

Activity B-2. Flash Duration and Intensity

Goal: To learn how to control the duration and intensity of the flash of light from a Vivitar 283

Prelab:

1. Read this entire activity before the lab period.
2. Prepare your lab book in the usual way.
3. Do the online reading questions.

Equipment:

- Vivitar 283 flash unit
- 4 AA batteries for flash power
- 100-k Ω variable resistor
- Auto thyristor extension cord
- Flash lens adapter and lens kit LK-1

Introduction: An important factor to control for high-speed photography is the *flash duration*, that is, the amount of time the flash of light lasts. Typically, one wants the shortest possible burst of light. Figure 1 shows the intensity of the light vs. time for a full discharge. The intensity is not constant but rather increases from 0 to a maximum in about 0.3 ms.¹ The intensity then decreases more gradually over a period of about a millisecond. This is too long for high-speed photographs. However, if the flash unit is used in the *automatic exposure* mode,² the duration can be decreased to as little as 30 μ s.³ Such a discharge is represented in Figure 2. Note that the time scale is expanded by a factor of 50 over that of Figure 1. The intensity scale is expanded by about a factor of 10, pointing to the fact that decreasing the duration of the flash also decreases the brightness. A 30- μ s burst will be quite dim compared to a full discharge. However, there will still be sufficient light for photography.

The photographs below the graphs illustrate the effect of flash duration on moving subjects.

¹ The abbreviation, *ms*, stands for millisecond. The prefix, *milli-*, represents thousandths. Thus, 1 ms = 0.001 s (second).

² In the automatic mode, the light reflected by the subject is detected by a photoresistor in the auto-thyristor module on the front of the 283. A small capacitor in series with the photoresistor charges through it. When the voltage across the capacitor reaches some predetermined amount, the flash discharge is quenched.

³ The abbreviation, *μ s*, stands for microsecond. The prefix, *micro-*, represents millionths. Thus, 1 μ s = 0.001 ms = 0.000001 s.

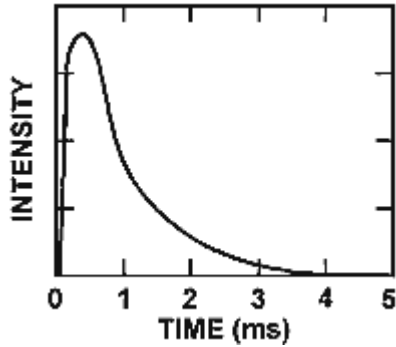


Figure 1. Intensity vs. time for full discharge of a flash unit

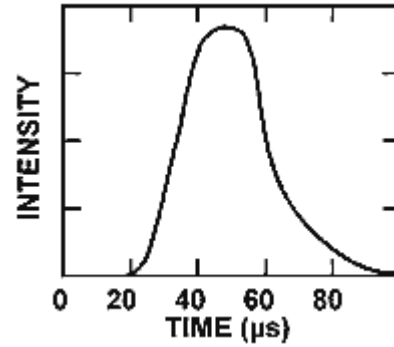
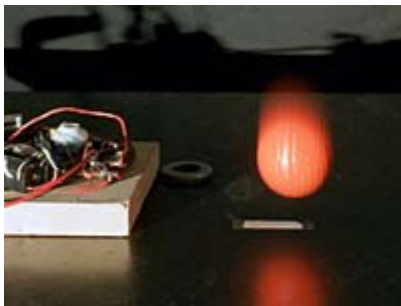


Figure 2. Intensity vs. time for a quenched discharge of a flash unit



A golf ball was dropped onto a black table for this photograph. The sound trigger on the left detected the sound of the collision and discharged the flash unit. The flash was set in manual mode so that the duration of the discharge would be a maximum. Note first that the ball is on the rebound, moving up. The top of the ball shows significant blur. This effect, called afterglow, results from the gradual decay of light intensity as shown in Fig. 1. Note also that the trailing side of the ball is sharp. Here the intensity from the flash is rising steeply to a maximum.



For this photograph, a golf ball and a rubber ball were dropped together beside a post. The sound trigger is not visible this time. The automatic-exposure circuit of the flash unit was used in order to shorten the flash duration to approximately $1/30,000$ second. There is no blurring this time and the printing on the ball is visible.

In order to obtain the briefest flash of light, one needs to arrange for the intensity of the reflected light to be as great as possible.⁴ This activity will show how to do that.

