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 $\rightarrow$ 81,000 sq ft production and R & D floor space
- $\rightarrow$ 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

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Introduction

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

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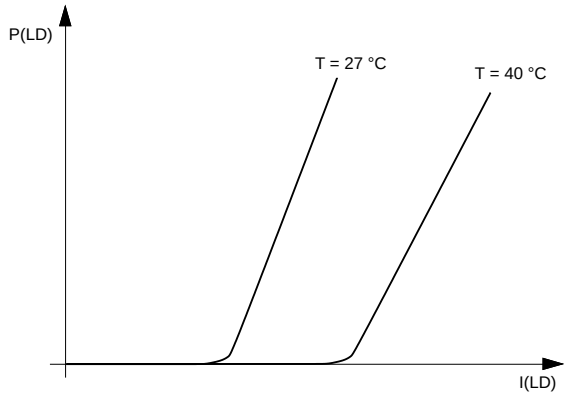
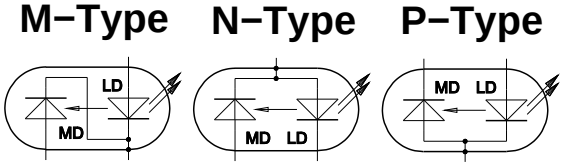
Outline

The laser diode basics



Characteristics

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



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?)

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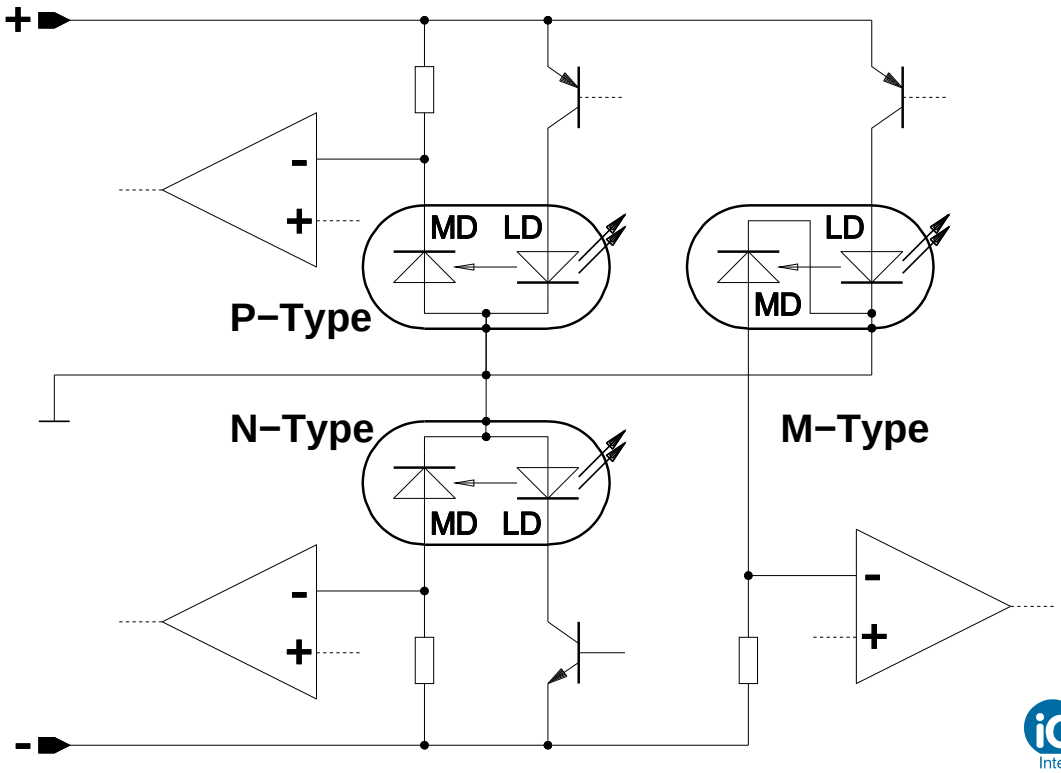
Laser diode configurations



