

iC-WKN

15 V CW LASER DIODE DRIVER

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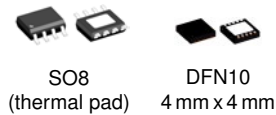
FEATURES

- ◆ CW operation up to 300 mA from 2.4 to 15 V supply voltage
- ◆ Rapid soft start after power-on typical within 70 μ s
- ◆ Optimised for N-type laser diodes
- ◆ Simple output power adjustment via an external resistor (APC)
- ◆ Power control loop accuracy better than 1.5% with changes in temperature, supply voltage and load current
- ◆ Integrated reverse polarity protection for the iC and laser diode
- ◆ Strong suppression of transients with very small external capacitors; integrated flyback path
- ◆ Permanent shut-down with excessive temperature and overcurrent (i.e. if the laser diode is damaged or the feedback current path fails)
- ◆ Two feedback inputs permit all current LD types to be used (N/P/M configurations)
- ◆ Modulation via the feedback inputs is possible
- ◆ Wide monitor current range from 2.5 μ A to 6.25 mA
- ◆ Pin compatible to iC-WK and iC-WKL (SO8 package)

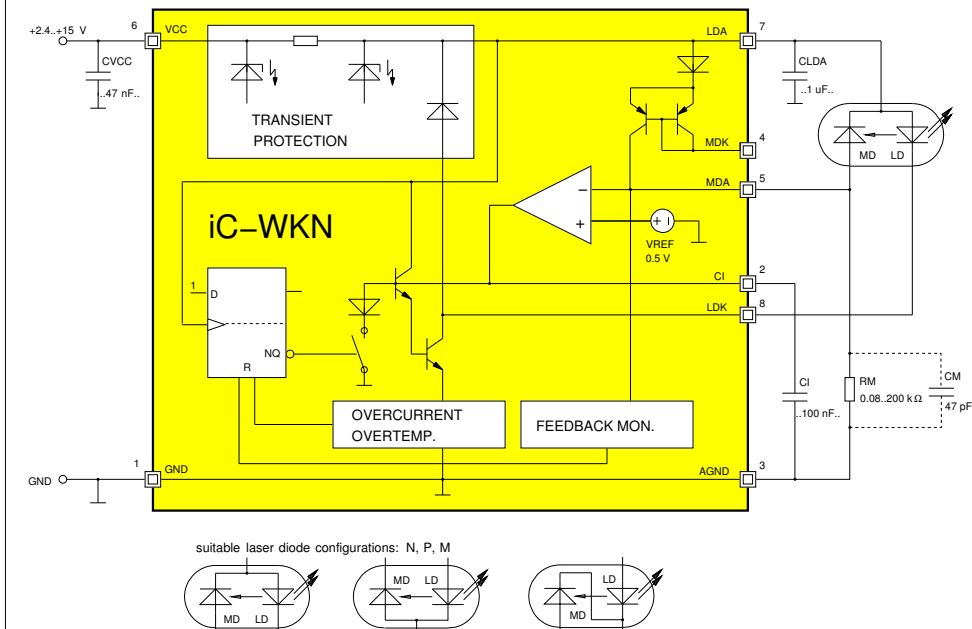
APPLICATIONS

- ◆ Laser diode modules
- ◆ Laser levels

PACKAGES



BLOCK DIAGRAM



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DESCRIPTION

iC-WKN is a driver for laser diodes in continuous wave operation with laser currents of up to 300 mA, which requires only four external components. The wide power supply range of up to 15 V allows for operation of blue laser diodes.

The iC includes integrated circuitry protecting against destruction by ESD, excessive temperature and overcurrent plus a soft start of the regulator to protect the laser diode when the power supply is switched on. The iC also filters the laser diode power supply for transients.

The regulator is adapted to the laser diode by an external resistor at MDA. The monitor current acts as a reference and is regulated independent of the influence of temperature and supply voltage (range: 2.5 μ A to 6.25 mA). The capacitor at C1 determines the control time constants and start-up time.

