iC-WJB

2.7V LASER DIODE DRIVER

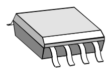
FEATURES

- LD driver for continuous or pulsed operation (CW to 300kHz) of up to 100mA
- Average control of laser power
- Simple LD power adjustment via external resistor
- Adjustable watchdog supervises digital input signals
- Soft starting after power-on
- Driver shutdown in the case of overtemperature and undervoltage
- Operation at 2.7V..6V suits battery-powered systems with two to four AA/AAA cells
- Reverse battery protection

APPLICATIONS

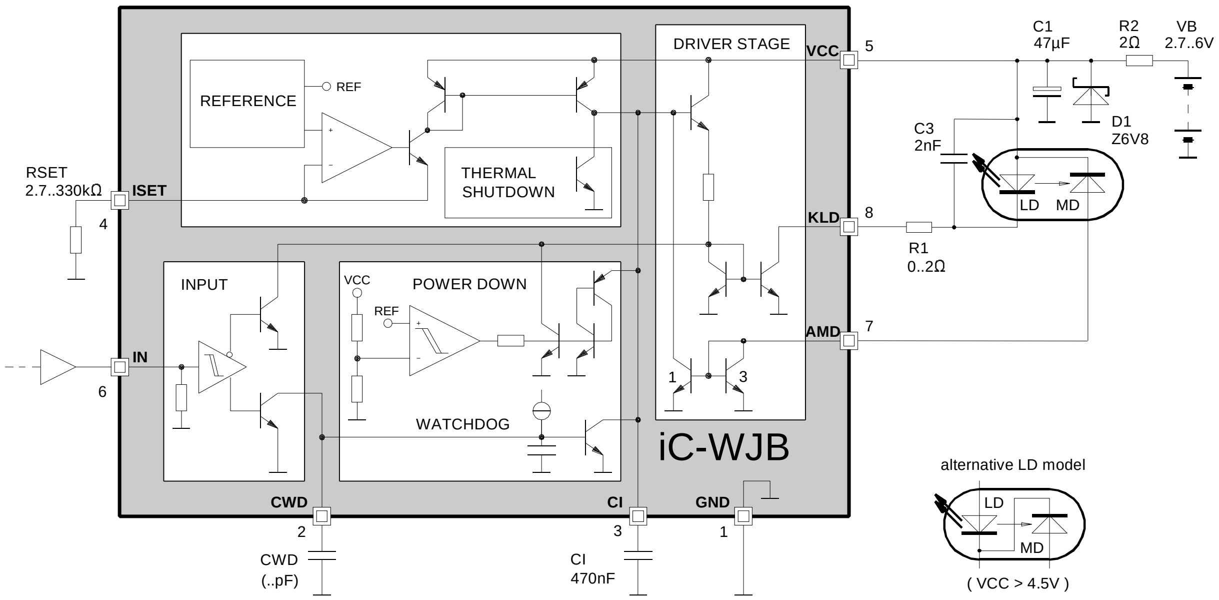
- Battery-powered LD modules
- LD Pointers

PACKAGES



SO8

BLOCK DIAGRAM



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DESCRIPTION

The iC-WJB device is a driver IC for laser diodes in continuous or pulsed operation of up to 300kHz. The broad power supply range of 2.7V to 6V and the integrated reverse battery protection allows for battery-operation with two to four AA/AAA cells.

The laser diode is activated via switching input IN. A control to the mean value of the optical laser power (APC) and integrated protective functions ensure nondestructive operation of the sensitive semiconductor laser.

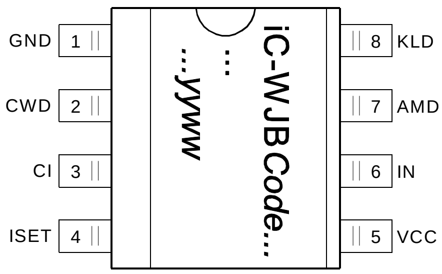
The IC contains protective diodes to prevent destruction due to ESD, a protective circuit to guard against overtemperature and undervoltage and a soft-start circuit to protect the laser diode when switching on the power supply.
Short-term reversed battery connection destroy neither the IC nor the laser diode.

An external resistor at ISET is employed to adapt the APC to the laser diode being used. The capacitor at CI determines the recovery time constants and the starting time.

A watchdog circuit monitors the switching input IN. If IN remains low longer than preset by the capacitor at CWD, the capacitor of the APC is discharged at pin CI. This ensures that the current through the laser diode during the next high pulse at input IN is not impermissibly high.

