

Shorting pin loaded dual-band compact rectangular microstrip antenna

Chaitanya Pande and Swrangsar Basumatary

IIT Bombay, Powai

November 27, 2013

LEDs vs Laser Diodes for short-range communication

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster?

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper
- safer for the human eyes

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper
- safer for the human eyes
- less sensitive to temperature variations

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper
- safer for the human eyes
- less sensitive to temperature variations
- and more durable

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper
- safer for the human eyes
- less sensitive to temperature variations
- and more durable

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper
- safer for the human eyes
- less sensitive to temperature variations
- and more durable

Disadvantage of using LEDs

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper
- safer for the human eyes
- less sensitive to temperature variations
- and more durable

Disadvantage of using LEDs

- The problem with LED is

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper
- safer for the human eyes
- less sensitive to temperature variations
- and more durable

Disadvantage of using LEDs

- The problem with LED is *low modulation rate!*

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper
- safer for the human eyes
- less sensitive to temperature variations
- and more durable

Disadvantage of using LEDs

- The problem with LED is *low modulation rate!*
- While laser diodes have reached to tens of Gbps,

LEDs vs Laser Diodes for short-range communication

Why use LEDs when Laser Diodes are faster? For broadband short-range optical fiber communications, like LANs and Fiber-in-the-Home networks, LEDs are:

- cheaper
- safer for the human eyes
- less sensitive to temperature variations
- and more durable

Disadvantage of using LEDs

- The problem with LED is *low modulation rate!*
- While laser diodes have reached to tens of Gbps, commercial DH-LED (double heterostructure) is still limited at 100 Mbps.

Efforts that were not successful

Efforts that were not successful

Efforts have been made to get upto 500 Mbps for conventional LEDs using

Efforts that were not successful

Efforts have been made to get upto 500 Mbps for conventional LEDs using

- multilevel Pulse Amplitude Modulation (M-PAM)

Efforts that were not successful

Efforts have been made to get upto 500 Mbps for conventional LEDs using

- multilevel Pulse Amplitude Modulation (M-PAM)
- and discrete multitone modulation (DMT)

Efforts that were not successful

Efforts have been made to get upto 500 Mbps for conventional LEDs using

- multilevel Pulse Amplitude Modulation (M-PAM)
- and discrete multitone modulation (DMT)

But these techniques are *highly complex* compared to the simple on-off keying (OOK) direct modulation scheme.

Limitations of OOK modulation rate for LED

Limitations of OOK modulation rate for LED

OOK direct modulation rate of LED is limited by two factors:

Limitations of OOK modulation rate for LED

OOK direct modulation rate of LED is limited by two factors:

- 1 spontaneous carrier recombination lifetime

Limitations of OOK modulation rate for LED

OOK direct modulation rate of LED is limited by two factors:

- 1 spontaneous carrier recombination lifetime
 - depends on the material and thus it's beyond our control

Limitations of OOK modulation rate for LED

OOK direct modulation rate of LED is limited by two factors:

- 1 spontaneous carrier recombination lifetime
 - depends on the material and thus it's beyond our control
 - typically in the range of a few nanoseconds

Limitations of OOK modulation rate for LED

OOK direct modulation rate of LED is limited by two factors:

- ① spontaneous carrier recombination lifetime
 - depends on the material and thus it's beyond our control
 - typically in the range of a few nanoseconds
- ② response time (rise time + decay time) of the LED

Limitations of OOK modulation rate for LED

OOK direct modulation rate of LED is limited by two factors:

- ① spontaneous carrier recombination lifetime
 - depends on the material and thus it's beyond our control
 - typically in the range of a few nanoseconds
- ② response time (rise time + decay time) of the LED
 - depends on capacitance and dynamic resistance of p-n junctions

Limitations of OOK modulation rate for LED

OOK direct modulation rate of LED is limited by two factors:

- ① spontaneous carrier recombination lifetime
 - depends on the material and thus it's beyond our control
 - typically in the range of a few nanoseconds
- ② response time (rise time + decay time) of the LED
 - depends on capacitance and dynamic resistance of p-n junctions
 - *but this can be controlled!*

Limitations of OOK modulation rate for LED

OOK direct modulation rate of LED is limited by two factors:

- ① spontaneous carrier recombination lifetime
 - depends on the material and thus it's beyond our control
 - typically in the range of a few nanoseconds
- ② response time (rise time + decay time) of the LED
 - depends on capacitance and dynamic resistance of p-n junctions
 - *but this can be controlled!*

So, the only way to increase OOK modulation rate of LED is by *reducing the rise and decay times of the **EL** signal.*

Ways to reduce the response time

Ways to reduce the response time

We look at *two* promising ways of improving the response time of the LED have been found upto now

Ways to reduce the response time

We look at *two* promising ways of improving the response time of the LED have been found upto now

- ① using highly-doped InGaAsP/InP Surface Emitting LED with high current density

Ways to reduce the response time

We look at *two* promising ways of improving the response time of the LED have been found upto now

- ① using highly-doped InGaAsP/InP Surface Emitting LED with high current density
- ② using Novel LED's driver circuit

Response of an InGaAsP/InP SE LED

Response of an InGaAsP/InP SE LED

In an undoped InGaAsP/InP Surface Emitting LED

Response of an InGaAsP/InP SE LED

In an undoped InGaAsP/InP Surface Emitting LED

- the rise time decreases with increasing current

Response of an InGaAsP/InP SE LED

In an undoped InGaAsP/InP Surface Emitting LED

- the rise time decreases with increasing current
- but the decay time is higher than the rise time and independent of current

Response of an InGaAsP/InP SE LED

In an undoped InGaAsP/InP Surface Emitting LED

- the rise time decreases with increasing current
- but the decay time is higher than the rise time and independent of current

Response of an InGaAsP/InP SE LED

In an undoped InGaAsP/InP Surface Emitting LED

- the rise time decreases with increasing current
- but the decay time is higher than the rise time and independent of current

But with *heavy zinc-doping concentration* in the active layer and low impedance driving circuit the fall time decreases.

References

References

- P. H. Binh, V. D. Trong, C.T. Anh, P. Renucci, X. Marie, C. T. Truong, A. T. Pham, "Novel LED's Driver Circuit for Broadband Short-Range Optical Fiber Communication Systems," *Communications and Electronics (ICCE), 2012 Fourth International Conference on*.
- Akira Suzuki, Toshio Uji, Yasumasa Inomoto, Junji Hayashi, Yoichi Isoda, and Hidenori Nomura, "InGaAsP/InP 1.3- μ m Wavelength Surface-Emitting LED's for High-Speed Short-Haul Optical Communication Systems," *IEEE Transactions on Electron Devices*, December 1985.