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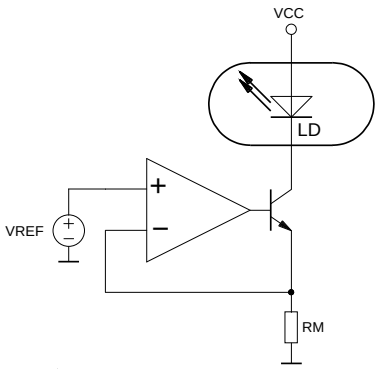
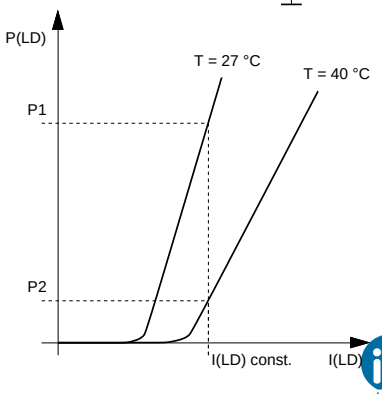
How does it work?

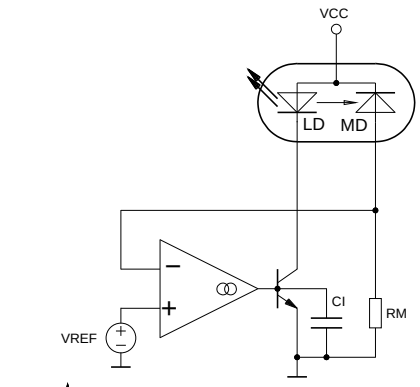
ACC (Automatic Current Control)

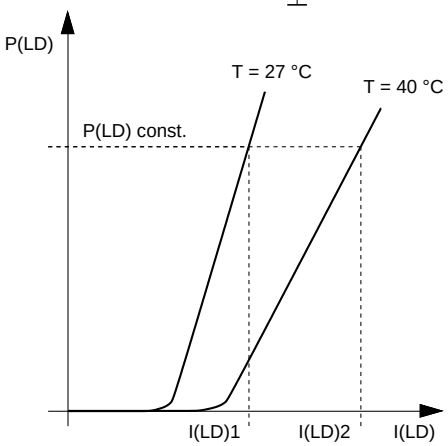
- Constant current
  - Fixed current (no danger of overcurrent)
  - Requires constant temperature for constant output power
  - Additional TEC controller required
- Mostly low volume “research” resp. ultra highspeed data transmission applications





How does it work?





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

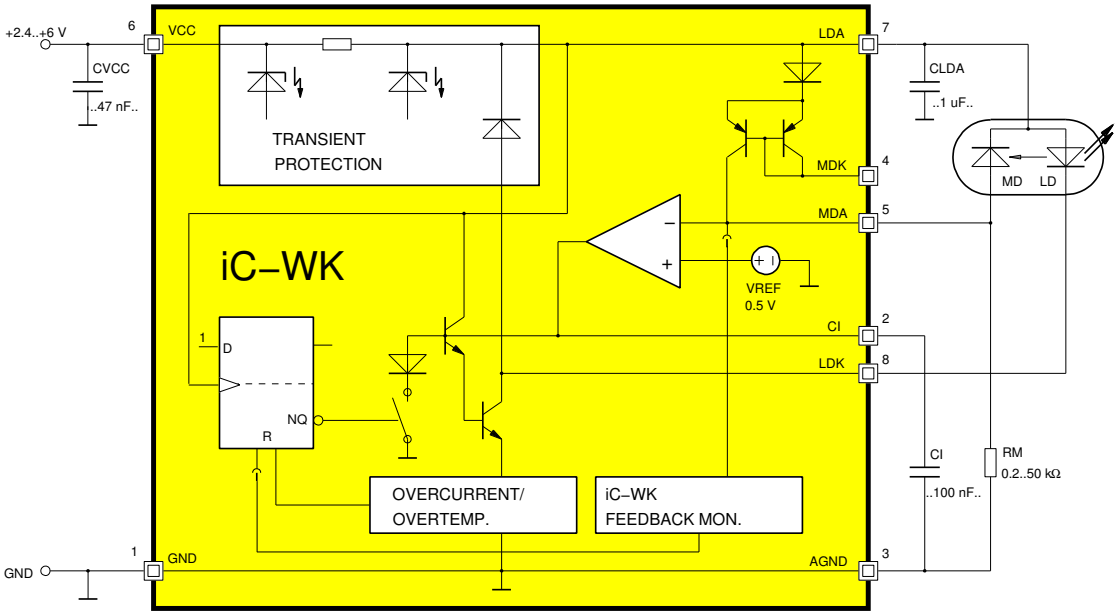
- Targetting industrial clientele
- Industrial sensor principles and applications usually require constant optical power

Why use an integrated driver at all?

