Driving Laser Diodes

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Integrated Circuits
GERMANY

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Introduction

iC-Haus
- Founded in 1984 by Dr. Heiner Flocke and Manfred Herz
- ASiC/ASSP manufacturer (Si-fabless)
- 160 employees world wide
- Annual sales $30 millions
Introduction

Integrated Circuits

- ASiCs
- ASSPs
- Analogue, Digital
- Mixed Signal
- Opto iCs, Hall iCs
- Power iCs
- Industrial and automotive applications

Introduction

iC-Haus’ third extension

- 38,500 sq ft → 81,000 sq ft production and R & D floor space
- → 6,500 sq ft cleanroom (Class < 10 k)
- COB packaging facility
Introduction

Who is Uwe M. Malzahn?

- Graduated in 1991 from the University Darmstadt in Solid State Electronics
- Joined iC-Haus as an R&D engineer in 1991
- Since 2000 Sales and Applications Manager at iC-Haus
- Attending to the laser diode drivers and optical sensors amongst others

Why this webinar?

- Help to better understand laser diode characteristics
- Replace uncertainty with confidence when choosing a driver
- Shed some light onto the working principles of the different drivers and operation modes
- Explain the advantages of integrated laser diode drivers by iC-Haus
# Characteristics of laser diodes

- The laser diode basics
- Driver selection criteria

## APC or ACC?
- ACC
- APC

## Solutions available by iC-Haus
- Why use an integrated driver?
- Operating laser diodes in CW mode
- Operating laser diodes in pulsed mode

### The laser diode basics

- Optical output vs. laser current
- Variation over temperature
- Pin configuration (if applicable)

### Characteristics

**M–Type**

**N–Type**

**P–Type**
What kind of laser diode do we have?

With or without monitor diode?
- With ⇒ output power control (APC)
- Without ⇒ current source resp. current control (ACC)

Do the required currents match the driver’s specification?
- Driver must provide the required laser diode current
- Driver must be able to process the corresponding monitor current

Which pin type configuration?
- Driver must support the configuration (alternative monitor input?)
- Power supply must match the configuration (single supply?)

Laser diode configurations
How does it work?

**ACC**
(Automatic Current Control)

- Constant current
  - Fixed current (no danger of overcurrent)
  - Requires constant temperature for constant output power
  - Additional TEC controller required
- Mostly low volume “research” resp. ultra highspeed data transmission applications

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**APC**
(Automatic Power Control)

- Current from the integrated monitor diode closes the control loop
- Constant optical output power
- Risk of overcurrent with self heating or ageing effects of the laser diode
Conclusion

iC-Haus ICs focus on APC
- Targeting industrial clientele
- Industrial sensor principles and applications usually require constant optical power

Why use an integrated driver at all?

IC vs. discrete solution
- Lower part count (< 1:4)
- Lower board space (≪ 1:4)
- Lower assembly costs
- Higher reliability (> 4)
- Excellent performance
  - High precision (< 1%)
  - High temperature stability (integrated band-gap reference)
  - Integrated reverse polarity protection (iC-WK family)
### Configurations covered by the iC-Haus CW drivers

<table>
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<th>Driver IC</th>
<th>Optimised for</th>
<th>N-type</th>
<th>M-type</th>
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<td>P-type</td>
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</tbody>
</table>

1 Laser diode case cannot be grounded
2 Alternative monitor input utilised

### Modulation

What does “modulation” stand for with CW drivers?
- “Analogue modulation”
- Modulation depth ≪ 100%
- Superimposed control loop
- Sinusoidal (or other shape) output
Modulation

How is it done?
- Modulation of the setup input
- Utilising the second monitor input (iC-WK family only)
- Maximum modulation frequency limited by corner frequency of the control circuit (typ. several 10 kHz)

Pulsed operation

What does “pulsed operation” mean?
- “On/off” modulation
- Modulation depth near or equal 100%
- Control principles
  - “Switched” CW mode (low frequencies)
  - Averaging control (moderate to high frequencies)
  - “Peak Control” (low to high frequencies)
  - “Burst mode” with a “learned” output power (high to ultra high frequencies)
The control principles in detail

Switched CW operation

- iC-WK family, iC-WJ family drivers
- Most simple approach
- Power on/off or switching input
- Limited by turn-on/turn-off time (ca. 1 kHz max.)
- Pulse delay by turn-on/turn-off time
**Averaging control**

- iC-VJ, iC-WJ family drivers, (iC-HK plus iC-WK)
- Simple, established approach
- Works well with most applications
- Lower frequency limited by averaging capacitor
- Requires fixed duty cycle
- Turn-on delay
The control principles in detail

Peak control
- iC-NZ
- Most flexible approach
- Widest operation frequency range
- Variable and wide duty cycle range
- Turn-on delay after long pauses
- “Burst mode” for very high frequencies

Range covered by iC-Haus drivers

Laser diode current

300 mA
200 mA
100 mA

Frequency

iC−WKP
iC−WKN
iC−WKL
iC−WKB
iC−WKM
iC−WJ
iC−WJZ
iC−VJ
iC−VJZ
iC−HK
iC−HKB
iC−NZ

Variable and wide duty cycle range
Widest operation frequency range
Most flexible approach
“Burst mode” for very high frequencies
Turn-on delay after long pauses
Peak control

Uwe M. Malzahn (iC-Haus GmbH)
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Conclusion

Benefit from using iC-Haus laser diode drivers!

- Large range of laser diodes and (industrial) applications covered by iC-Haus laser diode drivers
- Low part count and board space required
- Easy setup
- Safe operation and high reliability
- Excellent application support

For Further Reading

Uwe M. Malzahn
Driving Diode Lasers