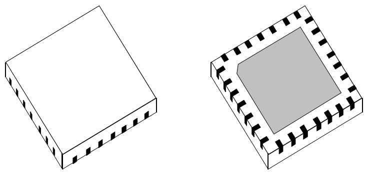
FEATURES

- Peak value controlled threefold laser switch for operation from CW up to 155 MHz
- Spike-free switching of laser currents of 100 mA per channel from 3.5 to 5 V supply voltage
- Single-failure-proof
- System-enable with self test
- Separate setting of laser power for each channel via external resistors
- Strong suppression of transients with very small external capacitors
- Adjustable laser current limitation
- Permanent shutdown with overcurrent, overtemperature and undervoltage
- Autonomous safety circuit for a second diode monitoring the laser power
- All current LD types can be used (M/P/N configurations)
- Error signal output at shutdown and current limitation

APPLICATIONS

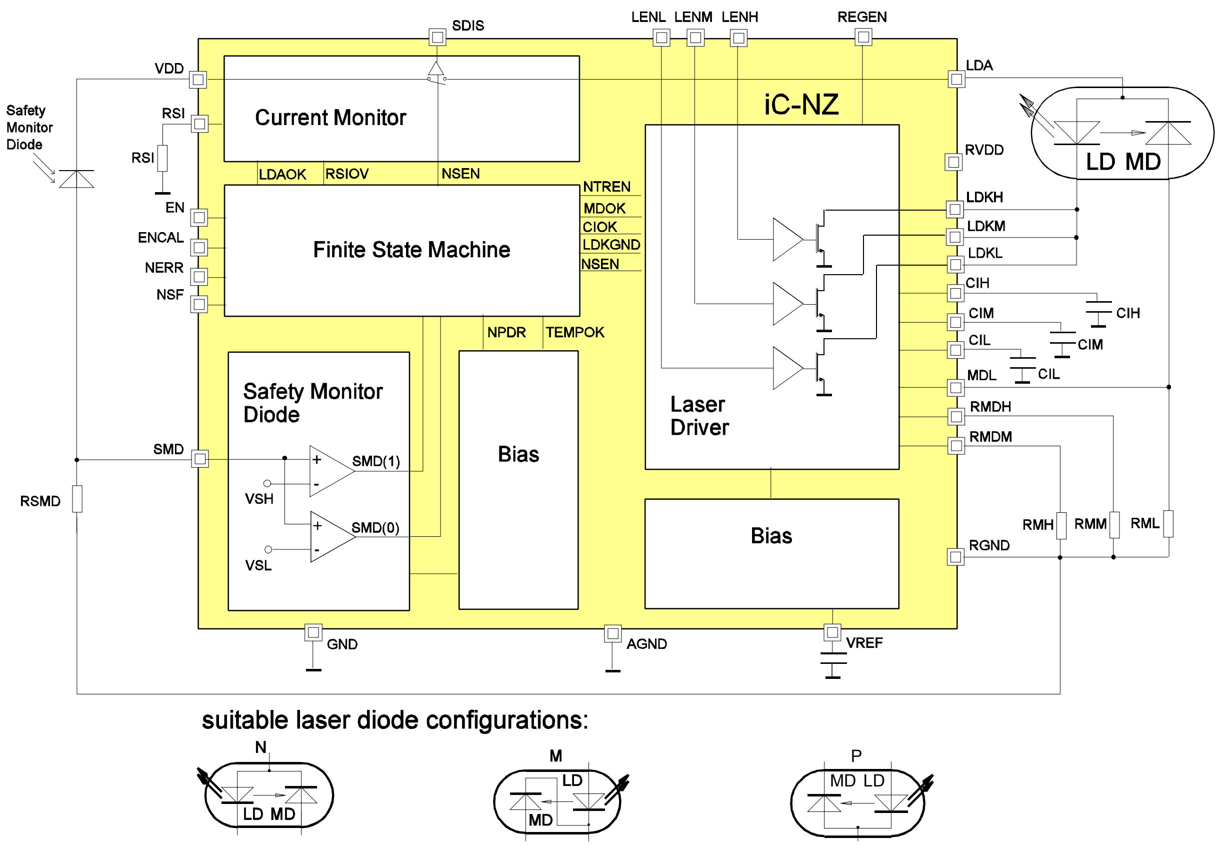
- Pulsed LD modules for safety applications
- Distance measurement

PACKAGES



QFN28 5 x 5 mm²

BLOCK DIAGRAM



DESCRIPTION

Three-channel laser diode pulse regulator iC-NZ enables the continuous wave operation of laser diodes and spike-free switching with defined current pulses in a frequency range of up to 155 MHz. The three channels can be accumulatively pulsed via inputs LENL, LENM and LENH. The peak optical power of the laser diodes is regulated separately for high, middle and low levels and adjusted using the three external resistors RMH, RMM and RML.

The iC is switched on via pin EN which triggers a self-test of the device. The system is enabled if no errors are detected. Any errors are signaled at pin NERR.
The (average) current monitor can be set using external resistor RSI. Overcurrent is signaled at NERR; this causes the iC to be shut down.

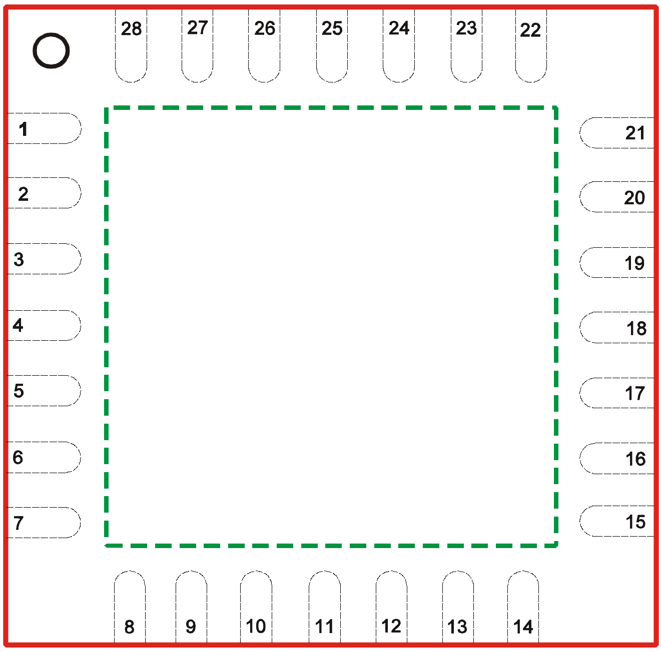
To ensure that the selected laser class is maintained a second monitor input SMD (safety monitor diode) is needed. This optional diode monitors the laser power. Exiting the monitor window set using RSMD triggers a permanent reset. This is reported at output NERR and can be deleted when the system is restarted at EN.

For high pulse frequencies the device can be switched into controlled burst mode at input REGEN. A preset operating point is maintained throughout the burst phase.

When the iC is switched on all safety-relevant signals pertinent to the current monitor, SMD and control unit are checked. These units are in turn monitored for the following: overcurrent, short circuiting, open pins and whether the laser is switched off in terms of output power. With the exception of the latter these checks are carried out intermittently during operation. So that the device is single-failure-proof various safety check routines are also implemented. To this end a second SMD (safety monitor diode) monitoring laser power is required. This must be within a defined area during operation (thus maintaining the laser class). If this area is exited the system is shut down and an error message generated.