PACKAGES SO8 to JEDEC Standard

PIN CONFIGURATION SO8
(top view)



PIN FUNCTIONS

No.	Name	Function
1	GND	Ground
2	CWD	Capacitor for Watchdog
3	CI	Capacitor for Power Control
4	ISET	Attachment for RSET
5	VCC	+2.7V to +6V Supply Voltage
6	IN	Input
7	AMD	Monitor Diode Anode
8	KLD	Laser Diode Cathode

ABSOLUTE MAXIMUM RATINGS

Values beyond which damage may occur; device operation is not guaranteed.

Item	Symbol	Parameter	Conditions	Fig.	Min.	Max.	Unit
G001	VCC	Supply Voltage VCC			-0.3	6	V
G002	VCC	Reverse Voltage at VCC	T< 10sec		-4		V
G003	I(VCC)	Current in VCC	T< 10sec		-500	50	mA
G101	I(CI)	Current in CI			-4	4	mA
G102	V(KLD)	Voltage at KLD	IN= lo		0	9	V
G103	I(KLD)	Current in KLD	IN= hi IN= lo		-4 -4	400 4	mA mA
G104	I(AMD)	Current in AMD			-6	6	mA
G201	I(IN)	Current in IN			-10	2	mA
G301	I(ISET)	Current in ISET			-2	2	mA
G401	I(CWD)	Current in CWD	IN= lo		-2	2	mA
EG1	Vd()	ESD Susceptibility at CWD, CI, ISET, IN, AMD, KLD	MIL-STD-883, HBM 100pF discharged through 1.5kΩ			1	kV
TG1	Tj	Junction Temperature			-40	150	°C
TG2	Ts	Storage Temperature			-40	150	°C

THERMAL DATA

Operating Conditions: VCC= 2.7..6V

Item	Symbol	Parameter	Conditions	Fig.	Min.	Typ.	Max.	Unit
T1	Ta	Operating Ambient Temperature Range (extended range on request)			-25		90	°C
T2	Rthja	Thermal Resistance Chip / Ambient	soldered on PCB, no additional cooling areas				140	K/W

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

ELECTRICAL CHARACTERISTICS

Operating Conditions:
VCC= 2.7..6V, RSET= 2.7..27kΩ, I(AMD)= 0.15..1.5mA, Tj= -25..125°C, unless otherwise noted.

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
Total Device									
001	VCC	Permissible Supply Voltage				2.7		6	V
002	Idc(VCC)	Supply Current in VCC	RSET= 5kΩ, IN= hi, Idc(KLD)= 40mA			4	7	13	mA
003	I0(VCC)	Standby Supply Current in VCC	RSET= 5kΩ, IN= lo	27			5		mA
004	Iav(VCC)	Supply Current in VCC (average value)	Ipk(KLD)= 80mA, f(IN)= 200kHz ±20%, twhi/twlo= 1				9	15	mA
005	tp(IN-KLD	Delay Time Pulse Edge V(IN) to I(KLD)	IN(hi←→lo), V(50%):I(50%)			65		135	ns
006	Pcon	Power Consumption	VCC= 3V, V(KLD)≈ 0.6V, RSET= 5kΩ, Idc(KLD)= 40mA				50		mW
E001	Vc()hi	Clamp Voltage hi at VCC,IN,AMD,KLD,CI,CWD, ISET	I()= 2mA, other pins open	 27		6.2	 7.5	9	V V
Driver Stage									
101	Vs(KLD)	Saturation Voltage at KLD	IN= hi, I(KLD)= 80mA	 27			 0.11	0.3	V V
102	Vs(KLD)	Saturation Voltage at KLD	IN= hi, I(KLD)= 100mA					0.4	V
103	I0(KLD)	Leakage Current in KLD	IN= lo, V(KLD)= VCC					10	µA
104	V(AMD)	Voltage at AMD	I(AMD)= 1.5mA	 27		0.4	 0.84	1.0	V V
105	tr	Current Rise Time in KLD	Imax(KLD)= 20..80mA, Ip(): 10% to 90%	 27			 30	100	ns ns
106	tf	Current Fall Time in KLD	Imax(KLD)= 20..80mA, Ip(): 90% to 10%	 27			 20	100	ns ns
107	K/KL	Control Tolerance K= I(AMD) × RSET	KL constant for each lot, VCC steady			0.85	1	1.15	
108	CR1()	Current Ratio I(AMD) / I(ISET)	I(CI)= 0, closed control RSET= 2.7..27kΩ RSET= 27..330kΩ			 2.4 2.4	 3 3.6	 3.8 5.4	
109	CR2()	Current Ratio I(AMD) / I(CI)	V(CI)= 1..2V, ISET open			2.7	3	3.3	
110	TC1()	Temperature Coefficient of Current Ratio I(AMD) / I(ISET)	I(CI)= 0, closed control RSET= 2.7..27kΩ RSET= 27..330kΩ				 0.01 -0.1	 -0.25	 %/°C %/°C
Input IN									
201	Vt()hi	Threshold hi				45		70	%VCC
202	Vt()lo	Threshold lo				40		65	%VCC
203	Vt()hys	Hysteresis		 27		20	 65		mV mV
204	Rin	Pull-Down Resistor	V(IN)= -0.3..VCC	 27		4	 10	16	kΩ kΩ
205	V0()	Open-loop Voltage	I(IN)= 0					0.1	V