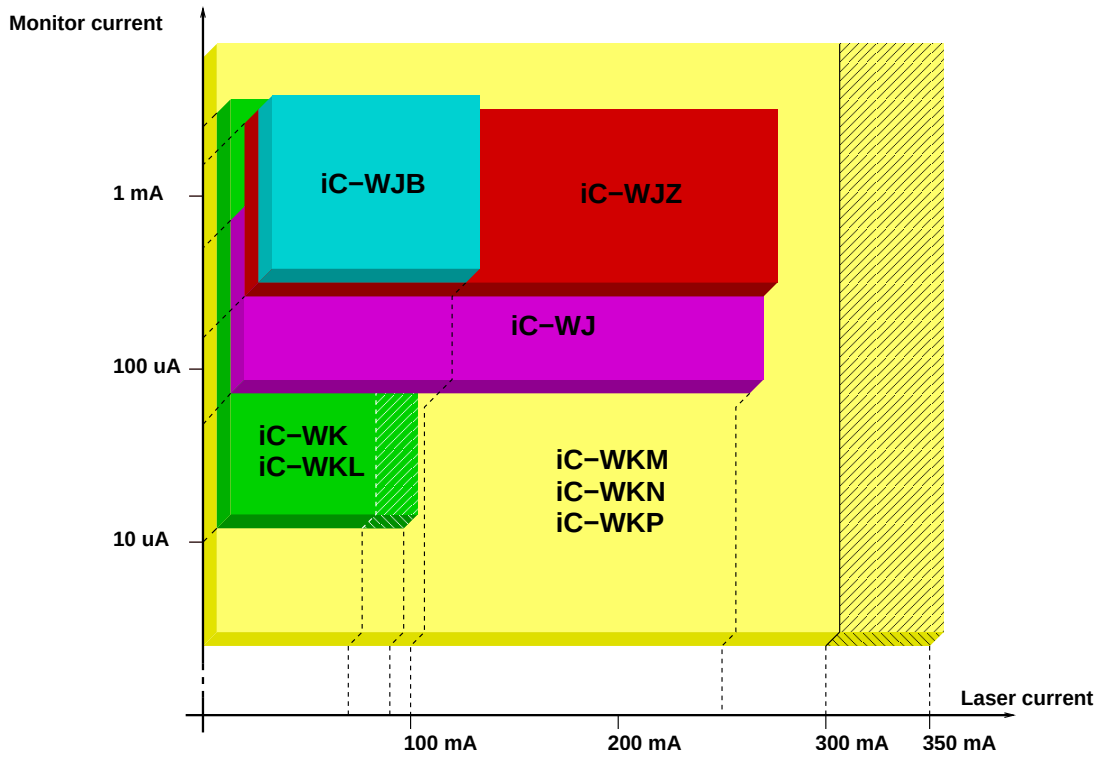
IC vs. discrete solution

- Lower part count ($<$ 1:4)
- Lower board space ($\ll$ 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)

Easy to set up



Laser/monitor current range covered



Configurations covered by the iC-Haus CW drivers

Driver IC	Optimised for	N-type	M-type	P-type
iC-WK/L	N-type	**yes**	yes[1]	yes[12]
iC-WKN	N-type	**yes**	yes[1]	yes[12]
iC-WJ/Z	N-type	**yes**	yes[1]	no
iC-WJB	N-type	**yes**	yes[1]	no
iC-WKM	M-type	yes[1]	**yes**	yes[2]
iC-WKP	P-type	yes[12]	no	**yes**

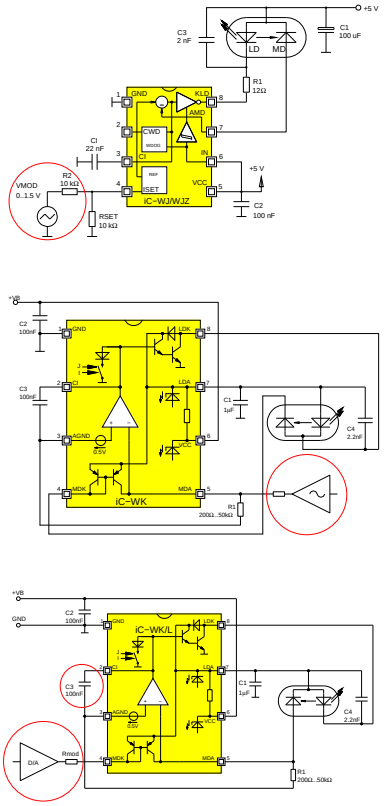
[1] Laser diode case cannot be grounded
[2] Alternative monitor input utilised

Modulation

What does “modulation” stand for with CW drivers?