PACKAGES QFN28 5 × 5 mm² to JEDEC Standard (MO-220-VHHD-1)

PIN CONFIGURATION QFN28 5 × 5 mm²
(top view)



PIN FUNCTIONS

No.	Name	Function	No.	Name	Function
1	RMDH	APC Setup, Monitor Input Hi	15	LENM	Enable Laser Channel Mid
2	RVDD	Reference (P-type laser diodes)	16	GND	Ground
3	RMDM	APC Setup, Monitor Input Mid	17	LDKM	Cathode Laser Diode Mid
4	NSF	No-Safety Signal	18	AGND	Analog Ground
5	MDL	APC Setup, Monitor Input Lo	19	LDKL	Cathode Laser Diode Lo
6	ENCAL	Enable Calibration	20	LDKH	Cathode Laser Diode Hi
7	RGND	Internal Ground	21	LENH	Enable Laser Channel Hi
8	SMD	Safety Monitor Diode	22	NERR	Error Output
9	GND	Ground	23	EN	Enable Input
10	VREF	Reference Voltage	24	CIH	Power Control Capacitor Hi
11	CIL	Power Control Capacitor Lo	25	LDA	Anode Laser Diode
12	REGEN	Regulator Enable	26	RSI	Current Monitor Setup
13	CIM	Power Control Capacitor Mid	27	SDIS	External Current Limitation
14	LENL	Enable Laser Channel Lo	28	VDD	Power Supply

ABSOLUTE MAXIMUM RATINGS

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

Item	Symbol	Parameter	Conditions	Fig.	Min.	Max.	Unit
G001	VDD	Supply Voltage VDD Current			-0.7	6	V
G002	I(VDD)	Current in VDD				400	mA
G003	I(CIx)	Current in CIx	V(LDA) = 0			5	mA
G004	I(NSF)	Current in NSF				20	mA
G005	I(SMD)	Current in SMD				20	mA
G006	I(NERR)	Current in NERR				20	mA
G007	I(MDL)	Current in MDL				20	mA
G008	I(RMDx)	Current in RMDx				20	mA
G009	I()dig	Current in LENL, LENM, LENH, REGEN, NEN, ENCAL				20	mA
G010	I(LDKx)	Current in LDKx				300	mA
G011	I(LDA)	Current in LDA				400	mA
G012	I(RSI)	Current in RSI				20	mA
G013	I(SDIS)	Current in SDIS				20	mA
G013	I(VREF)	Current in VREF				50	mA
G014	V()c	Voltage at RMDH, RVDD, RMDM, NSF, MDL, ENCAL, SMD, VREF, REGEN, CIx, LENx, NERR, LDA, RSI			-0.7	6	V
G015	V()h	Voltage at LDKx, SDIS			-0.7	20	V
E001	Vd()	ESD Susceptibility at all pins	MIL-STD-883, Method 3015, HBM 100 pF discharged through 1.5 kΩ			2	kV
TG1	Tj	Operating Junction Temperature			-40	150	°C
TG2	Ts	Storage Temperature Range			-40	150	°C

THERMAL DATA

Operating Conditions: VDD = 3.5 ... 5.5 V

Item	Symbol	Parameter	Conditions	Fig.	Min.	Typ.	Max.	Unit
T1	Ta	Operating Ambient Temperature Range (extended range on request)			-20		90	°C
T2	Rthja	Thermal Resistance Chip/Ambient	surface mounted, thermal pad soldered to ca. 2 cm^2 heat sink			30	40	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: VDD = 3.5 ... 5.5 V, Tj = -20 ... 85 °C, x: L, M, H; unless otherwise noted

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
Total Device									
001	VDD	Permissible Supply Voltage				3.5		5.5	V
002	Ioff(VDD)	Supply Current in VDD	EN = lo				460	600	uA
003	Idc(VDD)	Supply Current in VDD	EN = hi, RSI > 780 Ω				6.4	10	mA
004	Tab	Thermal Shutdown Threshold				110		150	°C
005	VDDen	Power-On Threshold		-20 27 125		2.4 2.3 1.4		3 2.8 2.8	V V V
006	Vc()hi	Clamp Voltage hi at REGEN, LENH, LENM, LENL, EN, ENCAL, LDA, NERR, NSF	I() = 1 mA, other pins open, VDD = 0			0.5		1.5	V
007	Vc()hi	Clamp Voltage hi at CIx, MDL, RMDH, RMDM SMD	I() = 1 mA, other pins open, VDD = 0			0.5		1.5	V
008	Vc()hi	Clamp Voltage hi at LDKx, SDIS	I() = 1 mA, other pins open,			20			V
009	Vc()hi	Clamp Voltage hi at RSI, VREF	I() = 1 mA, other pins open, VDD = 0			0.5	0.9	1.5	V
010	Vc()lo	Clamp Voltage lo	I() = 1 mA, other pins open			-1.5	-0.65	-0.5	V
Reference									
101	V(MDL)	Voltage at MDL, VDD - V(MDL) for P-type LD	closed control loop			480	500	520	mV
102	dV(MDL)	Temperature Drift of Voltage at MDL	closed control loop					120	uV/°C
103	I()	Current in MDL, RMDM, RMDH	LENL, LENM, LENH = hi			-300		300	nA
105	V(VREF)	Voltage at VREF, VDD - VREF for P-type LD	iC active			470	500	530	mV
Digital Inputs									
201	Ipd()	Pull-Down Current in LENx, REGEN, ENCAL, EN	V(LDA) = V(VDD)			1	4	10	uA
202	Vt()	Threshold Voltage at LENx, REGEN, ENCAL, EN	VDD = 5 V			0.75	1.8	2.2	V
203	Vhys()	Hysteresis					800		mV
204	Ipd (REGEN)	Pull-Down Current in REGEN	V(REGEN) = VDD V(SMD) > VSL, V(ENCAL) = hi			0.1		0.5	mA
Safety Monitor Diode									
301	VSL	Monitor Threshold lo, Signal SMD(0)				275	300	320	mV
302	VSH	Monitor Threshold hi, Signal SMD(1)				675	700	720	mV
303	dVS	VSH - VSL					400		mV
304	VCHK	Test Voltage for SMD				102		104	% VSH
306	VLDA	LDAOK Monitor Threshold VDD - V(LDA)				485	500	515	mV
307	VCI()	REGOK Monitor Threshold				100	760	900	mV
308	C(CIx)	Capacitance at CIx				100			nF
309	I(CIx)	Charge Current from CIx	iC active, control unit not yet settled			-0.4	-0.6	-1	mA
310	I(CIx)	Discharge Current in CIx	iC inactive, V(CIx) > 1 V			10		60	mA
311	Ipd(CIx)	Pull-Down Current in CIx	iC active, REGEN = lo			25		100	nA

ELECTRICAL CHARACTERISTICS

Operating Conditions: VDD = 3.5 ... 5.5 V, Tj = -20 ... 85 °C, x: L, M, H; unless otherwise noted

