Basic Notes
Laser Diodes

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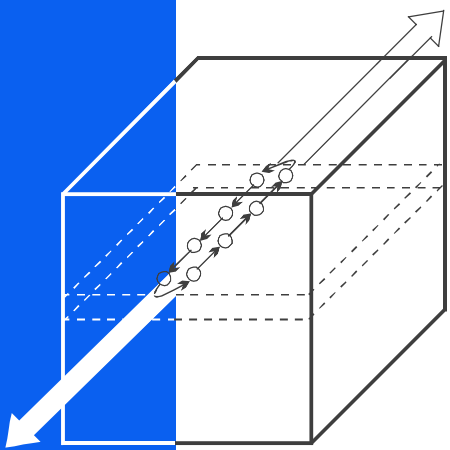

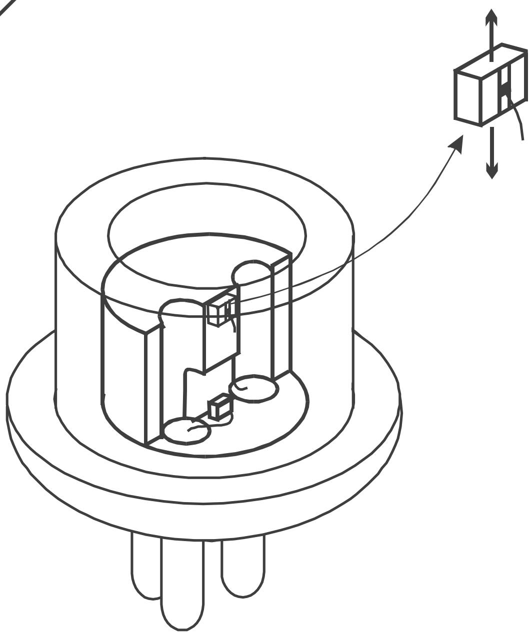

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Basics on laser diodes

Summary

Laser diodes are semiconductor devices emitting coherent light. They are the most frequently used laser sources. Their small size, the relatively low price and their long lifetime make them a component for multiple applications.

Since their invention in 1963 the development of laser diodes has been pushed considerably, mainly due to the strong growth in the fields of telecommunication and optical data storage. These and other fields of application have led to an important progress as to size and reliability. Continuous developments have resulted in laser diodes with shorter and shorter wavelengths, increasing output power and an improved beam quality.

In the following we will describe how laser diodes operate and what their special features are. This applies to the characteristic curves, the spectrum, the characteristics of the beam and other important parameters.

We will describe typical types of laser diodes and their fields of application.

Handling laser diodes requires utmost care to protect them against damage and destruction. Therefore, we will also give some instructions concerning the correct handling of laser diodes.

Contents

1 Generating a coherent emission in the laser diode

LD/ LED

The laser diode (LD) and the related light emitting diode (LED) are semiconductor devices with pn-junctions. Depending on the kind of emission there is a difference between surface or edge emitting diodes.

SLED - EELED

Most LEDs are surface emitters (SLED: **S**urface-**e**mitting **LED**). Due to a special layer set-up also edge-emitting LEDs (EELED) that have a higher degree of effiency, can be realized. If you combine this structure with a fiber guide you will reach – due to the concentration of the radiation in the fiber guide – still higher radiation densities. This is then called super-luminescence diodes.

Common laser diodes are always edge emitters. Recently, however, also surface emitting laser diodes have become of interest for special applications (VCSEL: **V**ertical **C**avity **S**urface **E**mitting **L**aser) (see chapter 2).

While LEDs can only emit **incoherent** light, laser diodes emit coherent light when operated above the threshold.

This is due to the **stimulated emission**. The emitted stimulated photon is conform with the photon that has released the emission regarding energy (wavelength resp. frequency), phase and direction propagation. Fig. 1 shows the differences between coherent and incoherent emission.

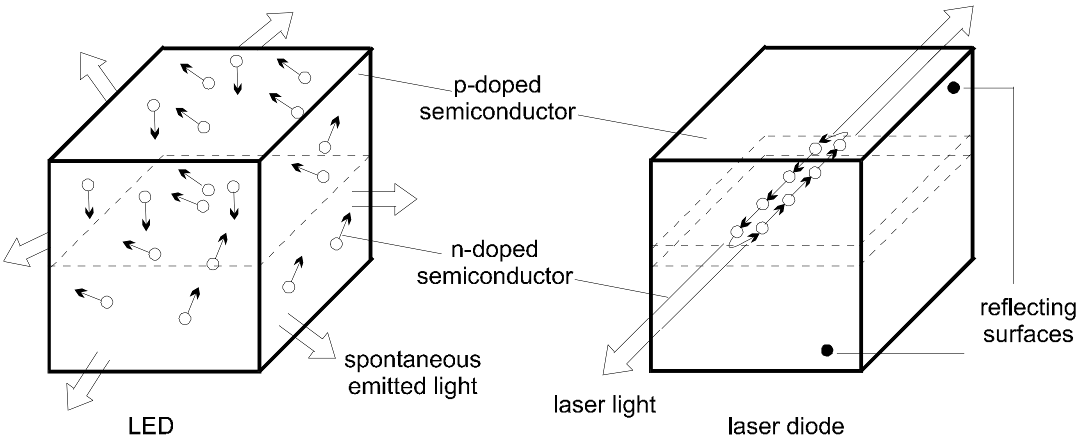

Figure 1: Incoherent and coherent emission

To cause an amplification of the light by stimulated emission, the probability of an emission must be above that of an absorption for the spectral range concerned. This is achieved by **„pumping“** the laser: the semiconductor is shifted into a **state of inversion**. Then, in the upper energy level the density in numbers of electrons is higher than in the lower one.

This so-called density inversion can be reached through an extreme doting of the n- or p-material by injecting minority carriers.

The emission becomes coherent due to a selective feedback generated by an optical resonator that can be realised in form of two mirrors facing each other (**Fabry-Perot resonator**, see fig. 2).

resonator principle

By multiple reflection, **standing waves** can build up for certain discrete wavelengths. The semiconductor in inversion operates as amplifier. The split end faces of the crystal serve as **mirrors** since due to the change of the refractive index against air, about 30 % of the emission is reflected.