ELECTRICAL CHARACTERISTICS

Operating Conditions:
VCC= 2.7..6V, RSET= 2.7..27kΩ, I(AMD)= 0.15..1.5mA, Tj= -25..125°C, unless otherwise noted.

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
Reference und Thermal Shutdown									
301	V(ISET)	Voltage at ISET		 27		1.19 	 1.22	1.27 	V V
302	CR()	Current Ratio I(CI) / I(ISET)	V(CI)= 1..2V, I(AMD)= 0			0.9	1	1.12	
303	RSET	Permissible Resistor at ISET (Control Setup Range)				2.7		330	kΩ
304	Toff	Thermal Shutdown Threshold				125		150	°C
305	Thys	Thermal Shutdown Hysteresis				10		40	°C
Power-Down and Watchdog									
401	VCCon	Turn-on Threshold VCC		 27		2.4 	 2.6	2.7 	V V
402	VCCoff	Undervoltage Threshold at VCC		 27		2.3 	 2.5	2.6 	V V
403	VCChys	Hysteresis	VCChys= VCCon-VCCoff			70	100	150	mV
404	Vs(CI)off	Saturation Voltage at CI in case of Undervoltage	I(CI)= 300µA, VCC < VCCoff					1.5	V
405	Vs(CI)wd	Saturation Voltage at CI for IN= lo	I(CI)= 300µA, t(IN= lo) > tp (*)					1.5	V
406	Isc(CWD)	Pull-Up Current at CWD	V(CWD)= 0, IN= lo			2		15	µA
407	tpmin	Min. Activation Time for Watchdog	IN= lo, CWD open	 27		10 	 25	45 	µs µs
408	Kwd (*)	Constant for Calculating the Watchdog Activation Time	IN= lo	 27		0.19 	 0.25	0.57 	µs/pF µs/pF

(*): tp = (C(CWD) × Kwd) + tpmin (see Applications Information)

APPLICATIONS INFORMATION

Laser Power Adjustment
The iC-WJB device can be adapted to CW laser diodes of up to 40mW. When the supply voltage is higher than approx. 4.5V, LD models with a common cathode can also be used.

The pin ISET is used for the adjustment to the sensitivity of the monitor diode and to set the desired optical laser power. The setpoint for the averaging control of the monitor diode current is preset at this pin.