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
312	I(RMDx)	Permissible Laser Monitor Diode Current	active safety funktion, VDD = 5 V					2.5	mA
313	I(RSMD)	Permissible Safety Monitor Diode Current						5	mA
314	Ipd(SMD)	Pull-Down Current in SMD				0.2	0.6	3	uA
Laser Drive LDA, LDKx									
401	Vs(LDKx)	Saturation Voltage at LDKx	one channel only is activated, I(LDK) = 100 mA I(LDK) = 60 mA				 1.2 0.8	 2 1.2	 V V
402	Idc (LDKL)	Permissible Current	DC					120	mA
403	Idc (LDKM)	Permissible Current	DC					100	mA
404	Idc (LDKH)	Permissible Current	DC					100	mA
Status Outputs									
501	I(NERR)	Current at Error Message	V(LDA) = V(VDD) = V(NERR), error state			1.5		10	mA
502	I(NERR)	Current in NERR	V(LDA) = V(VDD) = V(NERR), no error state, V(MDL) < 0.5 V			0.1		1	mA
503	I(NSF)	Current at NSF Message	V(LDA) = V(VDD) = V(NSF)			1.5		10	mA
504	I(SDIS)	Current at SDIS Message	V(LDA) = V(VDD) = V(SDIS)			1.5		10	mA
505	Vsat()	Saturation Voltage at NERR, NSF, SDIS	Isat = 1 mA, NERR in error state					600	mV
506	Vo()	Permissible Voltage at SDIS						20	V
Current Monitor RSI, LDA									
601	V(RSI)	Controlled Voltage at RSI	EN = hi			480	500	520	mV
602	RSI	Resistor at RSI				780		9000	Ω
603	Idc(LDA)	Current from LDA	DC					320	mA
604	Rpd (LDA)	Pull-Down Resistor at LDA	Reset					1	kΩ
605	td(SDIS)	Overcurrent Shutdown Delay	I(LDA) > I(RSI) * 500					10	us
606	rILDA	Current Ratio I(LDA)max/I(RSI)	780 Ω < RSI < 9000 Ω				500		
607	Ipd(RSI)	Pull-Down Current in RSI	V(RSI) > 0.5 V			3		10	uA
Timing									
701	ten	Propagation Time: EN lo → hi System-enable	no error at self test, CLDA = 1 µF					300	µs
702	tr	Laser Current Rise Time			4			1.5	ns
703	tf	Laser Current Fall Time			4			1.5	ns
704	tplh	Propagation Time: LENx lo → hi to Current lo → hi			2			10	ns
705	tphl	Propagation Time: LENx hi → lo to Current hi → lo			2			10	ns
706	ts0	Propagation Time: V(SMD) > VSL to SMD(0) lo → hi			3			200	ns
707	ts1	Propagation Time: V(SMD) > VSH to SMD(1) lo → hi			3			200	ns
708	toff	Propagation Time: SMD(1) lo → hi until shutdown			3			10	ns

ELECTRICAL CHARACTERISTICS

Operating Conditions: VDD = 3.5 ... 5.5 V, Tj = -20 ... 85 °C, x: L, M, H; unless otherwise noted

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
709	td	Propagation Time: SMD(1) lo → hi until Error Message			3			500	ns

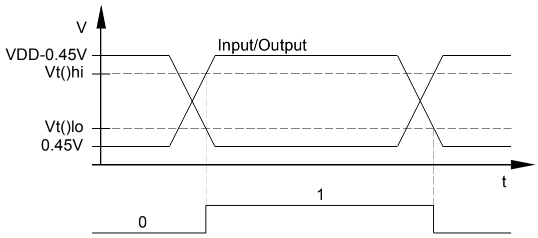


Figure 1: Reference levels

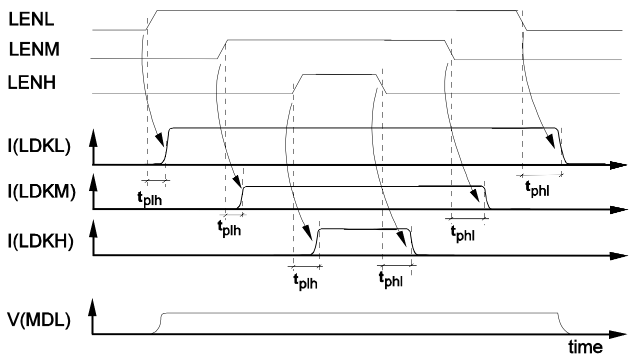


Figure 2: Turn on/turn off behavior of the laser current

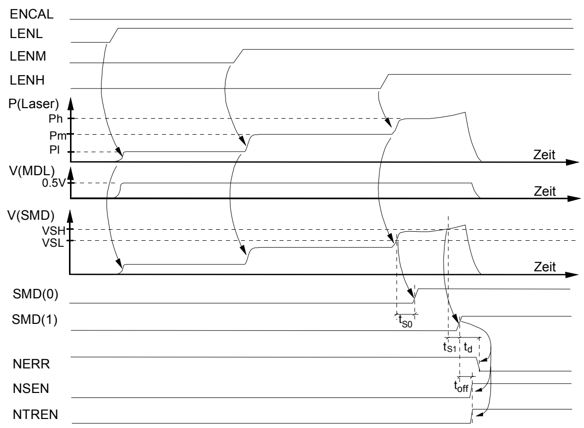


Figure 3: Safety shutdown times with failure of the control unit, for example

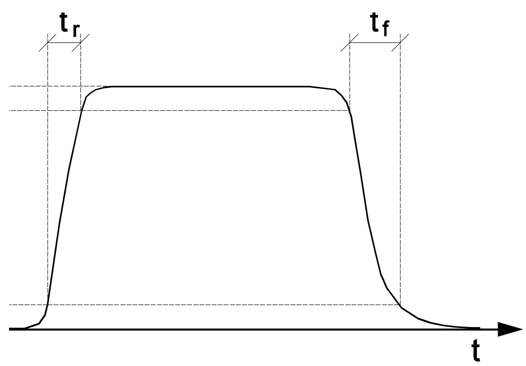


Figure 4: Laser current pulse

DESCRIPTION OF FUNCTIONS

iC-NZ is a three-channel laser diode pulse regulator which is single-failure-proof and able to maintain a selected laser class. The device includes the following functions:

- Monitoring of the laser current
- Switching of three laser light intensity levels which are regulated separately
- Single-failure-proof via laser light monitoring using a second monitor diode and shutdown of the laser in the event of error via three separate, independent switches
- External error messaging
- Pulses of up to 155 MHz in controlled burst mode, during which a set operating point is maintained
- Extension of the laser current with few external components
- Operation of blue laser diodes possible

To simplify the initial operation of iC-NZ the following passage first outlines the basic steps involved and then goes on to provide details referring to the demo board available for evaluation. A HL6339G HITACHI laser diode has been used here by way of example.

Monitoring the laser current

iC-NZ monitors the laser current flowing from pin LDA (Figure 5). The DC current threshold is set using a resistor at pin RSI. If this threshold is exceeded, the device is shut down for safety reasons.

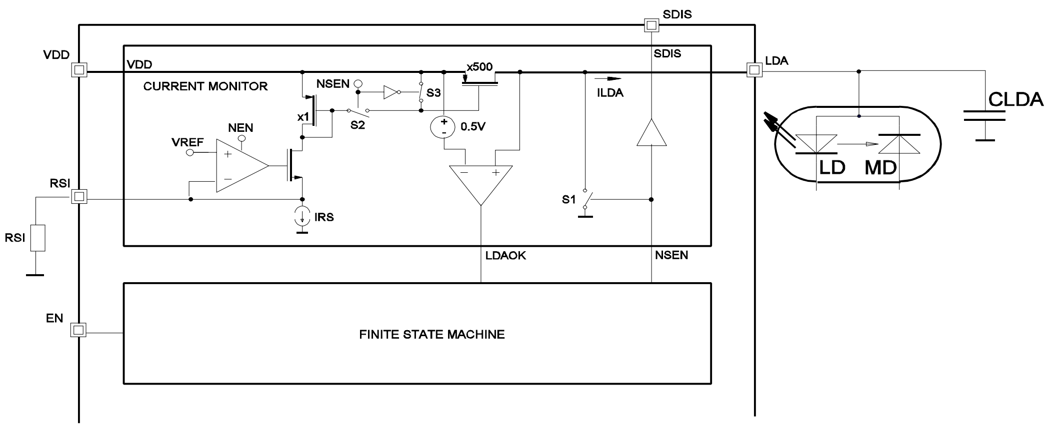


Figure 5: Current monitor

When dimensioning resistor RSI the following applies:

$$I_{max}(LDA) = 500 \times (0.5\ V / RSI).$$

Short pulses with higher currents are also possible as the DC current is monitored. Capacitor CLDA supplies the current for short, higher pulses.

