quench Tube Circuit

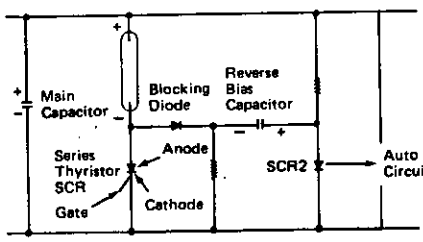


Figure 8. Typical Thyristor Circuit Using A Second SCR

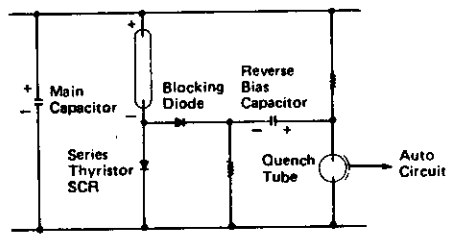


Figure 9. Thyristor Circuit in the Vivitar 283 Using a Quench Tube in place of the Second SCR

Space limitations prevented printing a list of Electronic Flash Troubleshooting Tips by Larry Lyells. For a free copy send a SASE to our Central Parts Department or request a copy be sent with your next parts order.

—Editor