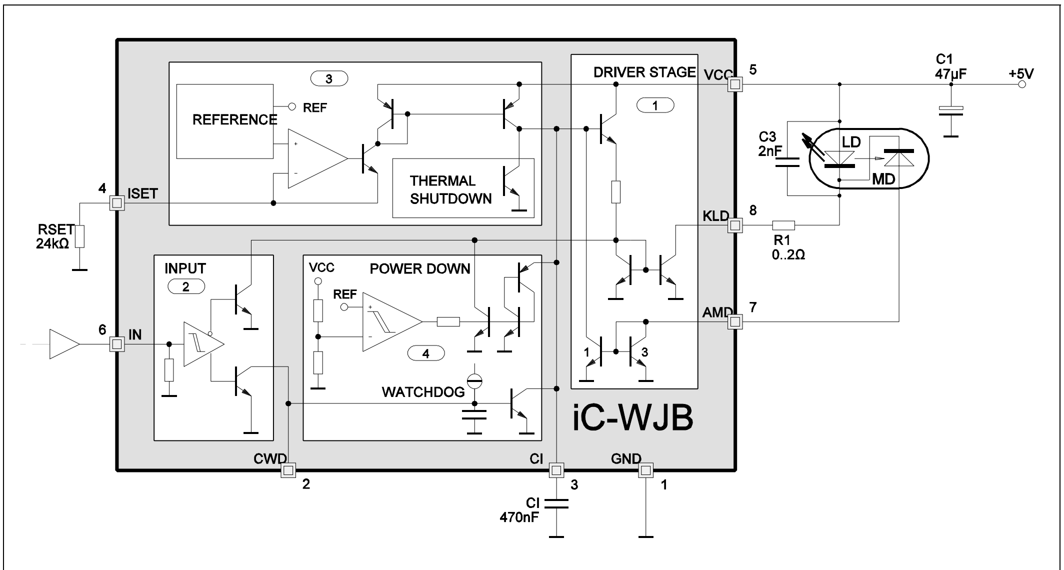


Fig. 1: Circuit diagram for LD models with a common cathode

To calculate the current required at ISET, the average optical laser power is to determine:

$$P_{av} = P_{peak} \times \frac{t_{whi}}{T}$$ with peak value P_{peak} and pulse/period duration t_{whi}/T

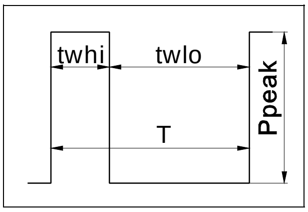


Fig. 2

Example for CW operation at P_{cw}= 1mW (pin IN to VCC, pin CWD open)
LD: maximum optical output 3mW, monitor diode with 0.75mA at 3mW;

At P_{av}= P_{cw}= 1mW, the monitor photocurrent is 0.25mA and RSET is calculated as:

$$RSET = \frac{CR1 * V\,(ISET)}{I_{av}\,(AMD)} = \frac{3 * 1.22V}{0.25mA} \approx 14.6k\Omega$$

with the Electrical Characteristics No.301 for V(ISET) and with No.108 for the current ratio CR1

Example for pulse operation with a pulse duty factor twhi/T of 20% and at P_{peak}= 3mW;
LD: as above, maximum optical output 3mW, monitor diode with 0.75mA at 3mW;

The average optical power is set to 0.6mW by the pulse duty factor; the mean monitor photocurrent I_{av} is then 0.15mA and for RSET, it follows that:

$$RSET = \frac{CR1 * V\,(ISET)}{I_{av}\,(AMD)} = \frac{3 * 1.22V}{0.15mA} \approx 24.4k\Omega$$

with the Electrical Characteristics No.301 for V(ISET) and with No.108 for the current ratio CR1

Averaging control (APC)

The control of the average optical laser power requires a capacitor at pin CI. This capacitor is used for averaging and must be adjusted to the selected pulse repetition frequency and the charging current preset with RSET. The ratios are linear in both cases, i.e. the capacitor CI must be increased in size proportionally as the pulse repetition frequency slows or the current from ISET increases:

$$CI \geq \frac{440 \times I\,(ISET)}{f \times V\,(ISET)} = \frac{440}{f \times RSET}$$

Example: Pulse repetition frequency 100kHz, RSET= 10kΩ: CI= 440nF, chosen 470nF

Otherwise the charging of the capacitor CI during the pulse pauses (with I(ISET)= 1.22 V/RSET) will create an excessive mean value potential and may destroy the laser diode during the next pulse. The capacitor CI is correctly dimensioned when the current through the laser diode and the optical output signal do not show any overshooting following the starting flank.

In steady-state condition and for a pulse duty factor of 50% (pulse/pause 1:1), signals as shown in Fig. 3 are present at the IC pins.

Fig. 4 shows the corresponding signals for a pulse duty factor of 20%. The influence of the pulse duty factor on the peak value of the monitor current proportional to the laser current is apparent. The average kept constant by the control (RSET unchanged) means a peak value increased by the factor 2.5. The pulse duty factor for which RSET was dimensioned should therefore be kept constant if at all possible.