Demo board:

According to the manufacturer's specifications laser diode HL6339G requires a maximum current of 70 mA for an optical power of 5 mW. For this maximum 70 mA current RSI is calculated as:

$$RSI = 500 \times (0.5\ V / 70\ mA) = 3.5\ k\Omega.$$

Switching up to three laser power levels:

The following steps must be taken to set the required optical power:

1. Enabling the system
2. Calibrating the low and middle channels
3. Calibrating the high channel

1. Enabling the system

Before iC-NZ is put into operation for the first time the external circuitry should be checked for the following (see block diagram):

- Resistor RSMD should be of low impedance. It may not, however, be lower than 250 Ω, otherwise the internal iC check will generate an error message.
- The resistors at pins RMDL, RMDM and RMDH should be of high impedance (low output).
- Inputs LENL, LENM and LENH should be switched to low (the driver stages switched off).

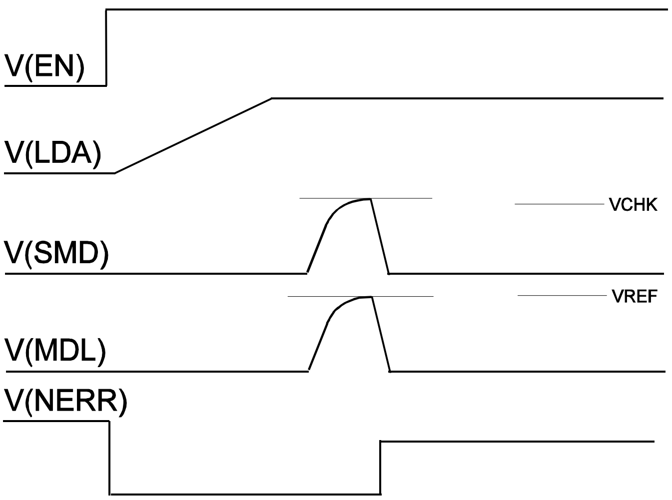


Figure 6: Signal pattern when the system is enabled

So that iC-NZ can be switched on pin EN must be set to high and pin ENCAL to low. A current in the milliamp range (Electrical Characteristics No. 501) now flows into pin NERR. This indicates that the device is now in its startup phase. The voltage at pin RSI is set to 0.5 V and capacitor CLDA charged at pin LDA. Once voltage V(LDA) has reached its final value the control unit and safety monitor diode are checked, if the latter is in use (see also "Operation without a second monitor diode"). Following this check the current into pin NERR is lowered (Electrical Characteristics No. 502). The residual current still remaining (ca. 500 µA) indicates that the control unit is not yet in operation (N type: V(MDL) < 0.5 V, P type: VDD - V(MDL) < 0.5 V). The entire process is described in Figure 6.

Demo board:

Before the demo board is put into operation trimmers PSMDL, PML, PMM and PMH should be set to the left and trimmer PSMDH to its center setting.

Possible sources of error:

- V(NERR) remains at low:
  - Check the current in NERR. Is the impedance of the pull-up resistor too high?
- Too high a current is flowing through pin NERR:
  An error has occurred during the device self-test. Check the following:
  - Is ENCAL lo?
  - Is RSMD of too low an impedance? RSMD may not be lower than 250 Ω.
  - Is pin SMD open or has it directly short-circuited with VCC?
  - Is there a direct connection between pin LDK and ground?
  - Is there a low-impedance connection between pin LDA and ground?
  - Have all CIx capacitors (x: L, M, H) been properly soldered and placed close to the iC?
  - Is VCC blocked?

2. Calibrating the low and middle channels

So that the optical power can be regulated pin REGEN must be set to high. The level at pin ENCAL is of no consequence when setting the low and middle channels.

Setting the low output level:

Pin LENL is first switched from low to high. The integration capacitor at CIL is then charged. Until the control unit has settled a small amount of current flows in pin NERR. Following this the voltage at pin MDL is 0.5 V for an N-type diode and VDD – 0.5 V for a P-type diode. The required optical power can now be set at resistor RML.

Demo board:

By way of example, three output levels of 1 mW, 3 mW and 5 mW are to be set. With an optical power of 1 mW laser diode HL6339G has a typical monitor current (I_M) of 15 µA. The following value is then obtained for the resistor at pin MDL (RMLn = PML + RML):

$$RMLn = V(MDL) / I_M = 0.5\ V / 15\ \mu A = \underline{\underline{33.34\ k\Omega}}.$$

Setting the middle channel:

Pin LENL must remain at high and LENM be switched from low to high. Following the settling of the control unit at CIM (N type: V(MDL) < 0.5 V; P type: VDD - V(MDL) < 0.5 V) the required optical power can be set at resistor RMM.

Demo board:

With an optical power of 3 mW the monitor current (I_M) is 43 µA. This current must flow through the parallel connection of RMLn and RMMn (RMMn = PMM + RMM). The following then applies:

$$RMLn \parallel RMMn = V(MDL) / I_M = 0.5\ V / 43\ \mu A = 11.62\ k\Omega$$

$$RMMn = RMLn \parallel RMMn \times RMLn / (RMLn - RMLn \parallel RMMn)$$

$$RMMn = 33.34\ k\Omega \times 11.62\ k\Omega / (33.34\ k\Omega - 11.62\ k\Omega) = \underline{\underline{17.84\ k\Omega}}.$$

3. Calibrating the high channel

Here, pins REGEN and ENCAL must be high. This deactivates the monitoring of the optical power, thus enabling the calibration of the high output level. Pins LENL and LENM must remain at high; pin LENH must also be switched from low to high. Following the settling of the control unit at CIH the required optical power can be set at resistor RMH.

Demo board:

With an optical power of 5 mW laser diode HL6339G has a typical monitor current (I_M) of 80 µA. The following value is then obtained for resistor RMHn = PMH + RMH:

RMLn || RMMn || RMHn = V(MDL) / I_M = 0.5 V / 80 µA = 6.25 kΩ

RMHn = RMLn || RMMn || RMHn × RMLn || RMMn / (RMLn || RMMn - RMLn || RMMn || RMHn)

RMHn= 17.84 kΩ × 6.25 kΩ / (17.84 kΩ - 6.25 kΩ) = 9.62 kΩ.

Possible sources of error:

- V(NERR) remains at low:
  – Check the current in NERR. Is the impedance of the pull-up resistor too high?
- Too high a current is flowing at pin NERR (ERROR state):
  – Is the laser diode properly connected and the control unit functioning correctly?
  – Are RMDL, RMDM or RMDH of too low an impedance? (Possible shutdown due to overcurrent!)
  – Are all the capacitors at CIx (x: L, M, H) large enough and have they been properly soldered?
  – Is pin AGND connected to ground?
- No laser light:
  – Is pin AGND connected to ground?
  – Is there a short circuit between CIx and ground?
  – Is the laser diode (type N or P) properly connected and the control unit functioning correctly?
  – The laser diode lights up for a few seconds and then turns off:
    Is the laser diode too hot? With insufficient cooling the laser diode power consumption increases which can trigger an overcurrent shutdown.

Demo board:

When using an N-type laser diode jumper J2 must be placed between pins 2 and 3 on the demo board. If a P-type laser diode is used the jumper must be connected between pins 1 and 2.

Warning!

Following calibration pin EN has to be briefly set to low before actual operation may start with EN set to high again. The following explains why.
When the low channel (LENL -> hi) is switched on capacitor CIL is charged. When the middle channel is switched in the internal control unit switches to CIM and starts to charge it. The voltage at CIL is then no longer regulated. As residual current could boost the voltage at CIL, which in turn would increase the current in the low channel, thus the capacitor at CIL is actively discharged with a maximum of 100 nA. The current in the low channel slowly decreases. As the control unit endeavors to keep the optical power constant, the capacitor at CIM is charged at the same rate as CIL is gradually discharged. If the middle channel is now switched off, the control unit switches back to the low channel. Capacitor CIL is regulated again; CIM, however, remains charged. If the middle channel were then again to be switched on, far too much current would flow; this could destroy the laser diode. The same happens if the low and middle channels are regulated and the high channel switched on for a

lengthy period of time. In this instance CIL and CIM are slowly discharged and the voltage at CIH rises in order to maintain a constant optical power. The entire process is illustrated in Figure 9.