A second monitor input, pin MDK, allows the driver to be used for other types of laser diode configuration; alternatively, it can be used as an analogue modulation input (DC to a few kHz).

In the event of failure, such as overcurrent in the laser path due to a lack of feedback, for example, a quick power lockout is activated. The shut-down persists until power is reapplied, permitting a restart. The strain on power packs and batteries is relieved and the laser class is retained even in the event of a disturbance.

iC-WKN offers additional protection by means of spike detection at pin MDA. Should spikes or oscillation occur at pin MDA the power lockout is activated after a certain time-out.

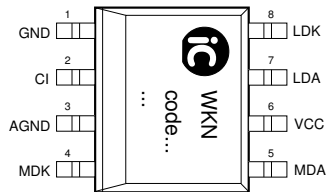
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PACKAGING INFORMATION SO8-TP, DFN10 4 mm x 4 mm to JEDEC standard

PIN CONFIGURATION SO8-TP

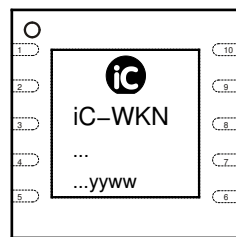


PIN FUNCTIONS

No.	Name	Function
1	GND	Ground
2	CI	Capacitance for Power Control
3	AGND	Reference Ground for CI, RM
4	MDK	Monitor Input 2 (MD Cathode, modulation)
5	MDA	APC Setup, Monitor Input 1 (MD Anode)
6	VCC	+2.4...+15 V Supply Voltage
7	LDA	Laser Supply (LD Anode)
8	LDK	Driver Output (LD Cathode)

The *Thermal Pad* is to be connected to a Ground Plane on the PCB. Do not short-circuit pins AGND and GND, for this may deteriorate the precision of the regulator and interfere with the soft-start!

PIN CONFIGURATION DFN10



PIN FUNCTIONS

No.	Name	Function
1	GND	Ground
2	CI	Capacitance for Power Control
3	AGND	Reference Ground for CI, RM
4	MDK	Monitor Input 2 (MD Cathode, modulation)
5	n.c.	
6	MDA	APC Setup, Monitor Input 1 (MD Anode)
7	n.c.	
8	VCC	+2.4...+15 V Supply Voltage
9	LDA	Laser Supply (LD Anode)
10	LDK	Driver Output (LD Cathode)

The *Thermal Pad* is to be connected to a Ground Plane on the PCB. Do not short-circuit pins AGND and GND, for this may deteriorate the precision of the regulator and interfere with the soft-start!

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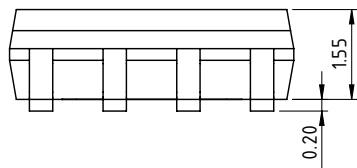
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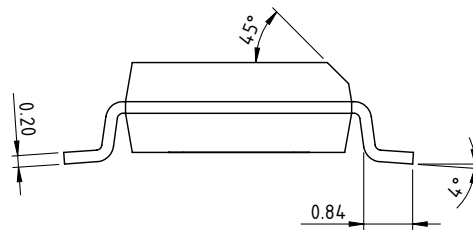
PACKAGE DIMENSIONS

All dimensions given in mm.

