perplexity

Q5: Human Visibility Range for LED Blinking

What is the fastest and slowest LED blinking the human eye can distinguish?

- **Human Perception Range:**
  - The human eye can perceive individual ON and OFF states when an LED blinks at **less than about 50–60 Hz**.[1] [2] [3]
  - **Below ~30 Hz:** The blinking is obvious and can be clearly seen as ON/OFF flashes.
  - **Between 60 and 90 Hz:** Flicker becomes harder to spot, but sensitive people may still detect it (especially at high brightness or contrast)
  - **Above ~100 Hz:** For almost everyone, the LED appears ON continuously; any flicker is imperceptible in normal viewing.[2] [3] [1]
  - **Exception:** In special conditions (moving your eyes quickly, high-contrast environments, very bright LEDs), a few people can perceive flicker at much higher rates, even up to several hundred Hz.[4]

Typical delays and what you see:

- A 1 Hz blink (one cycle per second): Very easy to see ON/OFF flashes.
- 10 Hz: Still easily visible as flashing
- 50 Hz: Flickering is barely noticeable for many people (most will say it's steady)
- 100 Hz or more: Basically continuous, no flicker seen

Minimum delay human can notice?

- To see ON/OFF clearly, the LED should spend at least about **10–20 ms ON, 10–20 ms OFF** each cycle (i.e., blink period at least 40 ms, or about 25 Hz)

Summary Table:

Blink Frequency (Hz)	Typical Perception	Delay per Blink (ms)
1	Very slow, obvious	1000
10	Obvious ON/OFF	100
25	Fast but visible	40
50	Hard to see flicker	20
100+	No flicker seen	10

So, if you want to make a LED blink and have a human see distinct ON and OFF states, use delays so the total ON+OFF time per cycle is no less than 20–30 ms.[3] [1] [2]

If you'd like, I can show how to set your DELAY routine to make a visible blink in code, or explain how to measure/calculate the required delay value for "seen by humans" — just let me know!

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1. https://pmc.ncbi.nlm.nih.gov/articles/PMC8537539/
2. https://en.wikipedia.org/wiki/Flicker_fusion_threshold
3. https://www.flickersense.org/led-health-effects
4. https://www.nature.com/articles/srep07861
5. https://forum.allaboutcircuits.com/threads/blinking-led-and-the-human-eye-perception.185903/
6. https://www.reddit.com/r/askscience/comments/blzz4o/at_what_frequency_can_human_eye_detect_flashes/
7. https://lenalighting.com/company/knowledge-base/1714-why-are-the-leds-blinking-flickering-light-effect-in-led-luminaires
8. https://planetbanatt.net/articles/framerate.html