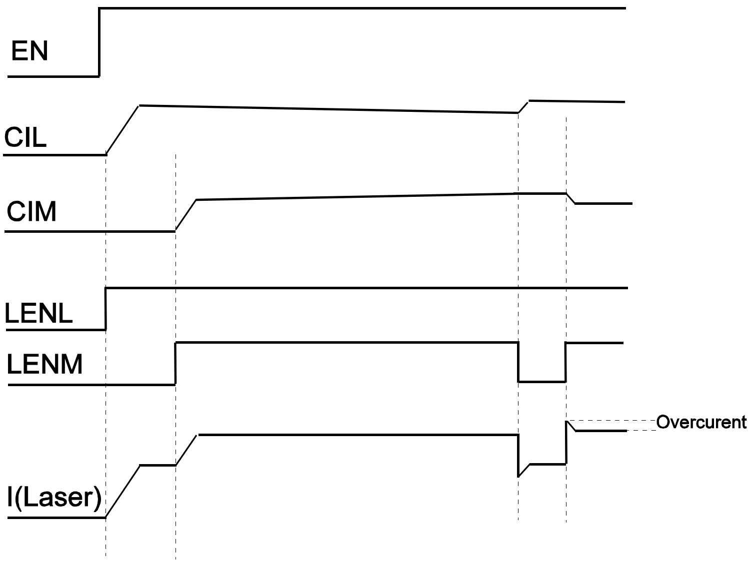


Figure 7: Behavior with very long power-on times

Operation with one or two channels:

It is of course also possible to operate iC-NZ with one or two levels of light intensity. To make use of the safety functions of the system in one- or two-channel mode, pins LDKx (x: L, M) on the unused channels must be kept unconnected and the relevant LENx inputs switched to high. Nodes CIx should be directly short-circuited with AGND. To use the safety functions of the safety monitor diode the high channel must always be in use in one- or two-channel mode. Figures 8 to 11 give the configuration of iC-NZ for one- or two-channel operation for both N- and P-type laser diodes.

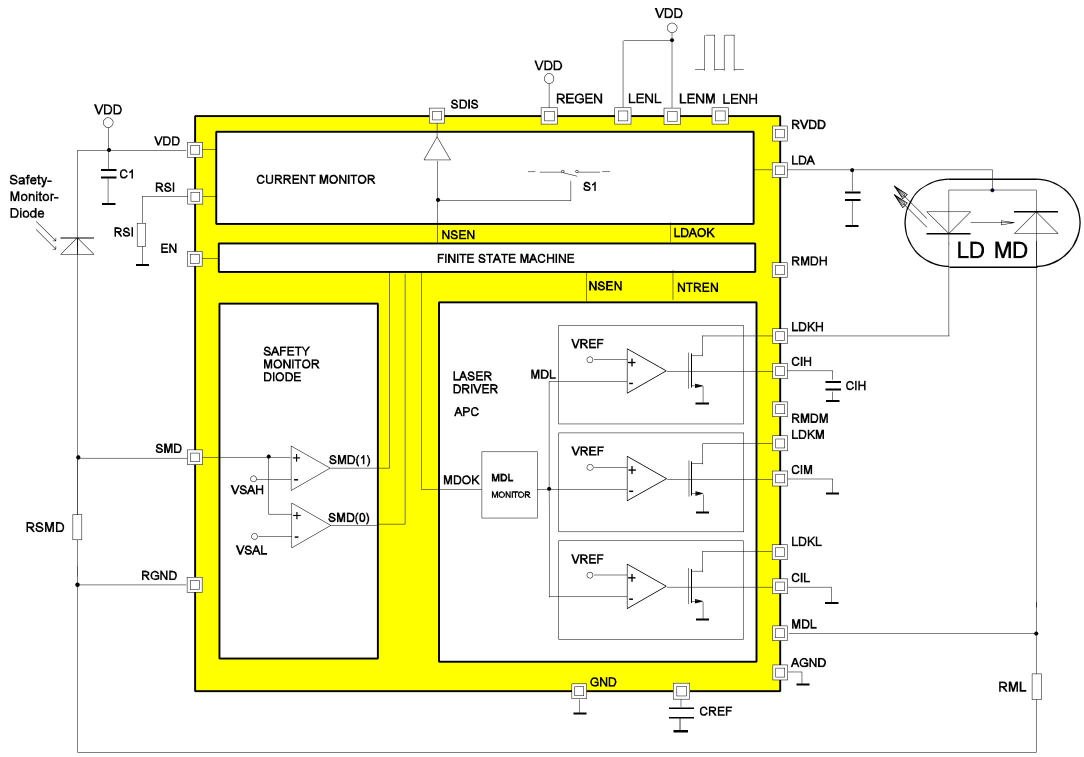


Figure 8: One-channel operation with safety function (N-type laser diode)

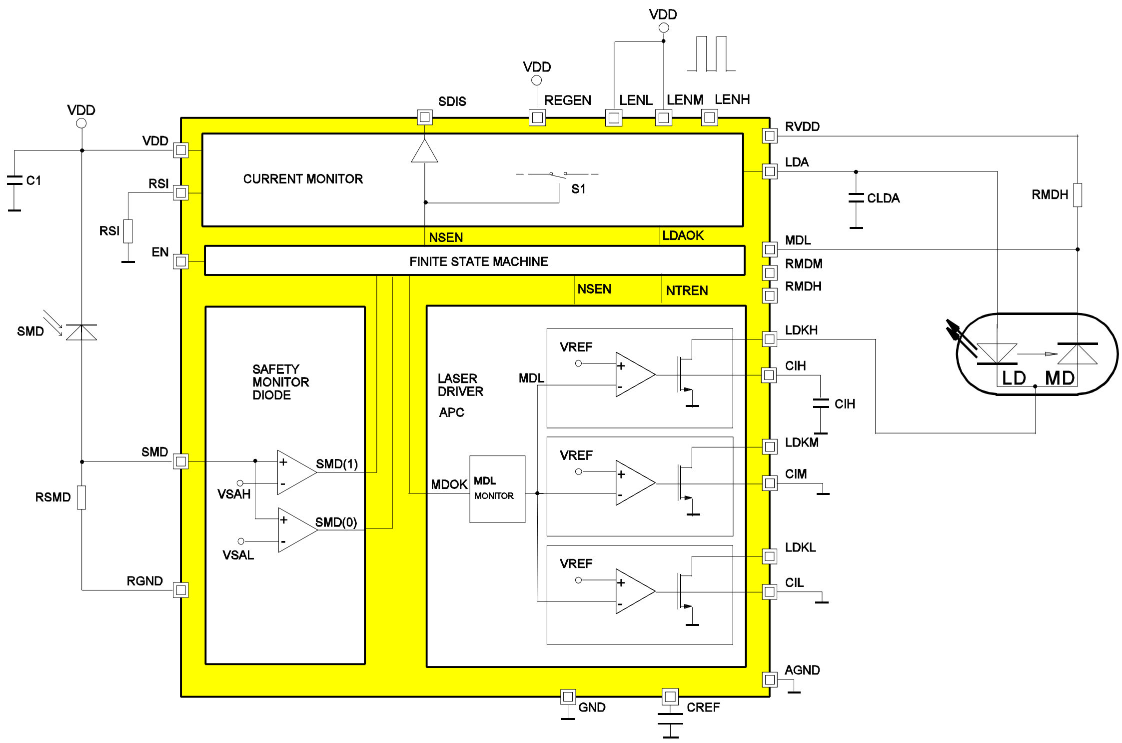


Figure 9: One-channel operation with safety function (P-type laser diode)