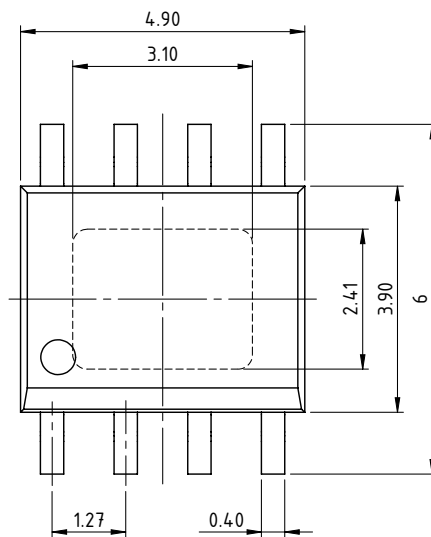
SIDE



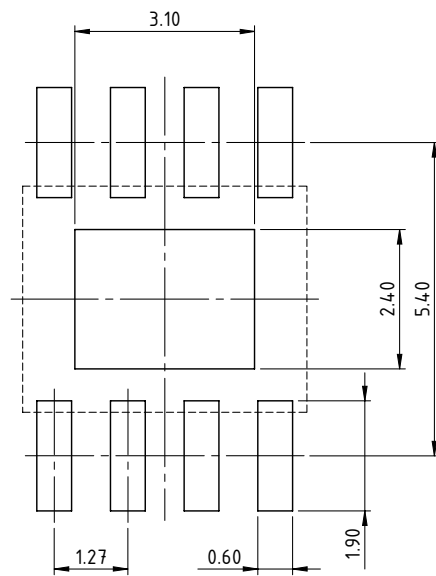
FRONT



TOP



RECOMMENDED PCB-FOOTPRINT



dra_so8-fp-1_pack_1_10:1

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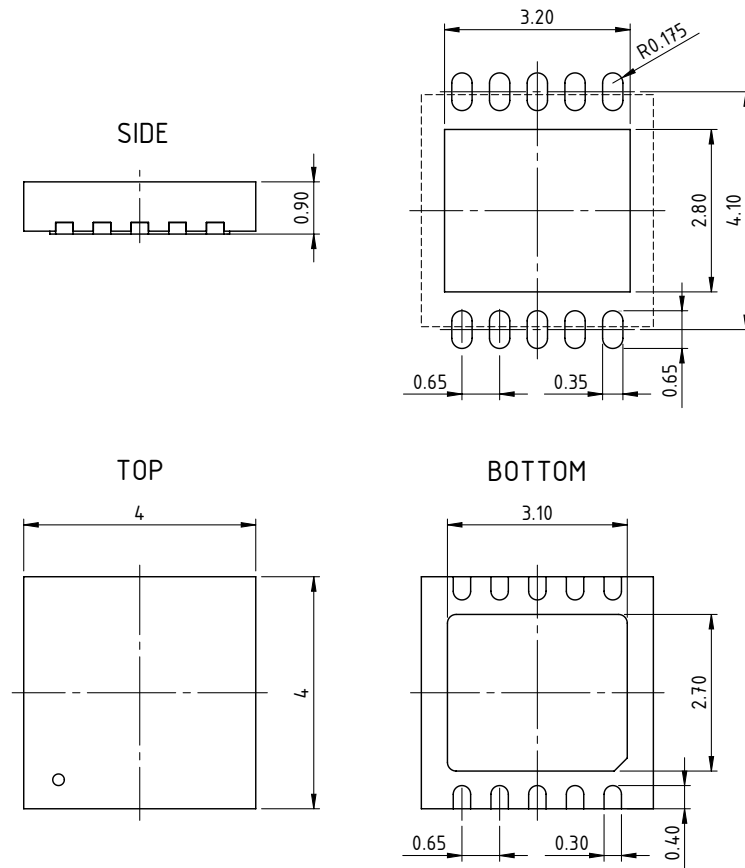
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PACKAGE DIMENSIONS

All dimensions given in mm.

RECOMMENDED PCB-FOOTPRINT



dra_dfn10-1_pack_1, 10:1

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ABSOLUTE MAXIMUM RATINGS

Beyond these values damage may occur; device operation is not guaranteed.