⁴ This results because the resistance of the photoresistor (see Footnote 3) decreases as the light intensity increases. The lower the resistance, the quicker the series capacitor will charge.

Method: Note the small, circular window on the front of the auto thyristor module as shown in Figure 3. This window allows light to reach a light detector⁵ inside the module. Light must reach this detector in order for the flash unit to operate in its automatic mode. In the M (manual) setting, the window is completely covered, and the flash unit produces its brightest and longest flash of light. For each of the colored settings--yellow, blue, red, purple--a different *neutral-density filter* is rotated in place over the light detector. Figure 4 shows the color settings on a disassembled module, and Figure 5 shows the neutral-density filters. These filters reduce the intensity of light reaching the light detector. The darker the filter, the brighter and longer the flash of light will be⁶ For high-speed photography, the most transparent filter would be used in order to obtain the shortest flash duration. You may ask the instructor to show you the disassembled end sensor.



Figure 3. Vivitar 283 with auto thyristor module removed



Figure 4. Disassembled auto thyristor module



Figure 5. Neutral-density filters from an auto thyristor module

Energize your flash unit batteries for this activity.

1. Which of the colored settings gives the shortest flash duration? Which gives the longest? In order to find out, aim the flash unit at a distant wall, making sure to keep the window over the light detector uncovered. Place the flash unit in each of the colored automatic modes in turn, and discharge the flash unit. Which mode gave the brightest flash? Which gave the dimmest? Remember that the brighter the flash, the longer it lasts.
2. Another way to change the amount of light reflected to the light detector is to change the distance from the flash unit to the subject. Try this by discharging the flash when it is very close to the wall and then again when it is as far away as you can get it. (This may work better in the hallway.) Use the yellow automatic mode. Did you get the brighter flash when

⁵ This is the photoresistor referred to in Footnote 5.

⁶ One would use darker filters in order to use smaller apertures for greater depth-of-field. For high-speed photography, however, the greater flash duration that results is usually undesirable.

the unit was closer or further from the wall? Based on material in the introduction, explain why this result is to be expected.

Tip: In addition to minimizing flash duration, using the yellow automatic mode will maximize battery life. Therefore, whenever possible when using batteries, be sure the flash unit is placed in the yellow mode and that the flash head is in the 90° position so that the reflected light reaches the photocell in the auto-thyristor. Be sure, of course, that nothing covers the detector.

3. The Vivitar 283 has a feature that makes it possible to conveniently adjust flash duration. That feature is the ability to remove the auto-thyristor module. Pull it straight out, away from the flash unit. This will expose an arrangement of five holes, as shown in Figure 6. The two holes on the right (as seen with the flash unit upright and facing you) are the connections for the light detector. By inserting the leads of a variable resistor into these two holes as shown in Figure 7, you can control the flash duration (and brightness) directly. Try this now with the 100-k Ω variable resistor. Note that turning the resistor counterclockwise increases the resistance.



Figure 6. Auto thyristor module pulled out, revealing a socket of 5 holes



Figure 7. Variable resistor replacing auto thyristor module

Tip: Often in high-speed photography, one wants the shortest possible flash duration. In that case, one need not use the variable resistor described above. Simply short across the two holes in the sensor socket with a stiff wire. A paper clip works fine, as shown to the right.



4. Another way to influence flash duration with the Vivitar 283 is with the use of a sensor extension cord. This cord, which is shown in Figure 8, allows the sensor to be placed about 4 feet from the flash unit. One could, for example, place the sensor in a location facing the flash unit so that the direct light of the flash reaches the photocell. The intensity would therefore be much greater than if the sensor were used in the normal way to detect reflected light. Try this now and give your results.



Figure 8. Sensor extension cord

5. When the flash unit is set for short duration, one may find it difficult to get sufficient intensity to light the subject for a photograph. One way to boost the intensity on the subject is to use a focusing filter on the flash. Several such filters are provided with the LK-1 lens kit. In order to use one, first mount the flash lens adapter on the flash unit. Then select the appropriate filter and slip it into the slot on the adapter. The telephoto filters focus the light to increase intensity. The wide-angle filters defocus the light in order to provide greater coverage for wide angle shots. The flash lens adapter and a filter are shown in Figure 9.



Figure 9. Flash lens adapter and focusing lens