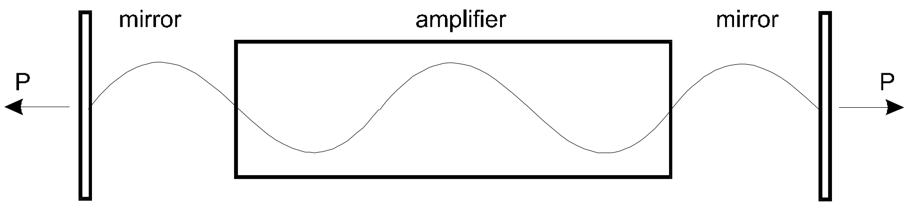

Figure 2: Fabry-Perot resonator

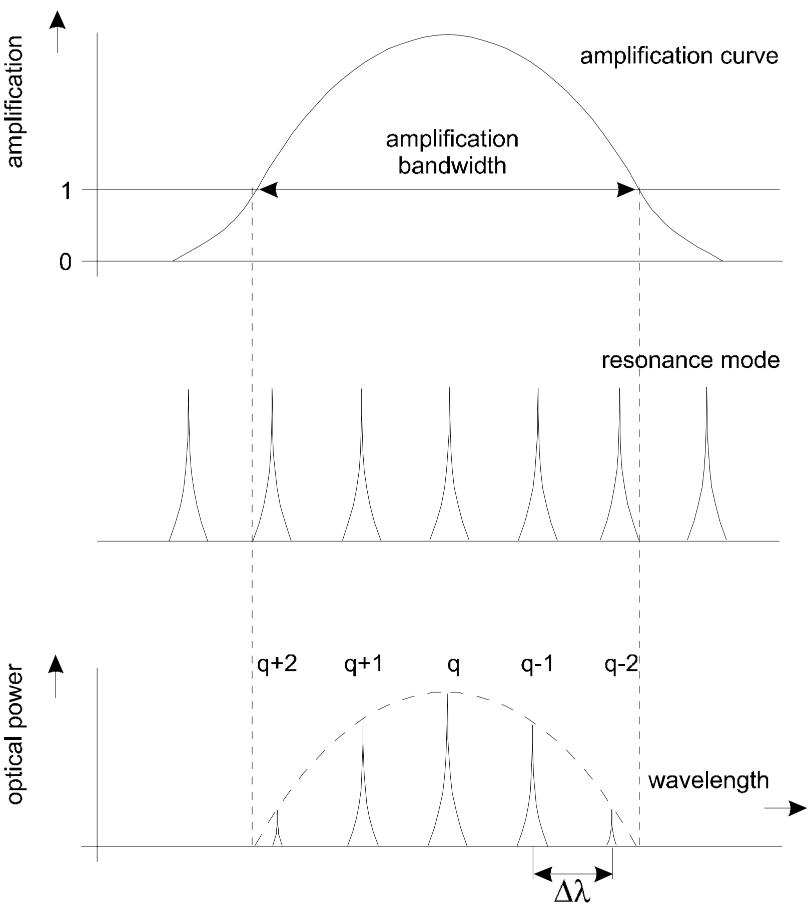

Figure 3: Amplification and resonant frequencies in the optical resonator

Laser operation is possible at those resonator frequencies (longitudinal modes) for which the optical amplification exceeds the losses due to coupling and absorption (compare fig. 3).

laser operation

The **modes** are competing with each other and are fluctuating in time (modal noise). By certain means it can be achieved that only one longitudinal mode is amplified. The laser then emits as singlemode source.

2 Types of laser diodes

Traditional laser diodes provide a horizontal resonator structure where the double hetero structure serves to guide the light vertically in the active zone (fig. 4).

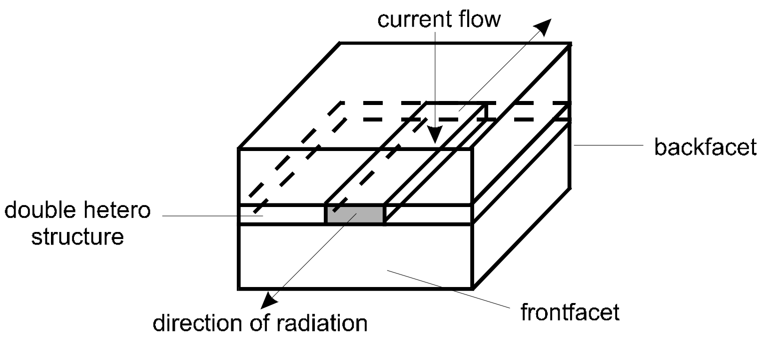

Figure 4: Principle structure of a laser diode guided in the active laser region

According to the different refractive indices of the different layers the light is guided in the active zone. The lateral limitation of the light is achieved by either index guiding or by gain guiding.

gain guiding
index guiding

Index guided lasers provide an additional built-in refractive index profile perpendicular to the direction of light propagation. With **gain guided lasers** the guiding in the narrow stripe is achieved by lateral tightening and concentration of the stimulating electrical field.

Gain guided lasers are easier to produce, are offered at a lower price and have a higher reliability. Index guided lasers provide a better beam quality and require a lower threshold current.

Due to its better characteristics the index guided laser has clearly overtaken the gain guided laser on the market for telecommunication. This applies especially to the DFB laser (**D**istributed-**F**eedback-**L**aser).

DFB

With this kind of laser the reflections are not effected by the plane mirrors of the crystal but by a corrugation of the semiconductor substrate. These undulated elevations have the effect of a mirror with a high reflection power (fig. 5).

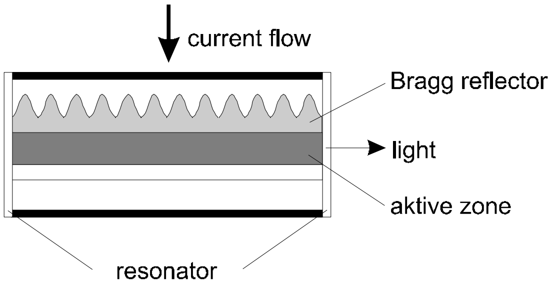

Figure 5: Schematic structure of a DFB laser

DFB lasers are very selective. Contrary to the Fabry-Perot resonator this principle is called **Bragg reflector**. Only one mode of the spectrum fulfils the resonance condition and is amplified.

Thus it is possible to realise very narrow-band lasers that result in small signal distortion by chromatic dispersion of a fiber, using the laser as a carrier for data. In connection with singlemode fibers DFB lasers are therefore especially suited to realise large bandwidths and long transmission distances.