Item No.	Symbol	Parameter	Conditions			Unit
				Min.	Max.	
G001	VCC	Voltage at VCC		-6	16	V
G002	I(VCC)	Current in VCC		-10	900	mA
G003	I(CI)	Current in CI		-10	10	mA
G004	I(LDA)	Current in LDA		-900	10	mA
G005	I(LDK)	Current in LDK		-10	900	mA
G006	I(MDA)	Current in MDA		-10	10	mA
G007	I(MDK)	Current in MDK		-10	10	mA
G008	I(AGMD)	Current in AGND		-10	10	mA
G009	I(GND)	Current in GND		-900	10	mA
G010	Vd()	ESD Susceptibility at all pins	HBM, 100 pF discharged through 1.5 kΩ		2	kV
G011	Tj	Operating Junction Temperature		-40	150	°C
G012	Tj	Storage Temperature Range		-40	150	°C

THERMAL DATA

Operating Conditions: VCC = 2.4...15 V

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
T01	Ta	Operating Ambient Temperature Range		-40		85	°C
T02	Rthja	Thermal Resistance Chip/Ambient	soldered to PCB; no additional cooling areas therm. pad soldered to approx. 2 cm ² cooling area		30	170 50	k/W k/W

All voltages are referenced to ground unless otherwise stated.
All currents flowing into the device pins are positive; all currents flowing out of the device pins are negative.

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ELECTRICAL CHARACTERISTICS

Operating Conditions: VCC = 2.4...15V, RM = 80 Ω...200 kΩ, Tj = -40...125 °C unless otherwise noted

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Total Device							
001	VCC	Permissible Supply Voltage		2.4		15	V
002	I(LDK)m	Permissible Laser Drive Current	power control range	10		300	mA
003	I _{dc} (VCC)	Supply Current without load path	closed control loop, I(MDK) = 0, I(LDK) = 290 mA		10	20	mA
004	I _{off} (VCC)	Supply Current on Reset			2.4	5	mA
005	I _r (VCC)	Reverse Supply Current	RM = 50 kΩ, VCC = -6 V	-10	-3		mA
006	t _{on} ()	Turn-on Delay	VCC: 0 → 5V to 95% I(LDK), I(LDK) = I(LDK)m; C _l = 47 nF C _i = 100 nF			70 150	μs μs
007	V _c ()hi	Clamp Voltage hi at VCC, LDA	I() = 10 mA, other pins open	16		24	V
008	V _c ()hi	Clamp Voltage hi at LDK	V() < VCC + 1 V; I() = 10 mA, other pins open	16		24	V
009	V _c ()hi	Clamp Voltage hi at MDK vs. LDA	I() = 10 mA, other pins open	8		11	V
010	V _c ()hi	Clamp Voltage hi at MDA, CI	I() = 10 mA, other pins open	1.1		4	V
011	V _c ()lo	Clamp Voltage lo at VCC, LDA, MDK, MDA, CI	I() = -10 mA, other pins open	-9			V
Reference and Monitor Inputs MDA, MDK, AGND							
101	V(MDA)	Reference Voltage at MDA	closed control loop, V(LDK) > V _s (LDK)	480	500	520	mV
102	dV(MDA)	Reference Voltage Temperature Drift at MDA	see 101			120	μV/°C
103	I _{err} (MDA)	Input Current in MDA	closed control loop, I(MDK) = 0, I(LDK) = 10...290 mA	-100		100	nA
104	dI(MDA)	Input Current Temperature Drift in MDA	see 103	-1		1	nA/°C
105	APC _{err}	Control Error	RM = 10 kΩ, Tj = 0...80 °C RM = 10 kΩ, Tj = -40...125 °C			0.3 1	% %
106	dI(RM)	Supply Voltage Suppression	V(VCC): 2.4 → 15V, I(LDK) = 290 mA	-1.5		1.5	%
107	R _{gnd} ()	Resistor AGND-GND				3	Ω
108	V _f (MDK)	Voltage at MDK	V _f () = V(LDA) - V(MDK), I(MDK) = 1 μA...6 mA	0.46		2	V
109	CR()	Current Ratio I(MDA) / I(MDK)	I(MDK) = 1...500 μA I(MDK) = 0.5...3 mA I(MDK) = 3...6 mA	0.97 0.95 0.92		1.03 1.05 1.06	
110	TC()	Current Ratio Temperature Coefficient I(MDA) / I(MDK)	I(MDK) = 1 μA...1 mA I(MDK) = 1...6 mA	-0.005 -0.025		0.005 0.025	%/°C %/°C
Laser Driver LDA, LDK							
201	V _s (LDK)	Saturation Voltage at LDK	I(LDK) = 40 mA I(LDK) = 290 mA			350 700	mV mV
202	dI(LD)	Load Balancing Error	I(LD) = 20 mA, I(LDK): 20 mA → 290 mA	-1.5		1.5	%
203	I _t (LDK)	Overcurrent Threshold in LDK	V(LDK) = 2...5.5 V	300		700	mA
204	I _t (LDK)m	Maximum Overcurrent Threshold in LDK				1.2	A
205	t _{off} ()	Overcurrent Reset Delay	lack of feedback: I(MD) = 0 to I(LDK) = I _t (LDK); C _l = 47 nF C _i = 100 nF			85 170	μs μs
206	V _f ()	Flyback Diode Forward Voltage LDK-LDA	I(LDK) < 290 mA			1.3	V
207	R _{vcc} ()	Transient Protection Resistor	VCC to LDA			3	Ω
208	V _t (MDA)	Shutdown Threshold at MDA	t > 1 μs	0.7		2	V

