# Power saving ad-hoc
# Laser temperature stability analysis

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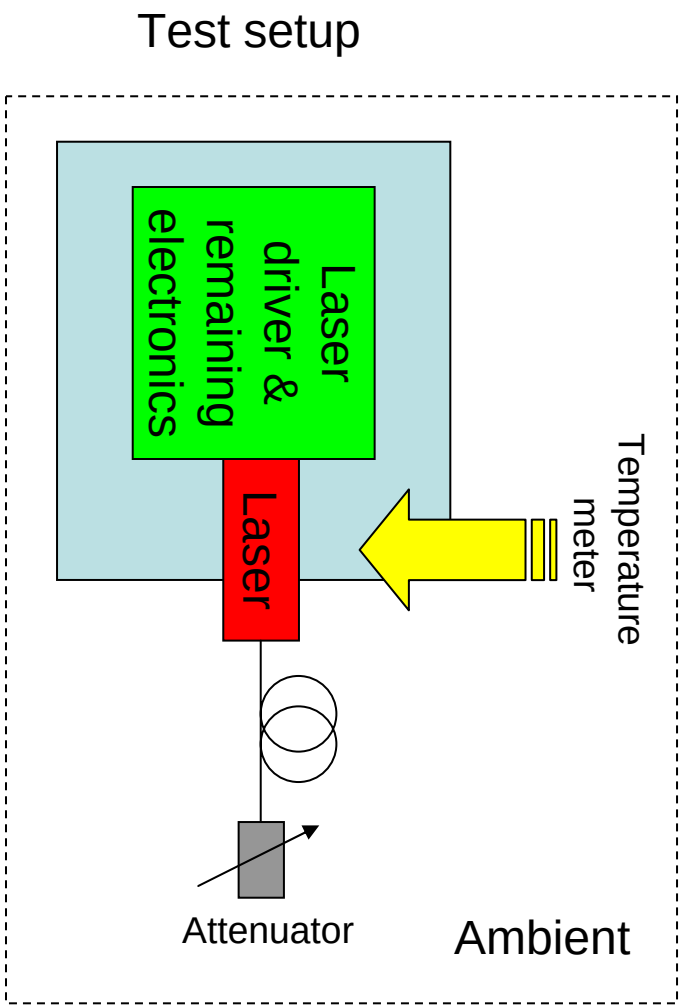
# Motivation

- Power saving ad-hoc discussions:
  - concerns about variations in laser casing temperature (TL) were identified.
  - deep laser off (DC & AC current shut down) state is different from regular laser operation.
    - under regular laser operation. DC current is applied to laser even when not transmitting – AC current is off
    - under complete power off. DC current is also disabled – laser temperature may suffer larger variation between on and off state than under regular operation

# Experimental setup for 1.25 / 10.3125 Gb/s lasers




- Test setup description:
  - ambient temp = 25.5°C
  - laser case temperature measured after stabilization (2-3 minutes after test start)
  - temperature meter accuracy = ±0.1°C
- During tests. laser is connected to the circuit board
- During the on/off ratio test. the circuit board is still powered on. when the laser is powered off

# 1.25 Gb/s laser temperature measurement [1]

- Experiment setup and test conditions as described on slide 2
  - initial ambient temperature $T_A$ = 25.5°C
  - ambient temperature varies slightly during testing ($T_A$)
  - laser case temperature ($T_L$) measured after stabilization (approx. 2-3 minutes after test start)
  - temperature meter accuracy = 0.1°C
- Measurement results for on/off case:

| | **ON / OFF ratio** | **Laser case temp ($T_L$)** | **Ambient temp ($T_A$)** | **$\Delta T = T_L - T_A$** |
|---|---|---|---|---|
| **Laser off** | 0/100 | 33.0 | 25.5 | 7.5 |
| **Laser on** | 100/0 | 33.6 | 25.6 | 8.0 |