Another important type of laser is the vertical cavity surface emitting laser diode (VCSEL). This type disposes of a resonator that is in a right angle to the active layer. The laser emits at the surface (fig. 6). VCSEL

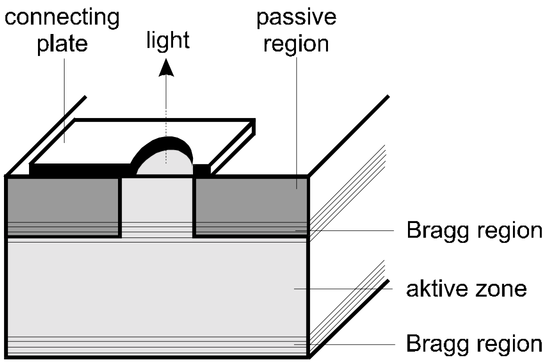

Figure 6: Vertical cavity surface emitting laser (VCSEL)

The resonator consists of multi-layer mirrors above and below the active zone. These mirrors must have a considerably higher reflection than those of horizontal emitting laser diodes as in the VCSELs the photons only pass a relatively short distance in the active zone.

VCSELs typically emit with relatively large symmetric apertures. Thus the beam is round and shows little divergence.

Due to their structure surface emitting laser diodes have **only one beam window,** compared to common diodes. This is a disadvantage as for many applications a second beam is necessary for controlling purposes, e.g. to stabilise the output power.

Many other types of lasers with increasingly complicated structures have been developed to improve certain parameters.

Another method is the set-up of laser bars (= arrays). Here several single lasers are arranged next to each other. If several laser bars are stacked onto each other, we are talking about laser stacks. With laser bars and laser stacks very high optical powers can be achieved. This is the reason why these devices are highly interesting for applications in material treatment (rapid prototyping...).

laser bar
laser stack

Further applications for these components are, for example, point-to-point communication in space, laser printing, laser beam writing, but also the optical pumping of solid state lasers like Nd-YAG.

However, the higher optical power can only be used if it is coupled into a medium with sufficiently large dimensions (diameter and numeric aperture).

When coupled into a singlemode fiber with a very small numerical aperture, even with additional collimating lenses it is not possible to get more power into the fiber than with only one single laser. This is due to general physical laws that do not allow an increase in beam density.

3 Substrates

The semiconductor substrates which the laser diodes consist of are directly responsible for the wavelength the laser diodes emit.

With a pn-junction **GaAlAs** can emit from 750nm to 880nm and thus fully covers the range of the first optical window.

The lasing wavelength is a function of the band gap and is determined by material, the concentration of dopants and the configuration of the active zone.

InGaAsP is mainly used to manufacture components in the 1300nm and 1550nm range (second and third optical window).

InGaAlP is used for semiconductor lasers in the visible range starting at 630nm. These lasers are suited for data transmission with synthetic plastic fibers. In many applications they substitute the HeNe laser, for example for barcode scanners.

Up to now even lower wavelengths can only be realised with semiconductor lasers via frequency doubling. For higher wavelengths (2,0µm to 2,3µm) **GaInAsSb** is used.

Profile supplies convenient temperature controllers also for lead sulfate lasers that emit at an working temperature of 25K to 70K (Kelvin) at a wavelength of 3 to 25 µm.

4 Characteristics and features of laser diodes

4.1 Characteristic curves

Above a characteristic **threshold current I_S**, at which the laser diode starts lasing, the ideal laser diode shows a linear dependence between optical output power and laser current. Below this threshold the optical amplification is not sufficient: The light is emitted spontaneous, like a LED does. Fig. 7 shows that the characteristic curve of a laser diode does not differ from that of an LED at operating currents below the threshold.

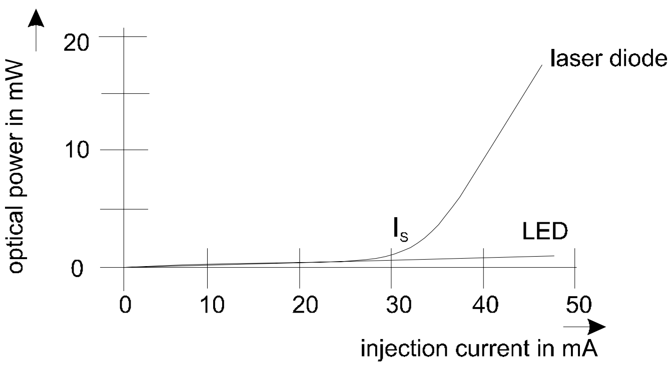

Figure 7: Characteristic curves of a LED and a laser diode

Important parameters of the characteristic curve are their **slope**, the threshold current, the roundness at the threshold and the linearity of laser operation.

important parameters

The linearity is characterised by a ratio of harmonics. Especially high demands to linearity are put for frequency modulated resp. analog signals.

If the optical output power is too high, the laser mirrors will be destroyed. Therefore it is essential to limit the maximum output power.

Attention!

Typical powers for fiber coupled components are at only a few milliwatts. You cannot couple the total power into the fiber. With singlemode fibers typical coupling efficiency is approximately 50 %.

With open beam laser diodes output powers up to some kilowatts can be reached.

The slope of the characteristic curve, measured in **mW/mA**, is directly determined by the **efficiency** of the device in laser operation. The slope of a laser diode with pigtail is reduced by a factor that is dependent on the coupling efficiency of the laser power into the fiber.

4.2 Optical spectrum

The optical spectrum of a laser with Fabry-Perot resonator has already been discussed in the first paragraph. It consists of **single spectral lines** with a spacing of Δλ. The spectral width of each spectral line is influenced by many factors, especially by the laser power.