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ELECTRICAL CHARACTERISTICS

Operating Conditions: VCC = 2.4...15 V, RM = 80 Ω...200 kΩ, Tj = -40...125 °C unless otherwise noted

Item No.	Symbol	Parameter	Conditions				Unit
				Min.	Typ.	Max.	
Control Release Flip-Flop							
401	VCCen	Set Threshold for Enable Flip-Flop	Tj = -40 °C	0.6		1.9	V
			Tj = 27 °C	1.2		1.9	V
			Tj = 125 °C	1.0		1.7	V
				0.6		1.2	V
402	Toff	Overtemperature Shutdown		140		165	°C

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SAFETY PRECAUTIONS

Laser light can damage the human eye and the eyes of animals. Do not look at any laser light directly or through any optical lens. When handling a laser diode, do not look directly at the light generated by it. Wear appropriate safety glasses to prevent light from entering the eye even by reflection.



FUNCTION DESCRIPTION

Turn-on behaviour

After switching the supply voltage on, the output stage remains disabled until the internal enabling flip-flop is set by a sufficiently high voltage at LDA.

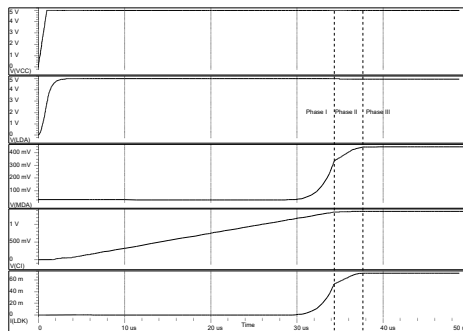


Figure 1: Turn-on behaviour

A quick soft-start follows during phase I; the control capacitor C1 is charged at an accelerated rate until the voltage at pin MDA reaches 1/3 of its nominal value.

With $V(MDA) > 1/3 V(MDA)_{nom}$ phase II starts, the controlled start-up. The transition to CW operation (phase III) is gradual and primarily determined by the values of C1 and RM. C1 is properly dimensioned when the voltage overshoot at MDA is at a minimum.

Turn-off behaviour

iC-WKN works without a fixed undervoltage lockout, thus the laser diode forward voltage is the prime factor determining the lowest possible supply voltage.

If the voltage drops below this value, the output driver is forcibly saturated and the laser current decreases. iC-WKN simultaneously discharges the control capacitor C1 so that no excessive laser diode currents occur when the supply voltage rises again.