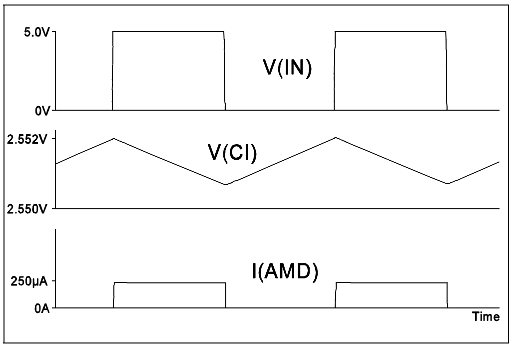


Fig. 3: Steady-state APC, f(IN)= 100kHz (1:1), CI= 470nF, RSET= 10kΩ

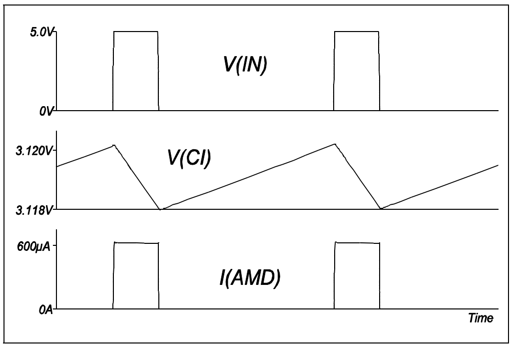


Fig. 4: Steady-state APC, f(IN)= 100kHz (1:4), CI= 470nF, RSET= 10kΩ

Turn-on and turn-off behavior

Capacitor CI also determines the starting time from switsching on the supply voltage VCC to steady-state laser pulse operation or after a discharge of CI by the watchdog. The following applies for estimating the starting time (Fig. 5):

$$T_{on} \approx \frac{1.7V \times CI}{I\,(ISET)} = \frac{1.7V \times CI \times RSET}{1.22V}$$

Example: CI= 470nF, RSET= 10kΩ: $T_{on} \approx$ 6.5ms

Figure 6 shows a detailed view of the start of laser operation; Figure 7 shows the shut-down behavior. The decline in the voltage at CI and the absence of the laser pulses are signs that the undervoltage detector is active.

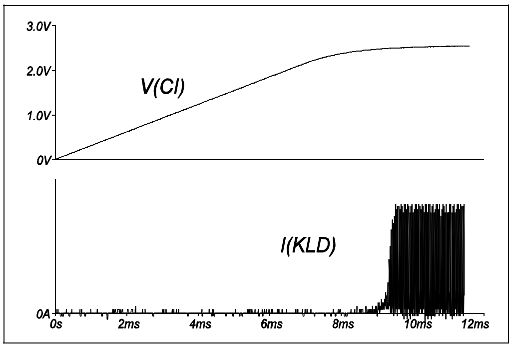


Fig. 5: Turn-on behavior, f(IN)= 100kHz (1:1), CI= 470nF, RSET= 10kΩ

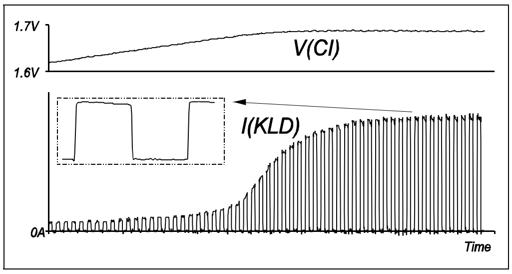


Fig. 6: Turn-on behavior, detailed view f(IN)= 100kHz (1:1), CI= 470nF, RSET= 10kΩ

Watchdog

The watchdog ensures that the capacitor CI is discharged during protracted pulse pulses at IN. During the pulse pauses the potential at CI increases by ΔV (Fig. 3):

$$\Delta V = \frac{I\,(ISET) \times t_{wlo}}{CI}$$

The discharge of capacitor CI by the watchdog protects the laser diode from being destroyed by an excessive turn-on current during the next pulse.

The capacitor CWD should be dimensioned such that the response time t_p of the watchdog is slightly longer than the pulse pause t_{wlo} of the input signal. As a result, the watchdog is just short of being activated.

For response times t_p longer than t_{pmin}:

$$CWD = \frac{t_p - t_{pmin}}{K_{wd}}$$

with t_{pmin} and K_{wd} from Electrical Characteristics No. 407, 408

Figure 8 shows the signal curves during normal operation, without the watchdog being activated. The potential at CWD rises during pulse pauses but does not reach the watchdog activation threshold.

Figure 9 shows the watchdog behavior when the input frequency is reduced from 100kHz to 10kHz. The pulse pauses are longer than the watchdog's response time. The watchdog begins to discharge the capacitor CI current limited. The remaining charge time during the pulse pauses before further watchdog intervention is not sufficient to maintain the initial potential at CI. The potential is thus gradually reduced until it reaches the saturation voltage $V_s(CI)_{wd}$ (Electrical Characteristics No. 405).

The watchdog therefore protects the laser diode from destruction when the input signal change in such a manner that the capacitor CI is not longer adequate for averaging.