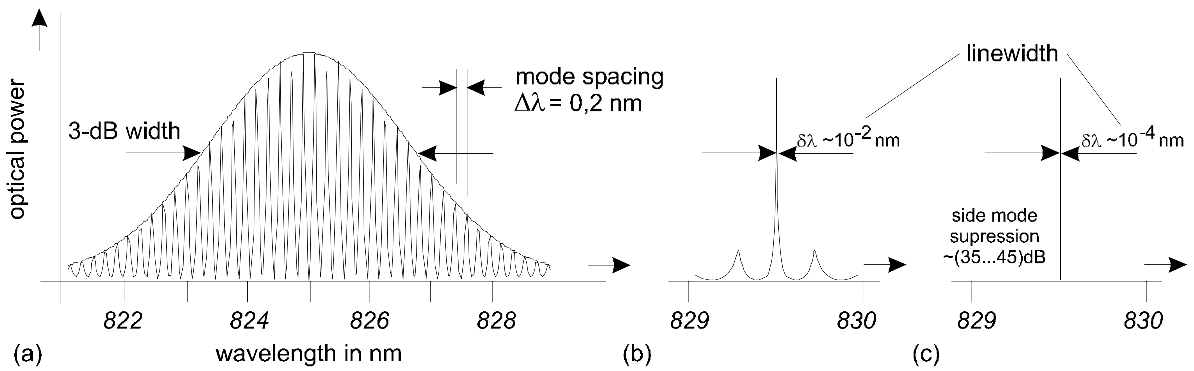

Figure 8: Spectrums of laser diodes:
(a) gain guided laser, (b) index guided Fabry-Perot laser, c) DFB laser

Fig. 8 shows the spectrums of gain guided and index guided semiconductor lasers. With gain guided lasers a multimode structure can be recognised. This is due to the higher spontaneous emission compared to that of the index guided laser. The envelope curve corresponds to the amplification profile above the laser threshold. The 3-db width is some nanometers.

With the index guided Fabry-Perot laser one spectral line is dominant, in most cases, but side modes can clearly be recognised. With the DFB laser, index guided too, the linewidth is considerably smaller and the side modes are much more suppressed than with the Fabry-Perot laser.

The **coherence length** l_{coh} of laser diodes is low. It can be calculated from the **spectral width** δλ of each emitted spectral line respectively from the **3-db width** of the spectrum:

$$l_{coh} = \frac{\lambda^2}{\delta\lambda} \quad resp. \quad l_{coh} = \frac{\lambda^2}{3 - dB\, width} \tag{1}$$

Thus an index guided Fabry-Perot laser, emitting a single spectral line of 10^{-2}nm at 825 nm, has a coherence length of 7 cm. For a gain guided Fabry-Perot laser with a 3-db bandwidth of 2,2 nm the coherence length is 300µm only. Thus, for a DFB laser with a typical line width of 10^{-4}nm the coherence length is 7 m correspondingly.

There is the following relation between the phase velocity v, the wavelength and the frequency f, which is determined during the generation of the radiation:

$$f = \frac{v}{\lambda} \tag{2}$$

By differentiating from f(λ) to λ you get a relation between the line width δλ respectively the $\delta\lambda_{3dB}$ (width) and the corresponding frequency range Δf:

$$\Delta f = \frac{v}{\lambda^2}\delta\lambda \;\; resp. \;\; \Delta f = \frac{v}{\lambda^2}\delta\lambda_{3dB} \tag{3}$$

frequencies

Typical multimode lasers with a 3-db width of 2 nm to 3 nm correspond to a frequency range of about 1000 GHz. The frequency range of an index guided Fabry-Perot laser is at some GHz. Extremely narrow-band lasers provide a line width in the sub-MHz range. They dispose of correspondingly high coherence lengths.

4.3 Beam characteristics

divergence

The beam of a laser diode **is divergent** with a rather large radiation angle. This is due to the diffraction of the light waves when coupled out of the laser diode. Inside the laser the light waves are limited to the active zone (see chapter 2).

As the active, light emitting area is shaped rectangular with strongly differing edge lengths, the parallel and vertical divergence are different.

Therefore, in some distance from the emitting area the beam will appear as an elliptical spot (fig. 9), so that the coupling into fiber with a low numeric aperture and a small core diameter becomes difficult.

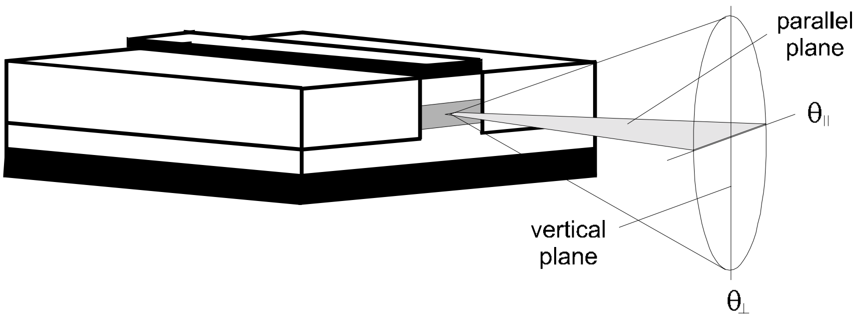

Figure 9: Typical beam characteristic of a semiconductor laser

Gain guided and index guided laser diodes have a different distribution of intensity inside the spots. The “ears” of the gain guided laser in the parallel plane θ_{II} are characteristic.

Fig. 10 compares the near field, the far field (corresponds to the intensity distribution as a function of the angle in a certain distance of the emitting area) and the spectrum of a gain guided and an index guided laser. FWHM (full with at half maximum) here is the 3-dB width of the near field intensity.