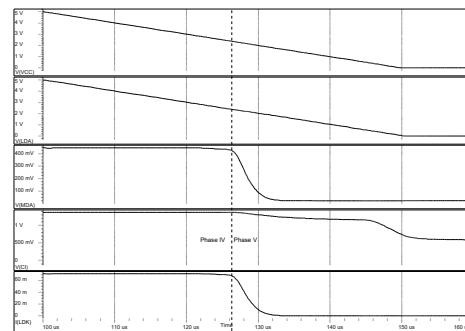


Figure 2: Turn-off behaviour

Disruptions in operation

The power control is shut down with excessive driver temperature or when the laser current reaches the overcurrent shut-down threshold, for example when the feedback is interrupted. If the monitor diode or the bias resistor RM fail, the device is shut down in less than 250 μ s, provided that the supply voltage applied is high enough. When modulating the laser current via pin MDK, excessive voltage occurring at pin MDA also may cause a shut-down.

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APPLICATION NOTES

Setting the output power

The output power is simply set by

$$RM = \frac{V(MDA)}{I(MD)}$$

with

$V(MDA)$ = Item-No. 101 and

$I(MD)$ = monitor current of the laser diode at the desired operating point.

RM should be combined from a fixed resistor (max. output power) and a trimmer (calibration).

Layout

Pin AGND acts solely as a ground reference for the power regulator (CI and RM) and must not be short-circuited with GND externally. This could have a negative effect on the control behaviour and monitor functions.

Cooling

Laser diodes should be sufficiently cooled, particularly with the power-regulated operation of setups which use iC-WKN, for example. The power dissipation in the laser diode otherwise causes the diode to heat up and the level of efficiency to drop which the power control unit then compensates for by increasing the laser current. This in turn brings about a rise in power dissipation in the laser diode and thus also in temperature. In this instance the laser diode could be damaged (resulting in spottiness and an increase in operating current) or even destroyed before the overcurrent shut-down threshold in iC-WKN is reached.

For improved power dissipation with N-type laser diodes the common terminal (= case) can be connected to the power supply line. This eases the heat conducting assembly into a module case, connected to the power supply (e.g. battery powered modules). Alternatively the power supply may be e.g. -5 V with the module case grounded.

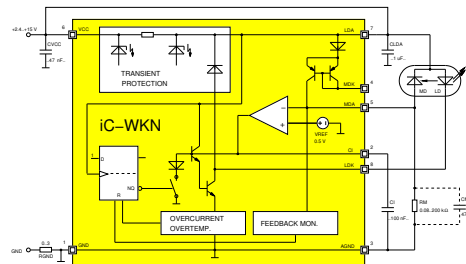


Figure 3: Laser diode case connected to the power supply

Figure 3 shows this setup with VCC and LDA short circuited. The function of the now by-passed transient protection resistor is replaced by an external resistor (typ. 3 Ω) in the GND line.

Current limiting

Figure 4 shows a relatively simple way to add a selectable current limiter to iC-WKN. $V_{BE}(Q_{lim})/R_{lim}$ sets the maximum current through the laser diode..

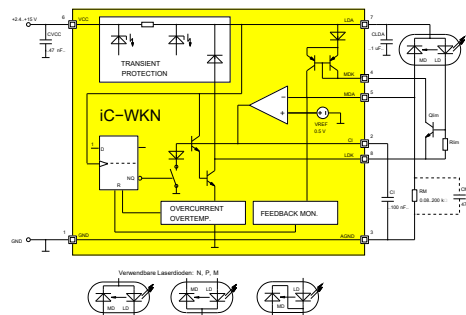


Figure 4: iC-WKN with selectable current limiter

Miscellaneous

Further application notes on the iC-WK family (iC-WK, iC-WKL, iC-WKN) and the data sheet of the demo board are available as separate documents.