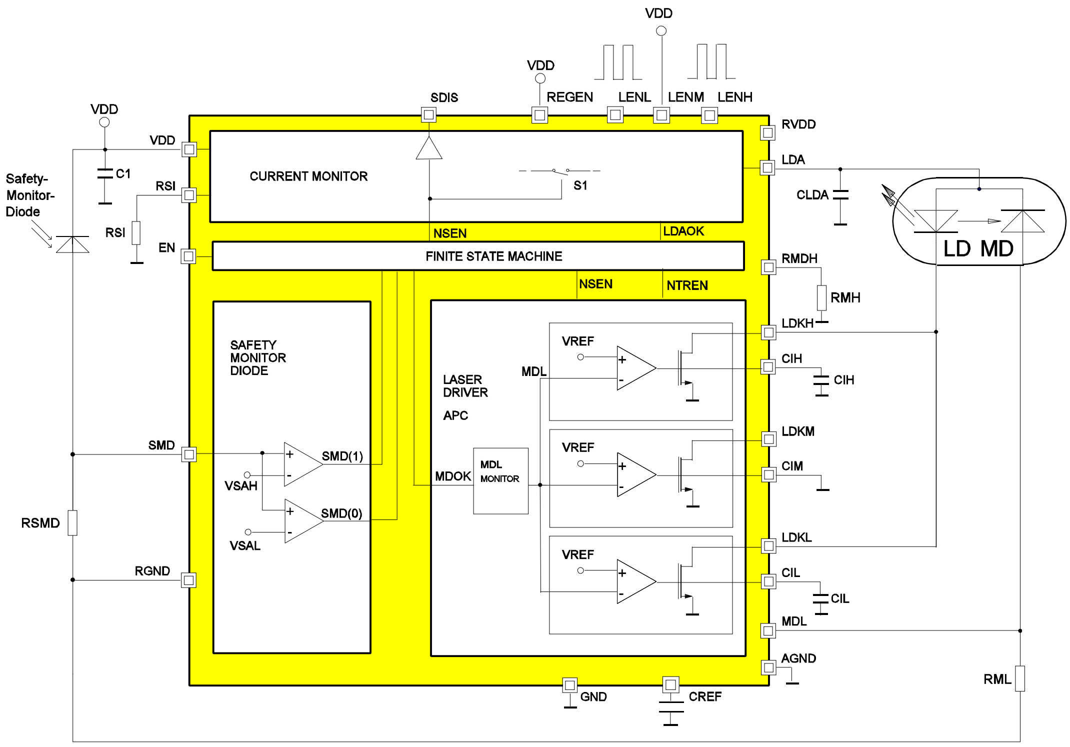


Figure 10: Two-channel operation with safety function (N-type laser diode)

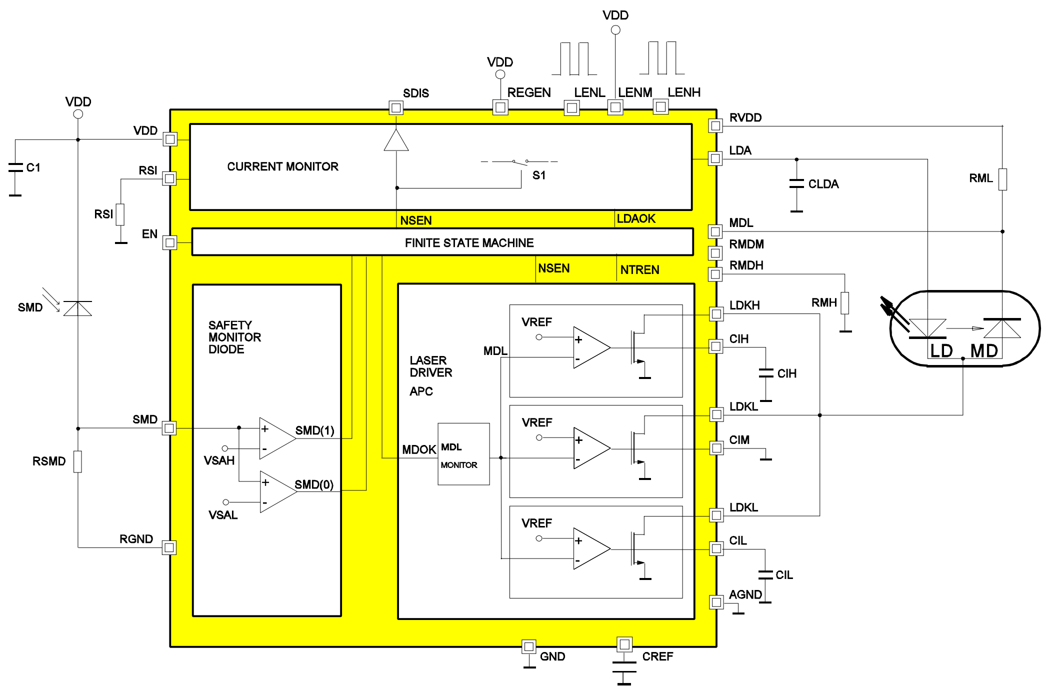


Figure 11: Two-channel operation with safety function (P-type laser diode)

Single-failure protection

Maintaining the laser class and the single-failure protection feature are achieved by means of a second monitor diode and by monitoring the laser current. Further safety is provided by the layout of the laser driver stages. The output stages consist of several identical driver cells where each cell can discharge the integration capacitor CIx (x: L, M, H) and shut down the laser current. So that the laser can be switched off in the event of error iC-NZ has three completely separate circuits. The second diode monitors whether the laser light is within a predetermined power range or not.

<u>Calibrating the safety monitor diode</u>

To calibrate the safety monitor diode iC-NZ is first activated via EN (low -> high) with ENCAL at low. Once the device self-test has been successfully carried out (NERR is high) pin ENCAL must be set to high and the system switched to maximum optical power (pins LENL, LENM and LENH switched to high). Resistor RSMD at pin SMD is now set so that voltage V(SMD) is inside the monitor window between 0.3 V and 0.7 V. ENCAL can now be switched back to low.

In applications with a low duty cycle both the peak and average laser power must be monitored to maintain the laser class. To this end the resistor at RSMD is split into RSMD1 and RSMD2 and a capacitor (CSMD) connected in parallel to RSMD1 (see Figure 12). With short laser light pulses capacitor CSMD behaves as if it is a short circuit and bypasses RSMD1. In this instance only RSMD2 is active (higher shutdown threshold). With longer pulses resistors RSMD1 and RSMD2 are in series (lower shutdown threshold). This setup dynamically alters the monitor window. An excess of the maximum permissible laser power through both too high a pulse power or too long a pulse duration is equally detected.