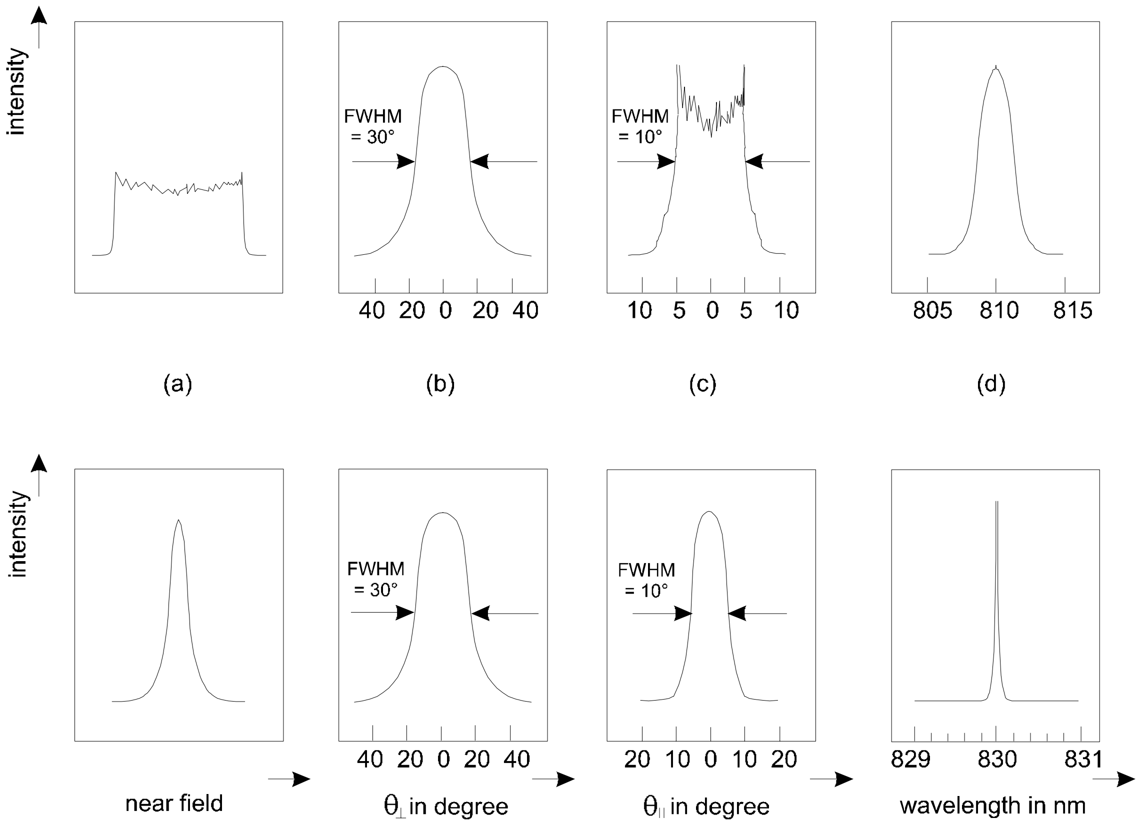

Figure 10: (a) near field (parallel plane), (b) far field (vertical plane), (c) far field (parallel plane) and (d) spectrum of a gain guided (upper) and an index guided (lower) laser diode

The ratio of vertical to parallel divergence, measured in the far field, is called the ratio of axes.

The focus of the vertical and the focus of the parallel divergence are not congruent but shifted against each other (fig. 11). This effect is called **astigmatism**. Typical values for astigmatism are for the gain guided lasers 30µm and for the index guided lasers 10µm.

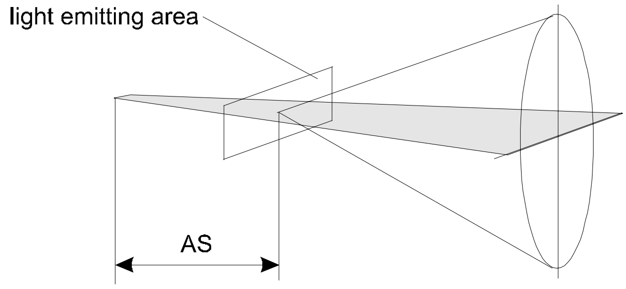

Figure 11: Astigmatism of a laser diode

Vertical cavity surface emitting lasers (VCSEL) have square or round emitting areas and therefore dispose of a relatively **symmetrical beam**. The emitting area is larger than that of a common laser and therefore has a lower divergence (7 to 10 degrees).

Laser diodes are emitting almost **linear polarised** light if they are driven above the threshold. The reason for this is the polarisation dependency of the reflection factor R of the emission area of the crystal.

This effect is only provided with rectangular emission areas. In this, the polarisation vector points in the direction of the longer edge of the rectangle.

The ratio between the parallel and vertical polarisation vectors of the beam is called **polarisation ratio**. At a lower operating current the share of unpolarised light is higher due to the spontaneous emission.

With increasing output power the polarisation ratio increases. Laser diodes that are driven near their maximum power show polarisation ratios of more than 100:1.

4.4 Temperature behaviour

The **characteristics** of a laser diode strongly depend on the **temperature.** Fig. 12 shows the characteristic curve of a diode at different temperatures. With increasing temperature the threshold current increases and the slope of the curve decreases.

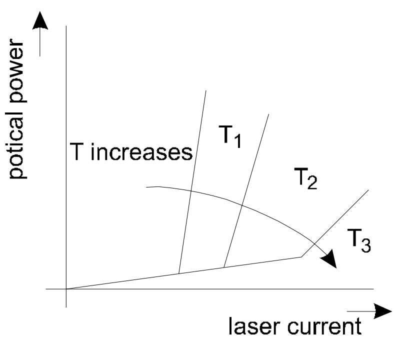

Figure 12: Temperature dependency of the characteristic curve

For the shift of the threshold current the following dependency was determined empirically:

$$I_S(T + \Delta T) = I_S(T)\, e^{\frac{\Delta T}{T_0}} \qquad (4)$$

T_0 is a substrate specific characteristic temperature and ΔT is the deviation from temperature T. The smaller T_0, the more sensitive the laser reacts to changes in temperature. For GaAlAs laser diodes T_0 ranges from120K to 230K and for InGaAsP lasers from 60K to 80K.

The shift of the threshold current is due to the temperature dependency of the carrier concentration in the active layer and also – with increasing temperatures - to an increasing probability for non-emitting recombination processes.

In pulsed operation the chip temperature of a laser diode is lower depending on the duty cycle. The characteristic curve shifts to lower currents accordingly (fig. 13).

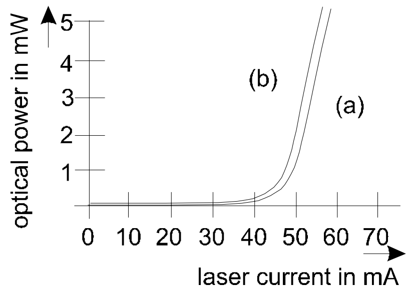

Figure 13: Characteristic curve of a laser diode in (a) CW operation or (b) pulsed operation

There are some other parameters of the laser diode that are temperature depending. One of them is the lifetime of laser diodes. When the chip temperature is reduced by about 10 degrees, the lifetime will double. This is why the laser chip should at least be mounted to a heat sink to avoid an overheating by power dissipation.

It is important to be aware of possible temperature effects on the spectral distribution: With increasing temperature the crystal will extend and thus the resonator length will get larger. At the same time the refractive index increases. By this, the single spectral lines drift to longer wavelengths (fig. 14).