- “Analogue modulation”
- Modulation depth $\ll$ 100%
- Superimposed control loop
- Sinusoidal (or other shape) output

Modulation



How is it done?

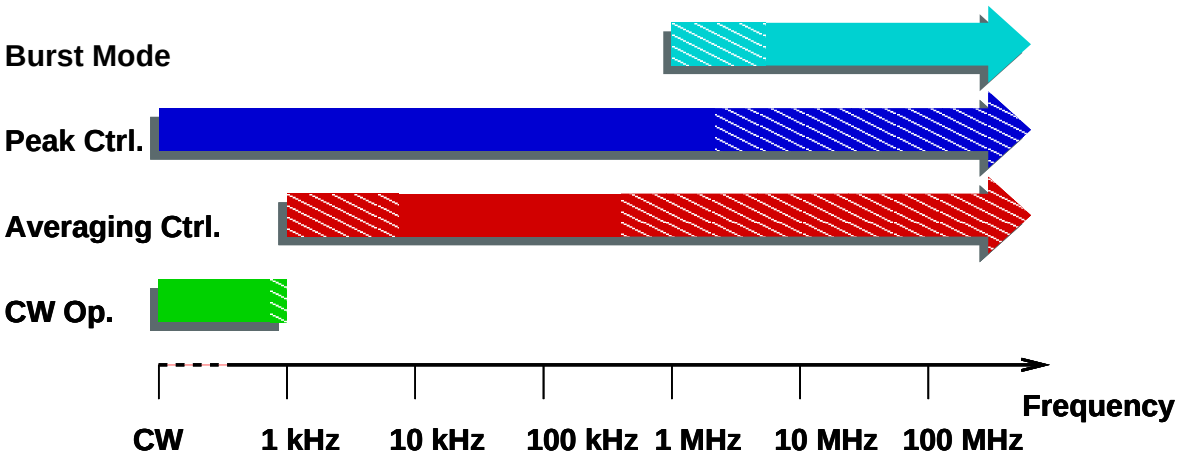
- Modulation of the setup input
- Utilising the second monitor input (iC-WK family only)
- Maximum modulation frequency limited by corner frequency of the control circuit (typ. several 10 kHz)

Pulsed operation

What does “pulsed operation” mean?

- “On/off” modulation
- Modulation depth near or equal 100%
- Control priciples
  - “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)

Frequency range



The control principles in detail

Switched CW operation

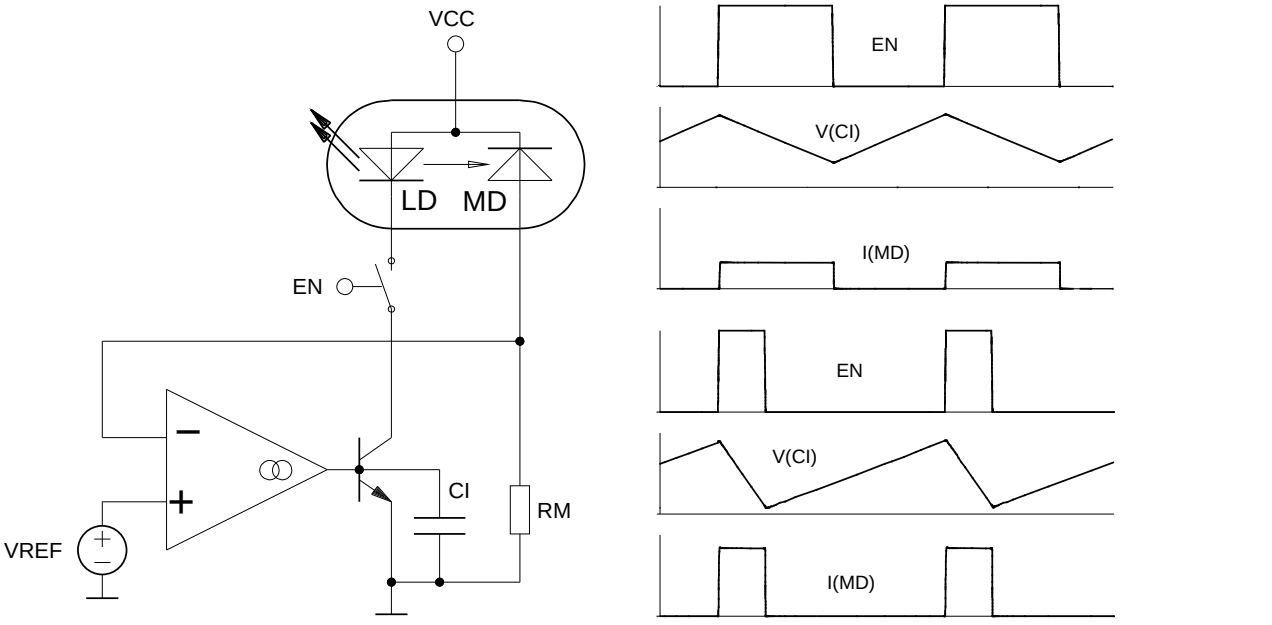
- iC-WK family, iC-WJ family drivers
- Most simple approach
- Power on/off or switching input
- Limited by turn-on/turn-off time (ca. 1 kHz max.)
- Pulse delay by turn-on/turn-off time