# 1.25 Gb/s laser temperature measurement [2]

- Measurement results for varied pulse lengths:

| X | ON / OFF ratio | Laser case temp ($T_L$) | Ambient temp ($T_A$) | $\Delta T = T_L - T_A$ |
|---|---|---|---|---|
| **Pulse width 10ms** | 25/75 | 32.6 | 25.7 | 6.9 |
| | 40/60 | 32.8 | 25.7 | 7.1 |
| | 60/40 | 32.9 | 25.6 | 7.3 |
| | 75/25 | 32.9 | 25.6 | 7.3 |
| **Pulse width 1ms** | 25/75 | 33.1 | 25.9 | 7.2 |
| | 40/60 | 32.7 | 25.8 | 6.9 |
| | 60/40 | 32.8 | 25.7 | 7.1 |
| | 75/25 | 33.0 | 25.7 | 7.3 |
| **Pulse width 100us** | 25/75 | 33.4 | 25.5 | 7.9 |
| | 40/60 | 33.5 | 25.5 | 8.0 |
| | 60/40 | 33.5 | 25.5 | 8.0 |
| | 75/25 | 34.0 | 25.5 | 8.5 |

# 1.25 Gb/s laser temperature measurement [3]

- Observations:
  - temperature difference is only 0.6°C between laser on and laser off cases
  - temperature difference ($\Delta T$) between laser and ambient ranges from 6.9°C to 8.0°C
  - minimum impact of the duty cycle is observed
    - for 10ms pulse. $T_L$ increases by only 0.3°C
    - for 1ms pulse. $T_L$ oscillates around 33.0°C
    - for 100µs pulse. $T_L$ increases by only 0.6°C
  - 10 µs pulse test not conducted due to signal generator limitations

# 10.3125 Gb/s laser temperature measurement [1]

- Experiment setup and test conditions as described on slide 2
  - initial ambient temperature $T_A$ = 24.0°C
  - ambient temperature varies slightly during testing ($T_A$)
  - laser case temperature ($T_L$) measured after stabilization (approx. 2-3 minutes after test start)
  - temperature meter accuracy = 0.1°C
  - 1310 nm. DML laser was tested
- Measurement results for on/off case:

| | ON / OFF ratio | Laser case temp ($T_L$) | Ambient temp ($T_A$) | $\Delta T = T_L - T_A$ |
|---|---|---|---|---|
| **Laser off** | 0/100 | 31.0 | 24.0 | 7.0 |
| **Laser on** | 100/0 | 33.7 | 24.0 | 9.7 |

# 10.3125 Gb/s laser temperature measurement [2]

- Measurement results for varied pulse lengths:

| X | ON / OFF ratio | Laser case temp ($T_L$) | Ambient temp ($T_A$) | $\Delta T = T_L - T_A$ |
|---|---|---|---|---|
| **Pulse width 10ms** | 25/75 | 31.9 | 24 | 7.9 |
| | 40/60 | 32.2 | 24 | 8.2 |
| | 60/40 | 32.5 | 24 | 8.5 |
| | 75/25 | 32.8 | 23.9 | 8.9 |
| **Pulse width 1ms** | 25/75 | 31.8 | 23.9 | 7.9 |
| | 40/60 | 32.0 | 23.8 | 8.2 |
| | 60/40 | 32.2 | 23.8 | 8.4 |
| | 75/25 | 32.4 | 23.8 | 8.6 |
| **Pulse width 100us** | 25/75 | 31.3 | 23.8 | 7.5 |
| | 40/60 | 31.5 | 23.8 | 7.7 |
| | 60/40 | 31.6 | 23.8 | 7.8 |
| | 75/25 | 31.8 | 23.8 | 8.0 |

# 10.3125 Gb/s laser temperature measurement [3]

- Observations:
  - larger temperature difference of 2.7°C between laser on and laser off cases
  - temperature difference ($\Delta T$) between laser and ambient ranges from 7.5°C to 8.9°C
  - minimum impact of the duty cycle is observed
    - for 10ms pulse. $T_L$ increases by only 0.9°C
    - for 1ms pulse. $T_L$ increases by only 0.4°C
    - for 100µs pulse. $T_L$ increases by only 0.5°C
  - 10 µs pulse test not conducted due to signal generator limitations

# Conclusions

- Laser casing temperature increases along with increase in the duty cycle (on/off ratio)
  - anticipated result. since laser stays on longer
  - temperature gradient below 1°C (insignificant)
- Largest temperature gradient observed between 100% on and 100% off cases
  - only 0.6°C for 1.25 Gb/s device
  - 2.7°C for 10.3125 Gb/s device
- Observed temperature changes cannot damage LDs and are within normal operation conditions