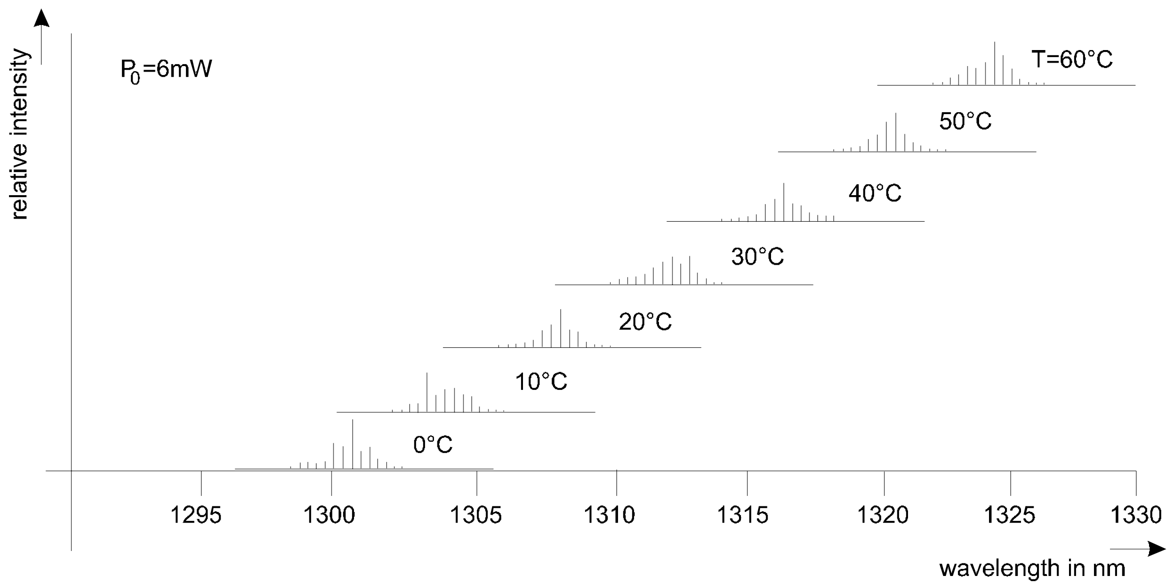

Figure 14: Temperature dependency of the mode spectrum of a gain guided laser diode

The amplification profile (= envelope of the spectrum) also shifts to longer wavelengths as the band gap decreases with increasing temperature.

For the wavelength drift of Fabry-Perot lasers the following temperature coefficients can be stated:

temperature coefficients

$$\left.\frac{\delta\lambda}{\delta T}\right|_{envelope} \approx \left\{\begin{matrix} 0{,}24 nm/K \\ 0{,}30 nm/K \end{matrix}\right\} \left.\frac{\delta\lambda}{\delta T}\right|_{line} \approx \left\{\begin{matrix} 0{,}12 nm/K \; | GaAlAs-lasers \\ 0{,}08 nm/K \; | InGaAsP-lasers \end{matrix}\right.$$

Since the temperature coefficients for the envelope curve and the single spectral lines are different, **mode hoppings** result from changes in temperature.

This effect is clearly visible with the index guided Fabry-Perot lasers, where the envelope curve covers only one single spectral line. As the envelope is moving faster than the spectral lines, at certain temperatures the emitted wavelength jumps from one spectral line to the next (see fig. 15). If the temperature is kept constant exactly where the spectral line jumps, an irregular mode hopping between the two possible wavelengths occurs.

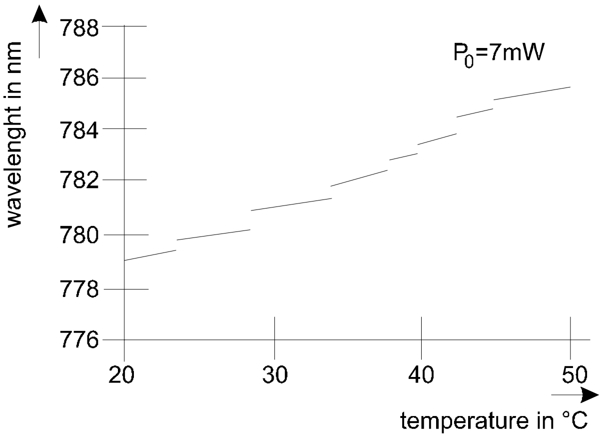

Figure 15: Temperature depending mode hoppings of an index guided Fabry-Perot laser

The slopes of the single parts of the curve corresponds to the temperature coefficient of the spectral lines. The changeover to the next part of the curve corresponds to the hopping to the neighbour mode caused by the shift of the amplification profile. However, at lower powers the index guided Fabry-Perot laser shows several modes in most cases (fig. 16).

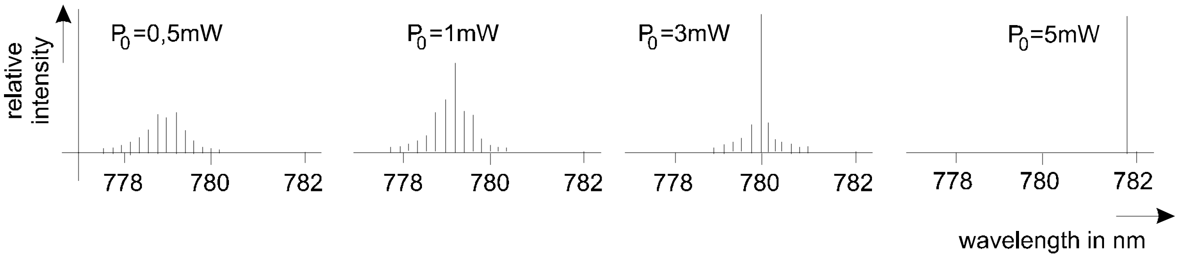

Figure 16: Spectrum of an index guided Fabry-Perot laser

With DFB lasers the shift of the envelope curve can be neglected since the envelope curve is very wide and the distance to potential further modes is rather far. This means that the temperature dependency of the spectrum of the DFB laser is only determined by the shift of the single spectral line.

The corresponding temperature coefficient of a DFB laser is approximately 0,02nm/K to 0,1nm/K, which is much lower than that of a Fabry-Perot laser. Since there is no envelope curve effect the DFB laser does not show any mode hoppings.

In singlemode fibers the **temperature drift** of the wavelength causes another annoying effect: the wavelength is drifting away from the zero crossing of the dispersion. This results in a higher dispersion and leads to a reduction of bandwidth.

Therefore it is necessary to **stabilise the laser temperature**. The temperature is controlled thermoelectrically via a thermistor and a TE cooler that enable heating or cooling of the laser diode.