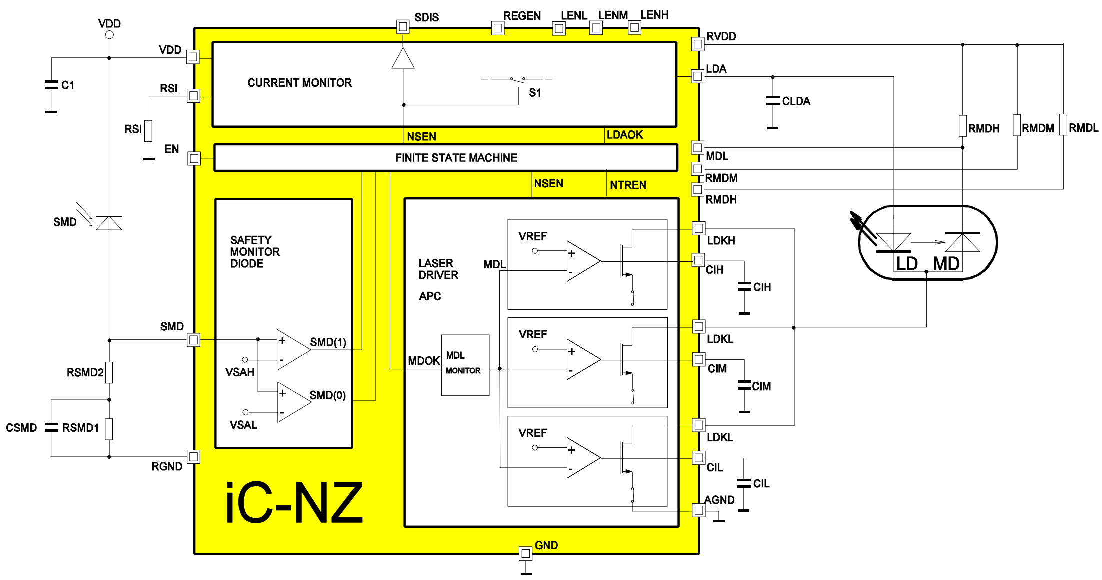


Figure 12: Dynamic adaptation of the monitor window

Demo board:

So that the second monitor diode can be used jumper J1 must be placed between pins 1 and 2 on the demo board. The voltage at SMD is set using the two potentiometers PSMDH (peak) and PSMDL (average).

Operation without a second monitor diode:

The monitoring function can disabled for applications which do not require a second monitor diode. To this end pins SMD and ENCAL must be set to high. This no safety function (NSF) is signaled at pin NSF. The overcurrent monitor at LDA is, however, still active in this mode. This ensures safe operation with what are known as low-power applications – even without a second monitor diode. Figures 13 and 14 give the circuitry for N- and P-type laser diodes.

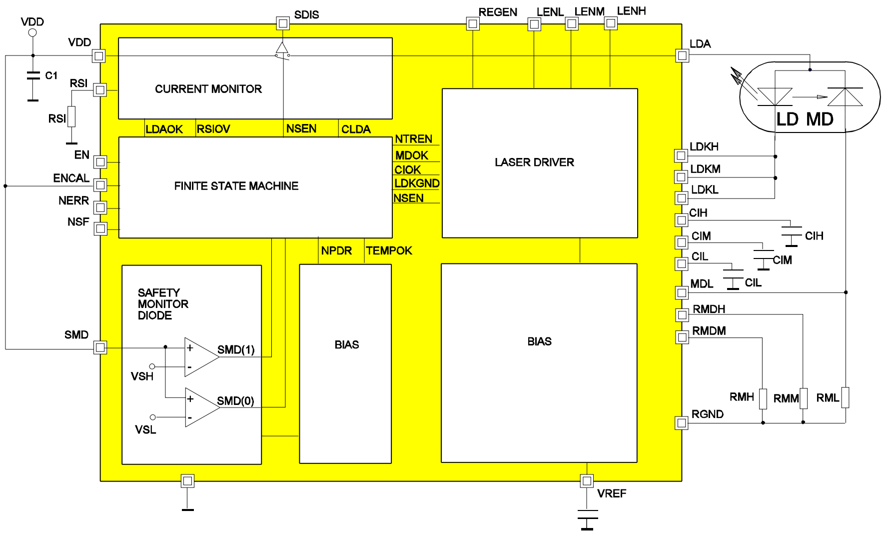


Figure 13: Operation without a second monitor diode (N-type laser diode)

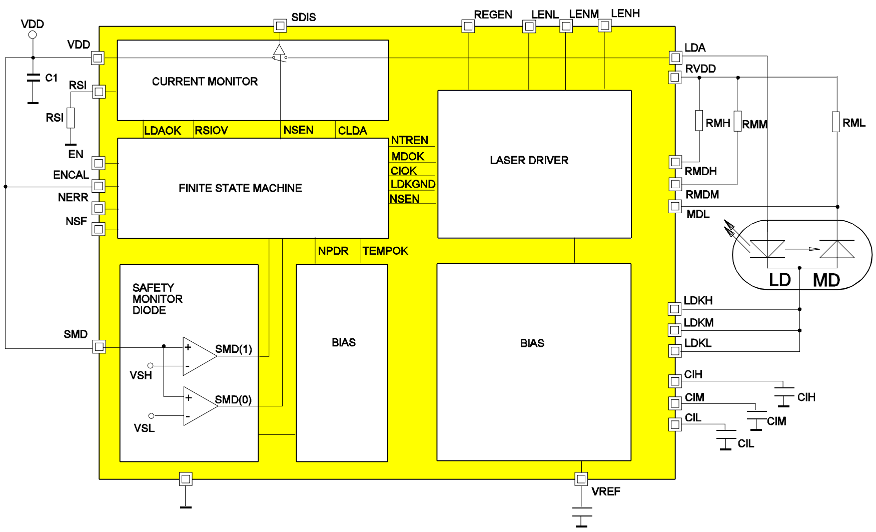


Figure 14: Operation without a second monitor diode (P-type laser diode)

Demo board:

So that the demo board can be operated without a second monitor diode, jumper J1 must be placed between pins 2 and 3.

Status outputs NERR and NSF

Pin NERR is an open-collector output with three states:

I(NERR) = 0 mA	->	Pin EN is low or the control unit is operational (no error) N-type laser diode: V(MDL) = 0.5 V P-type laser diode: V(MDL) = VDD - 0.5 V
I(NERR) > 1.5 mA	->	Error or iC-NZ is still undergoing its self-test
0 < I(NERR) < 1.5 mA	->	No error, the control unit is not yet settled or not enough laser light N-type laser diode: V(MDL) < 0.5 V P-type laser diode: V(MDL) < VDD - 0.5 V

Pin NSF is also an open-collector output and signals the no safety mode:

I(NSF) > 1.5 mA	->	iC-NZ is in safety mode; operation with a second monitor diode
I(NSF) = 0 mA	->	iC-NZ is in no safety mode; operation without a second monitor diode

Controlled burst mode

In controlled burst mode iC-NZ can pulse with up to 155 MHz, thus making it suitable for use in laser projection or data transmission. "Controlled" here means that a preset operating point is maintained during rapid pulsing or the burst phase.

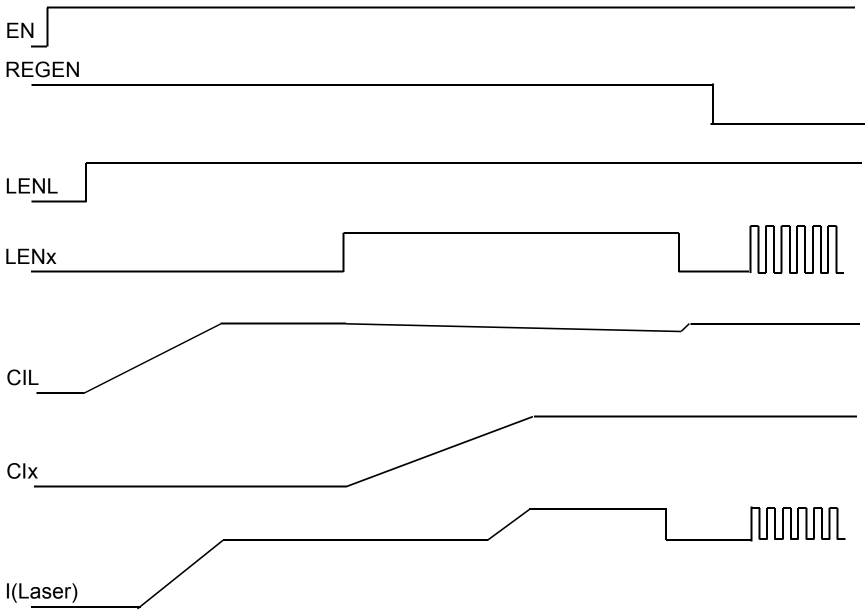


Figure 15: Controlled burst mode

A low power level is first regulated, for which REGEN and LENL must be high. Following this the middle or high power level can be set (LENx -> high). The control unit then switches over to the middle or high channel. As only one channel can be regulated at any one time and as the voltage at CIL must not increase by residual current (this could destroy the laser diode) the capacitor at CIL is discharged with a maximum of 100 nA. Once CIx has been regulated LENx can return to low. REGEN at low switches into burst mode and thus turns the control unit off. The preset operating point is maintained. To prevent the laser current rising due to residual current the capacitors for the three channels are discharged with a maximum of 100 nA. This process is illustrated in Figure 15. As the capacitors are discharged gradually the output levels must be regulated again after a certain period. With an integration capacitance (CIx) of 100 nF, for example, the level must again be regulated after 500 µs, with this rising to 1 ms with 200 nF.