Furthermore, the intervention of the watchdog permits long pulse pauses and activation of the laser diode with pulse packets.

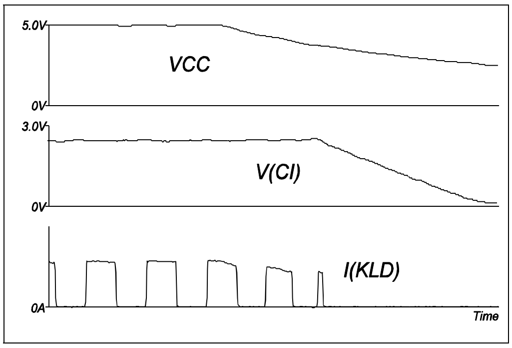


Fig. 7: Turn-off behavior, f(IN)= 100kHz (1:1), CI= 470nF, RSET= 10kΩ

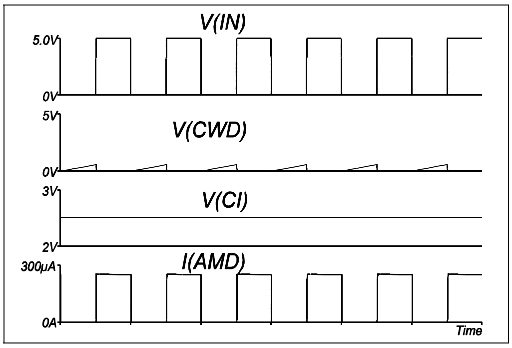


Fig. 8: Watchdog, CWD open, f(IN)= 100kHz (1:1), CI= 470nF, RSET= 10kΩ

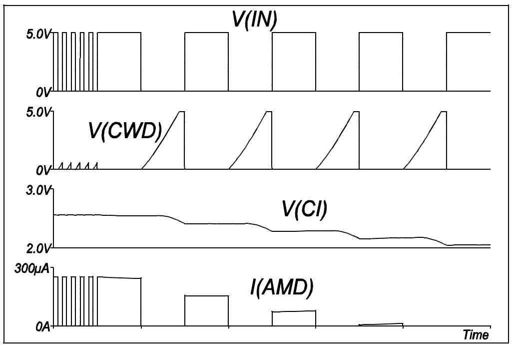


Fig. 9: Watchdog, CWD open, f(IN)= 100kHz → 10kHz (1:1), CI= 470nF, RSET= 10kΩ

CW OPERATION

In case of CW operation, the input IN can be connected to the power supply VCC. The pin CWD may be unloaded, because the capacitor for the watchdog is not necessary. The capacitor CI for the averaging control can be reduced to 100nF.

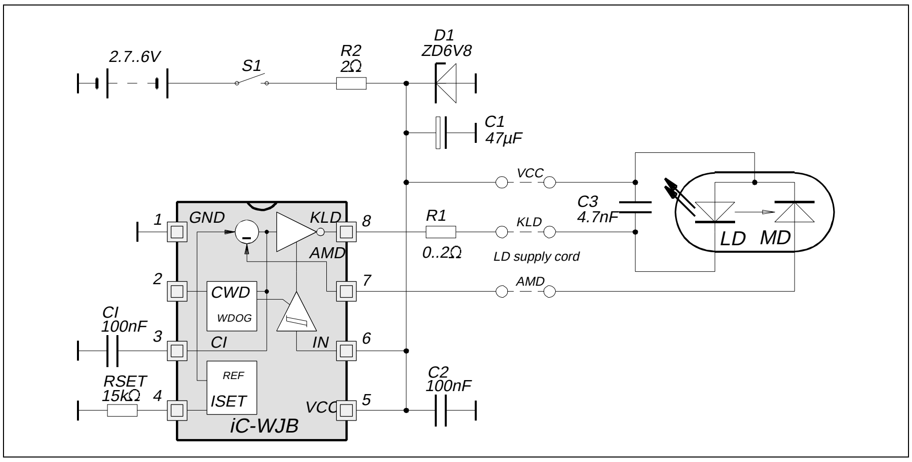


Fig. 10: CW operation via cable plus protective circuitry

Operation of laser diode via cable, protective circuitry

It is recommended to connect a capacitor from 1nF up to 10nF across the laser diode in order to protect the laser diode against destruction due to ESD or build-up transients. This capacitor should be placed close to the laser diode and not at the entry of the LD supply line.

An approx. 12Ω series resistor at pin KLD reduces the IC power consumption and damps possible resonances of the load circuit caused by the inductive LD supply line. This resistor is useful for many applications, also for those which do not operate via cable.