For this purpose Profile offers numerous thermoelectric temperature controllers (see chapter 6).

TE cooling is costly and makes the laser diode expensive. Therefore it has been tried since long to develop lasers with less temperature dependency. For applications in telecommunication an operating temperature of -40°C to +85°C is required.

A breakthrough in reducing the temperature dependency was reached by using the so-called distorted **Quantum-Well (QW) layers** as laser active zone. These structures enable an operation without cooling up to +85°.

quantum well laser

Besides temperature control it is also possible to **control the optical output power** (see chapter 6). For this purpose a photodiode **(monitor diode)** is mounted opposite to the backfacet of the laser**.**

The laser diode, the monitor diode, the thermistor and the TE cooler are installed in an hermetically closed package (refer to chapter 7). The complete device is called **laser module** (fig. 17).

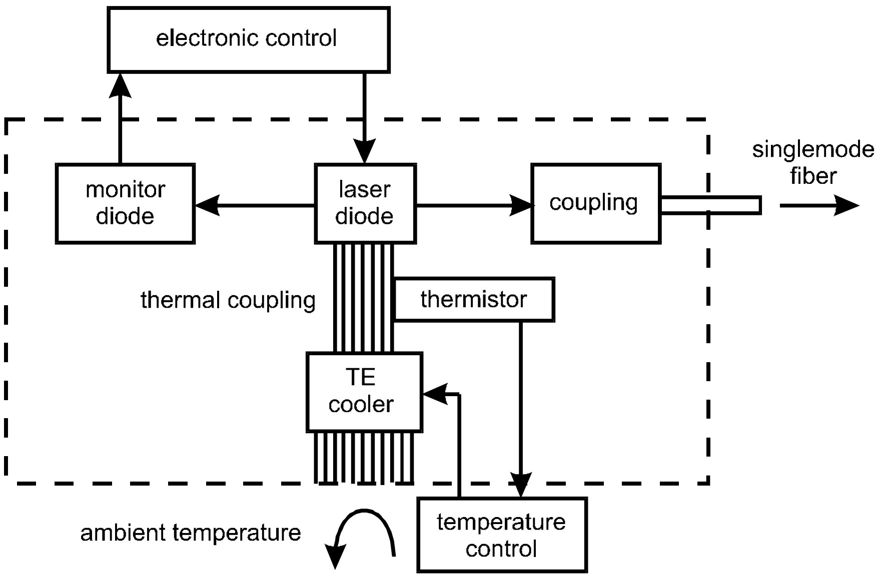

Figure 17: Set-up of a laser module

4.5 Modulation behaviour

Laser diodes can either be driven unmodulated, i.e. continuous wave - (CW) or modulated. For analog transmission the modulation is done in the linear range of the characteristic curve. The operating point has to be chosen accordingly. analog modulation

At lower frequencies digital modulation is generated by a TTL signal (transistor-transistor-logic) that is added to a bias current below the laser threshold. digital modulation

For modulation frequencies in the GHz range the digital modulation is done by an ECL (emitter-coupled-logic) signal that is added to a bias current above the laser threshold.

So-called pulse laser diodes are driven in quasi continuous wave (QCW). Rather long time intervals are between the single pulses. Duty cycles of less than 1:100 are typical. QCW laser diodes

Since the average power decides how much a laser mirror can stand, with QCW laser diodes much higher pulse powers can be achieved than with modulated or unmodulated CW laser diodes.

If a QCW laser diode is driven cw, this will inevitably destroy the laser due to overheating as the QCW laser provides a bad thermal contact to the heat sink.

When modulating the laser diode (intensity modulation) the wavelength of the laser changes due to the coupling of amplitude and phase.

This unintended **frequency modulation** can broaden the spectrum remarkably and can result in signal distortions.

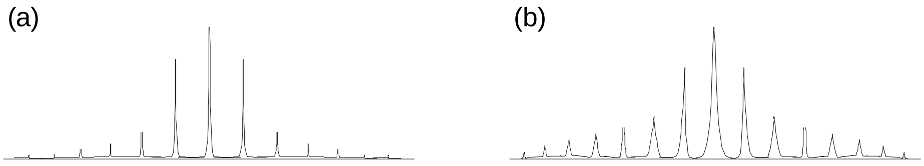

Figure 18: Spectrum of a Fabry-Perot laser (a) in CW mode or (b) modulated

DFB lasers remain singlemode in modulation and show, especially at higher modulation frequencies, less broadening of the spectrum than Fabry-Perot lasers.

At high data rates signal distortions can be extremely annoying. In that case the laser is driven in CW mode and modulated externally with an electro-optical modulator. The remaining broadening of the linewidth is proportional to the date rate only (equation 3). e/o-modulator

4.6 Noise and backreflections

noise sources

Laser diodes are sensitive against noise resulting from various origins. Most of these noise sources can be controlled and thus the total noise in the laser system can be limited. The four main noise sources are: **mode hoppings, amplitude intensity noise, optical feedback** and **speckle noise.**

Mode hoppings from one longitudinal mode to the next provoke a jump in the output wavelength. As explained in chapter 4.4, mode hoppings result from temperature changes in the active zone.

The shift of the output wavelength is accompanied by a short noise period. This effect only occurs with Fabry-Perot lasers, not with DFB lasers.

Amplitude intensity noise is a function of the operating current. It is the result of irregular changeover of electrons in the spontaneous as well as in the stimulated phase of emission.

The interaction between photons and charge carriers in the active zone creates an inner amplitude noise. This strongly decreases above the threshold.

When selecting the current source to operate the laser diode, special attention should be paid to low noise specifications.

Optical feedback results from back reflection of laser light into the laser resonator at optical components as, for example, connectors. An external resonator builds up, competing with the internal laser resonator.

This external resonator is instable, so that the amplitude and phase deviations due to the optical feedback lead to a broad-band noise. Especially index guided lasers with their small spectrum are very sensitive to optical feedbacks.

In transmission systems where index guided lasers are used, optical backreflections must be minimized. This is possible by using special connectors, the high-return-loss connectors, which - due to angle polished endfaces and a physical contact - only provoke very low reflection.

If backreflections cannot be avoided, an **optical isolator** must be installed directly behind the laser chip. This isolator provides a low insertion loss from the laser to the fiber and a high insertion loss i the back direction.

Speckle noise occurs strongest with lasers with a large coherence length.