Extending the laser current

iC-NZ also has a high-current mode. Here, the laser current no longer flows through the iC but passes instead through the external circuitry (RLDA, Q1, iC-HK); pin RSI is switched to VDD. The current monitor is still active and the shutdown threshold can be set using RLDA. iC-HK is a fast, spike-free laser switch with which up to 1.4 A can be driven in pulsed operation. An iC-HK can be connected to each channel on iC-NZ so that a maximum laser pulse current of 4.2 A can be achieved (depending on pulse frequency, duty cycle and thermal dissipation). To this end pins CIx (x: L, M, H) on iC-NZ must be connected to the CI inputs of the relevant iC-HK and iC-NZ inputs LENx to iC-HK inputs EN1 and EN2 (Figure 16). Individual levels are set as described above in "Switching up to three laser power levels".

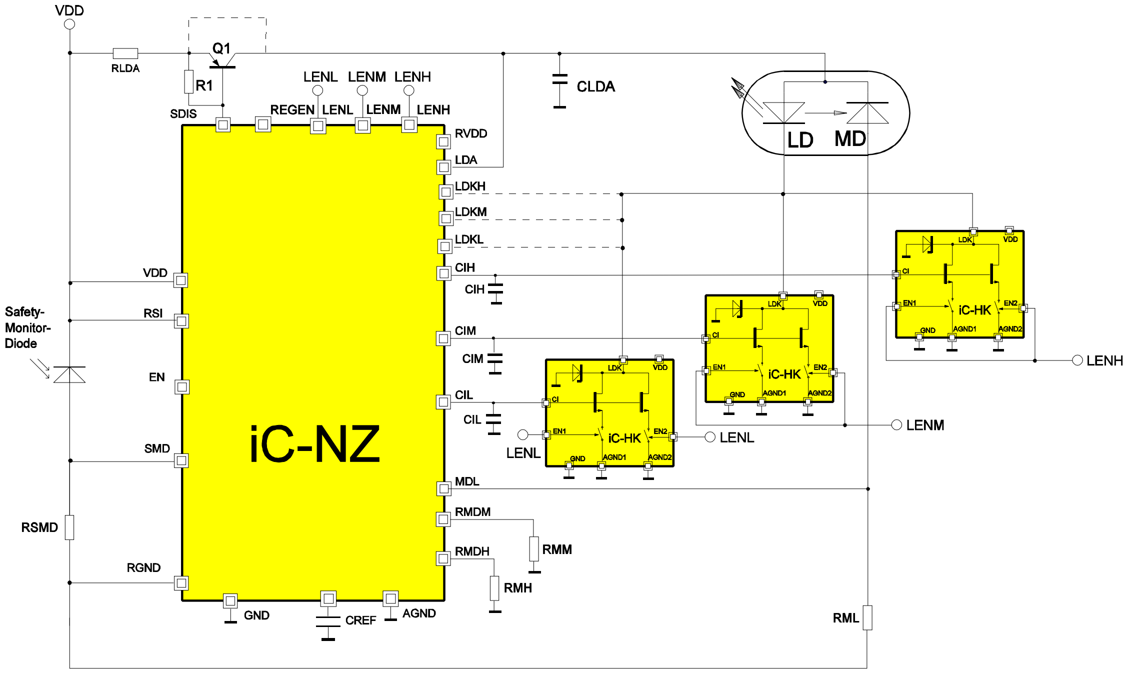


Figure 16: Extending the laser current

Driving blue laser diodes

It is also possible to drive blue laser diodes with iC-NZ. The laser diode is then directly powered by a second, higher voltage. The laser power is set as described above in "Switching up to three laser power levels". Figure 17 shows iC-NZ connected up to a blue laser diode. It is important to note that here the laser diode supply voltage should be as low as possible to keep iC power dissipation to a minimum.

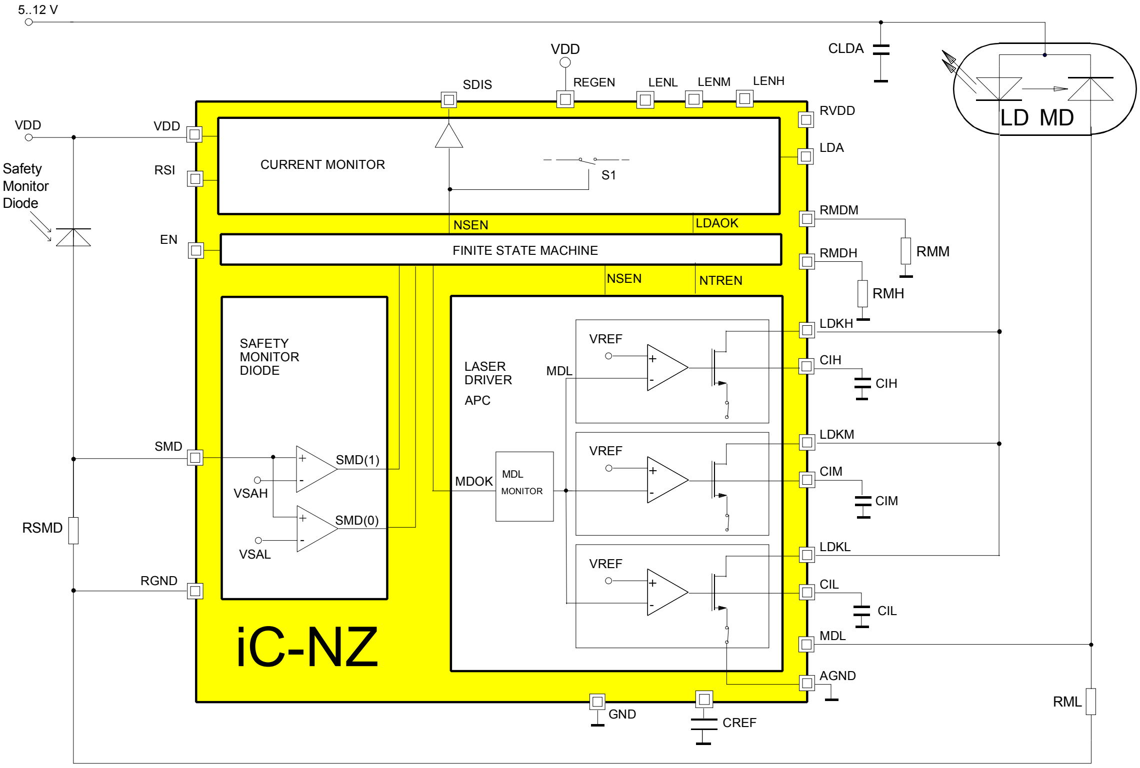


Figure 17: Driving blue laser diodes

DEMO BOARD

The iC-NZ device is equipped with a Demo Board for test purposes. A description of the demo board is available as a separate document.

ORDERING INFORMATION

Type	Package	Order designation
iC-NZ	QFN28 5 x 5 mm²	iC-NZ QFN28
NZ Demo Board		NZ1D DEMO

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

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