When the LD supply line is printed on the PCB, the forward path VCC should be arranged in parallel with, i.e. be close to the return path to KLD, even when the line is only a few centimeters in length.

Additional protective components for the clipping of strong, positive and negative spikes can be useful, especially when contact bouncing occurs in an inductive accumulator power supply line. Elements which come into question here are D1 and R1 as in Fig. 10.

Analog modulation during CW operation

The modulation cut-off frequency is determined by the capacitor CI as well as by the operating point set with the resistor RSET. With CI= 100nF and RSET= R3= 15kΩ the cut-off frequency is approx. 30kHz, with CI= 22nF and the same resistor value of about 150kHz.

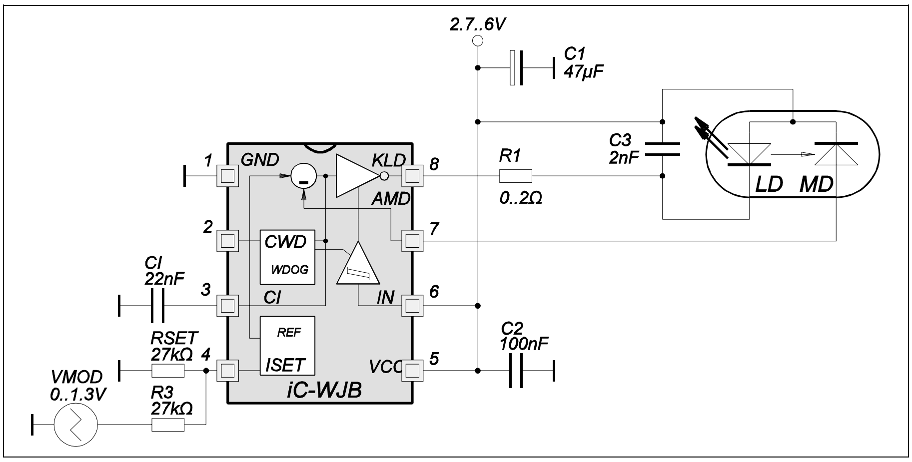


Fig. 11: Analog modulation during CW operation

The laser power can also be modulated by adapting a current source, e.g. by using an operational amplifier with a current output (OTA). To limit the current at pin ISET while turning on the power supply for the OTA circuitry, however, the OTA output should be linked to the base point of RSET (instead of to GND). The maximum current possible at ISET must be taken into consideration when dimensioning the capacitor CI.

PC BOARD LAYOUT

The ground connections of the external components CI, CWD and RSET have to be directly connected at the IC with the GND terminal.

DEMO BOARD

The iC-WJ/WJZ/WJB devices are equipped with a demo board for test purposes. The following figures show the wiring as well as the top and bottom layout of the test PCB.