The control principles in detail

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

Averaging control

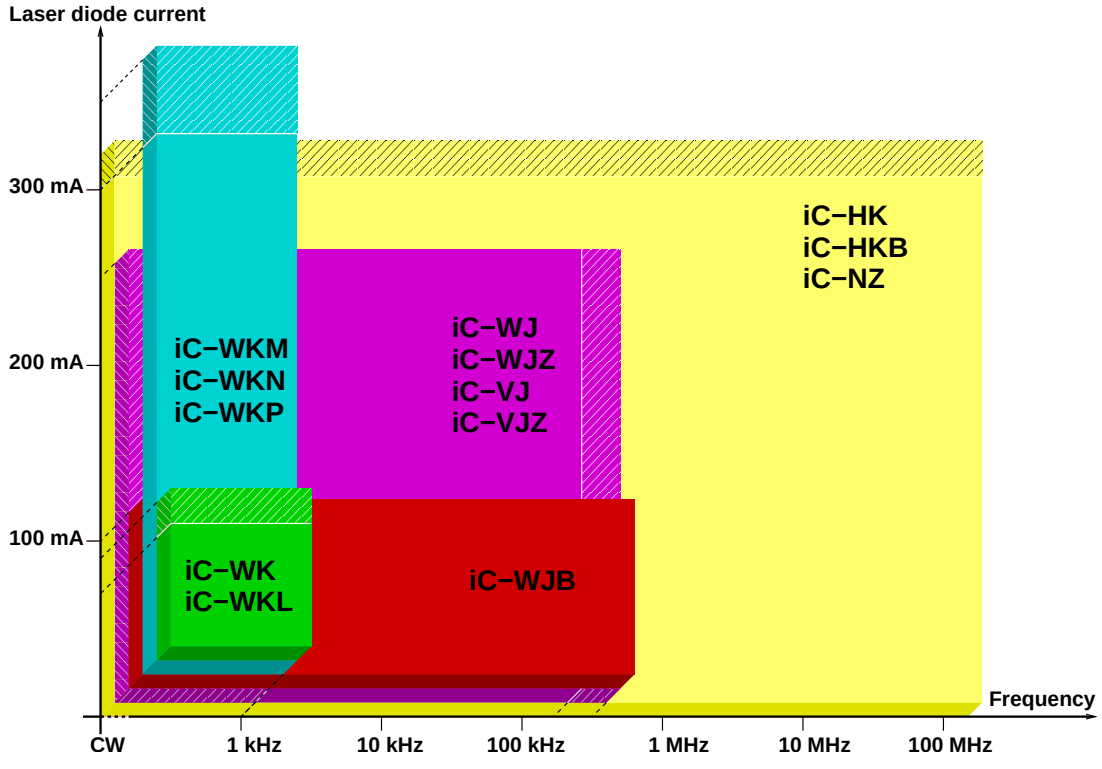


The control principles in detail

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



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
EuroPhotonics, 8/9:22–23 2004.