Table 1 compares the most important properties of LEDs and laser diodes. Table 2 compares some properties of Fabry-Perot lasers to DFB lasers.

LED	Laser diode
Wide beam, incoherent light	Narrow beam, coherent light
Easy to handle	Requires current and temperature control
Frequency modulation up to several 100MHz	Frequency modulation up to 10GHz
Spectral width 30nm to 100nm	Spectral width < 5nm
Optical power up to 1mW	Optical power up to some 100mW
inexpensive	Expensive
Bad linearity	Good linearity

Table 1: Comparison of lasers diode with luminescence diodes

Properties	Fabry-Perot laser	DFB laser
Emission behaviour	React sensitive to temperature changes with mode hoppings	Remain stable in wavelength, always singlemode, can be tuned electronically
Spectral width	Wide => higher chromatic dispersion	Narrow => smaller chromatic dispersion
Spectrum	Emitting in multi-mode when RF modulated	Emitting in singlemode when RF modulated
Temperature dependency	high	Insignificant

Table 2: Comparison of Fabry-Perot and DFB lasers

5 Precautions in handling a laser diode

Ideal conditions provided, laser diodes show a **high reliability** and reach a lifetime of some 100.000 hours. They are, however, extremely sensitive to electrostatic discharge, to exceeding the maximum allowed laser current reverse breakdown voltage and to current spikes.

A reduction of output power, a shift of the laser threshold or a changed beam divergence indicate a damage of the laser diode. If the beam can no longer be focused sharply or when the lasers only emits like an LED the laser is damaged as well.

Laser diodes can be damaged by a multitude of mechanisms. First of all they are very sensitive against fast overshoots like short electric transients, electrostatic discharge as well as operating the laser with too high injection currents.

With a typical 5 mW laser the light intensity at the emitting area (2µm x 4µm) is 625 W/mm^2. A damage will occur when the intensity is 10^4 W/mm^2 or more.

protections

The required protections are substantial and should be adhered according to the instructions given by the manufacturer. The electrostatic discharge caused by human touch is the most frequent cause for the premature failure of the laser diode.

Latent damages that cannot be realised immediately will lead to a fast altering of the laser diode. This is very critical for applications where a long lifetime of the laser is required.

6 Laser diode controllers

To drive a laser diode save and stable a **precise current source** is required. This current source must also provide numerous protections functions: a slow increase of the laser current (softstart), protections against transients to block any kind of line disturbances, interlock control for the connection cable to the laser diode and a safe adjustable limit for the injection current.

Figure 19: Current source LDC 210 and temperature controller TED 200 of Profile for safe and stable control of a DIL-14 laser diode

Furthermore, the current source must be especially low noise and must provide both operating modes constant current (the injection current is kept constant) and constant power (the optical output power of the laser is kept constant).

Profile GmbH offers a wide variety of suitable current sources for low, medium and high-power laser diodes. To **stabilise the laser wavelength** several temperature controllers are available.

7 Laser diode packages

Laser diodes are available in different standard packages. The **CAN-package** (TO-18: 9 mm diameter, TO-46: 5,6 mm diameter, TO-3) is a hermetically closed package which contains a laser chip, a photodiode at the back facet for power monitoring (monitor diode) and a heatsink (fig. 20).

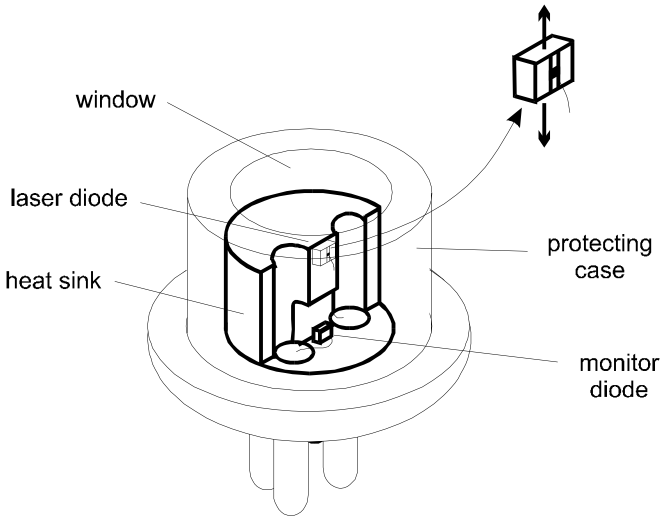

Figure 20: Set-up of a CAN-package (TO-18 or TO-46)

The 14-pin dual-in-line (DIL-14) packages and the 14-pin butterfly (BFY) packages are mainly used in telecommunication.

They contain a laser diode with already coupled to a singlemode fiber (pigtail), a heatsink, a TE cooler, a thermistor and a monitor diode. They have 14 electrical contacts. Usually the case is connected to the laser chip via the anode.

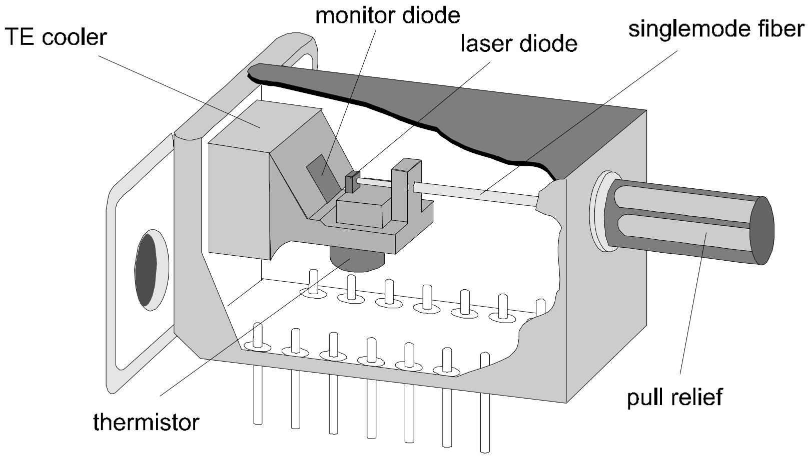

Figure 21: DIL-14 package with laser diode, monitor diode thermistor, TE cooler and fiber coupling

Laser diodes in butterfly packages are well suited for RF modulation. Therefore, the case must be grounded. Because of the modulation capabilities this package is mainly used with D-WDM systems (refer to BN 8000 Basic Notes D-WDM systems).

8 Literature

[1] Profile Basic Notes BN 8000, "DWDM systems", 2000