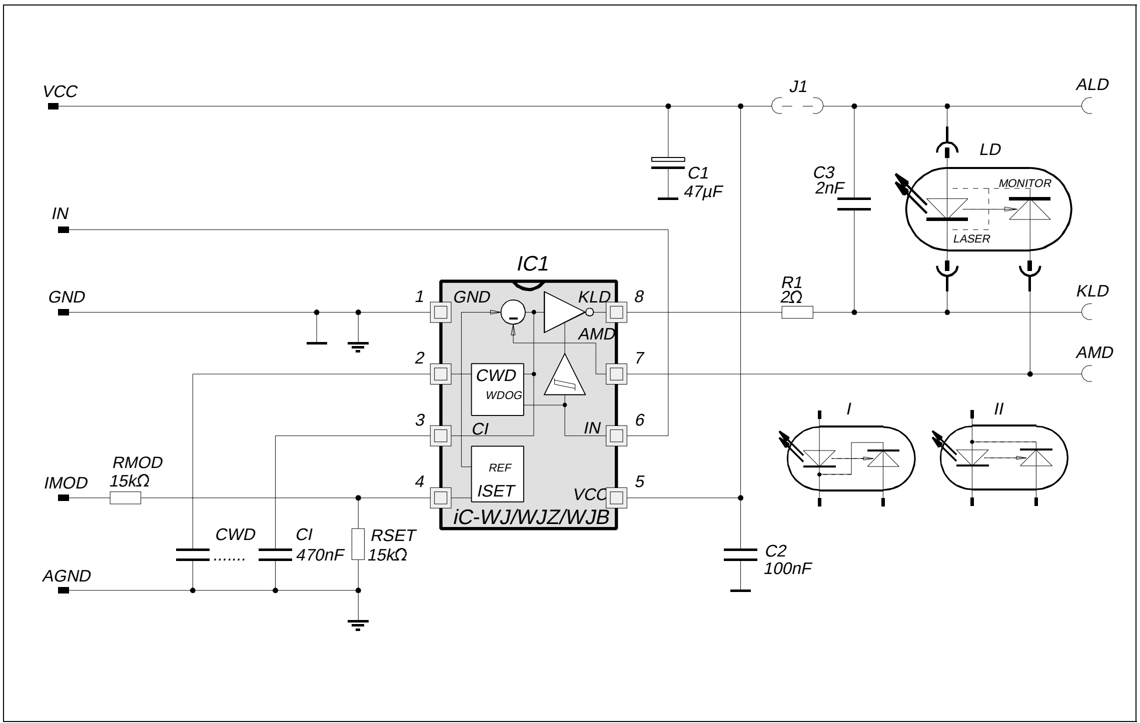


Fig. 12: Schematic diagram of the demo board

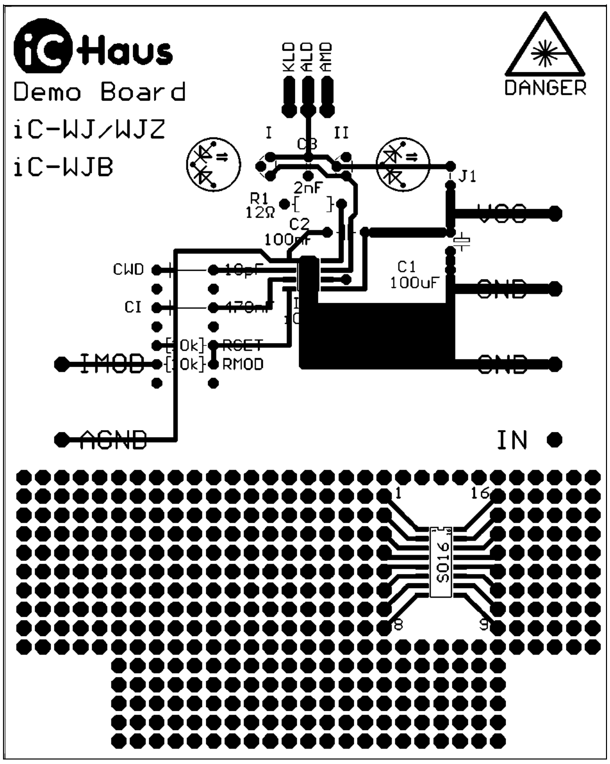


Fig. 13: Demo board (components side)

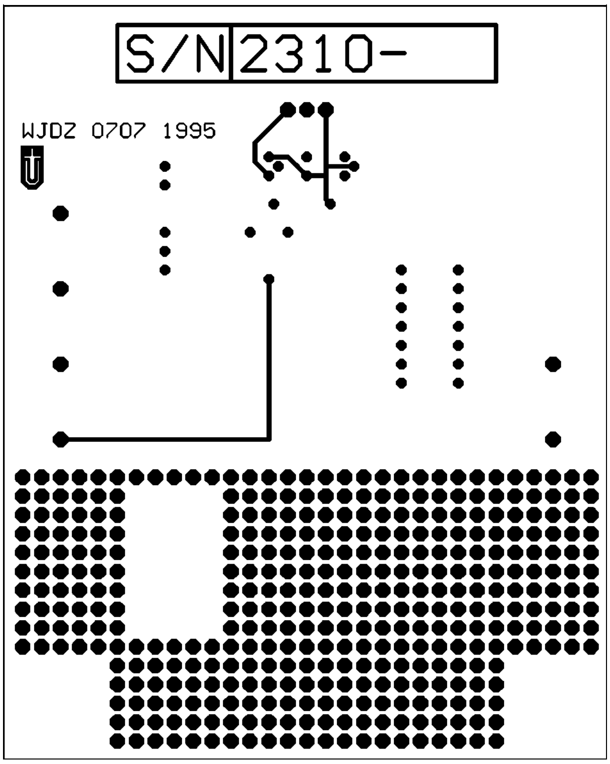


Fig. 14: Demo board (solder dip side)

ORDERING INFORMATION

Type	Package	Order designation
iC-WJB	SO8	iC-WJB SO8
WJB demo board		WJB DEMO

For information about prices, terms of delivery, options for other case types, etc., please contact:

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