

Discrete vs. Integrated

Driving laser diodes with discrete or integrated circuits?

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Trading off performance, reliability and cost

The Design Challenge

In low power laser diode modules the designer has the option to use the classical discrete solution or take advantage of fully integrated driver ICs. Often the component cost is the driving factor for the selection without considering the complete system cost to design, produce, test and support the product during its full life cycle. The key factors to be considered are:

- Output power stability over the full voltage and temperature range
- Reliability
- Space requirements and protection of the laser diode
- Assembly, test, and adjustment cost
- Circuit design and test time
- Component acquisition and carrying cost
- Potential warranty claim expense

It is often ignored that in many cases the most expensive part of a laser module is the laser diode itself. Therefore its protection is a good investment, despite the higher component cost for the circuit.

Discrete Driver Circuit

Figure 1 shows a typical discrete APC driver solution (Automatic Power Control) for a supply voltage range of 6 to 12 V in CW mode (Continuous Wave). In this case the universal OPAMP LM358 plus one Zener diode, one transistor and 17 passive components are used to control the output power. The circuit requires approximately 6 cm² of board space and has no reverse-polarity or failure protection for the laser diode. The start-up time of this discrete solution is approximately 20 ms.

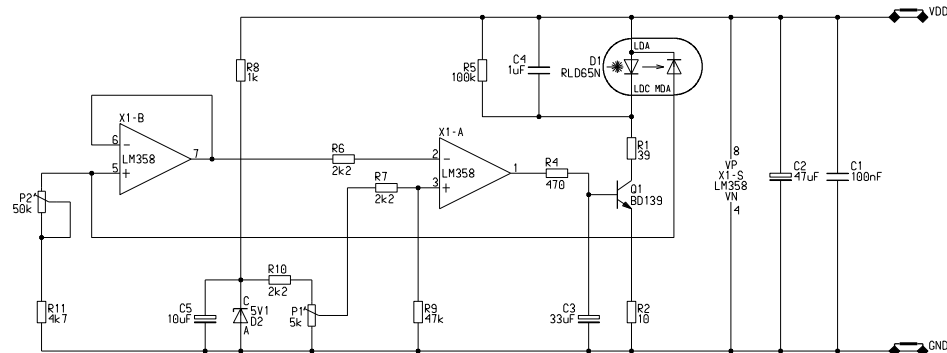


Figure 1: Typical discrete laser diode driver circuit*

Integrated Driver Circuit

Figure 2 shows the solution with the iC-WKN, a dedicated APC laser driver IC for CW operation up to 300 mA from a 2.4 to 15 V supply voltage. It requires only four additional passive components to build the complete driver. With approximately 1.25 cm² the required board space is four times smaller than the discrete solution. It has a reverse-polarity protection, over-current and over-temperature (of the IC) shut-down build in, as well as a fast soft start (typ. 70 μs). It also protects the laser diode against transients and keeps the output power stable over a wide supply voltage range.

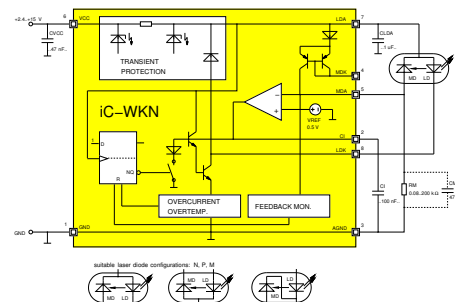


Figure 2: Integrated laser driver circuit

* As suggested by Sanjyo. Sanjyo is a trademark of Sanjyo Electric Co., Ltd.

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Conclusion

Figure 3 shows the result of measurements of the laser output power stability as a function of supply voltage (6 to 12V) for both circuits. The discrete solution has an output power variation of approx. 10% in the defined supply voltage range where the iC-WKN solution has a variation of less than 1.5%.

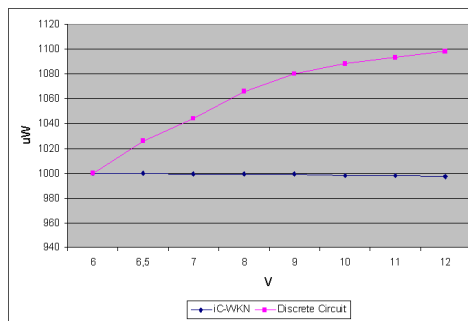


Figure 3: Power output variation of the discrete and the integrated solution

In terms of reliability it must be considered that the discrete solution has 46 solder joints, while the iC-WKN solution has only 17. The more than two times higher number of solder joints and even more than four times higher number of components have a direct impact on the MTBF (Mean Time Between Failure) of the

discrete solution (MIL-HDBK-217 / Parts Count technique). When comparing the total cost for the discrete and the integrated solution, one has to regard six important components:

- Parts
- Assembly
- Adjustment and Test
- Parts acquisition cost
- Inventory carrying cost
- Potential warranty claims expense

Considering only the cost of the parts needed, the integrated solution is approximately two times more expensive than the discrete version. But the larger number of components for the discrete circuit increases assembly cost as well as the two potentiometers increase cost for manual trimming of the output power. In this case, assembly, adjustment and testing are approximately two times more expensive than for the integrated version. Thus the cost of the two solutions balance each other. The system cost for the iC-WKN solution is clearly winning on reliability, stability and protection of the laser diode.

Consideration must also be given to the higher susceptibility of field failure in the discrete solution due to the increased part count, number of solder joints and the replacement or repair cost.

Table 1 summarizes the comparison of both solutions.

Parameter to compare	Discrete solution (Fig. 1)	Integrated solution (Fig. 2)
Output power stability 6 to 12 V	approx. 10%	< 1.5%
Number of components required	one LM358, one Zener diode, one transistor and 17 passives	one iC-WKN and 4 passives
Board space needed	approx. 6 cm ²	approx. 1.25 cm ²
Relative Cost		
Parts	1	2
Assembly	2	1
Adjustment and Test	2	1
Reverse-polarity protection	No	Yes
Transient protection	No	Yes
Over-current shut-down	No	Yes
Over-temperature shut-down	No	Yes
Start-up time	approx. 20 ms	approx. 70 μs
Relative MTBF	1	2.2

Table 1: Summary of discrete versus integrated driver solution

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