DATA SHEET

TZA3011A; TZA3011B
30 Mbits/s up to 3.2 Gbits/s, A-rate™ laser drivers

Preliminary specification
Supersedes data of 2002 Mar 12

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Philips
Semiconductors

PHILIPS

CONTENTS

1 FEATURES

- A-rate™ laser driver from 30 Mbits/s to 3.2 Gbits/s
- Bias current up to 100 mA
- Modulation current up to 100 mA
- Rise and fall times typical 80 ps
- Jitter below 20 ps (peak-to-peak value)
- Modulation output voltage up to 2 V dynamic range
- 1.2 V minimum voltage on the modulation output pin and 0.4 V minimum voltage on pin BIAS
- Retiming function via external clock with disable option
- Pulse width adjustment function with disable option
- Positive Emitter Coupled Logic (PECL and LVPECL) and Current Mode Logic (CML) compatible data and clock inputs
- Internal common mode voltage available for AC-coupled data and clock inputs and for Single-Ended (SE) applications
- 3.3 V supply voltage
- TZA3011A: AC-coupled laser for 3.3 V laser supply
- TZA3011B: DC-coupled laser for 3.3 V and 5 V laser supply.

2 CONTROL FEATURES

- Dual-loop control for constant and accurate optical average power level and extinction ratio (up to 2.7 Gbits/s)
- Optional average power loop control (up to 3.2 Gbits/s)
- Optional direct setting of modulation and bias currents.

3 PROTECTION FEATURES

- Alarm function on operating current
- Alarm function on monitor current
- Enable function on bias and modulation currents
- Soft start on bias and modulation currents.

4 APPLICATIONS

- SDH/SONET optical transmission systems
- High current drivers for converters
- High current drivers for high frequencies.

5 GENERAL DESCRIPTION

The TZA3011 is a fully integrated laser driver for optical transmission systems with data rates up to 3.2 Gbits/s. The TZA3011 incorporates all the necessary control and protection functions for a laser driver application with very few external components required and low power dissipation. The dual-loop controls the average monitor current in a programmable range from 150 μA to 1300 μA and the extinction ratio in a programmable range from 5 to 15 (linear scale).

The design is made in the Philips BiCMOS RF process and is available in a HBCC32 package or as bare die. The TZA3011A is intended for use in an application with an AC-coupled laser diode with a 3.3 V laser supply voltage. The TZA3011B is intended for use in an application with a DC-coupled laser diode for both 3.3 and 5 V laser supply voltages.

6 ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TZA3011AVH	HBCC32	plastic heatsink bottom chip carrier; 32 leads; body 5 × 5 × 0.65 mm	SOT560-1
TZA3011BVH			
TZA3011U	–	bare die; 2 560 × 2 510 × 380 μm	–

7 BLOCK DIAGRAM

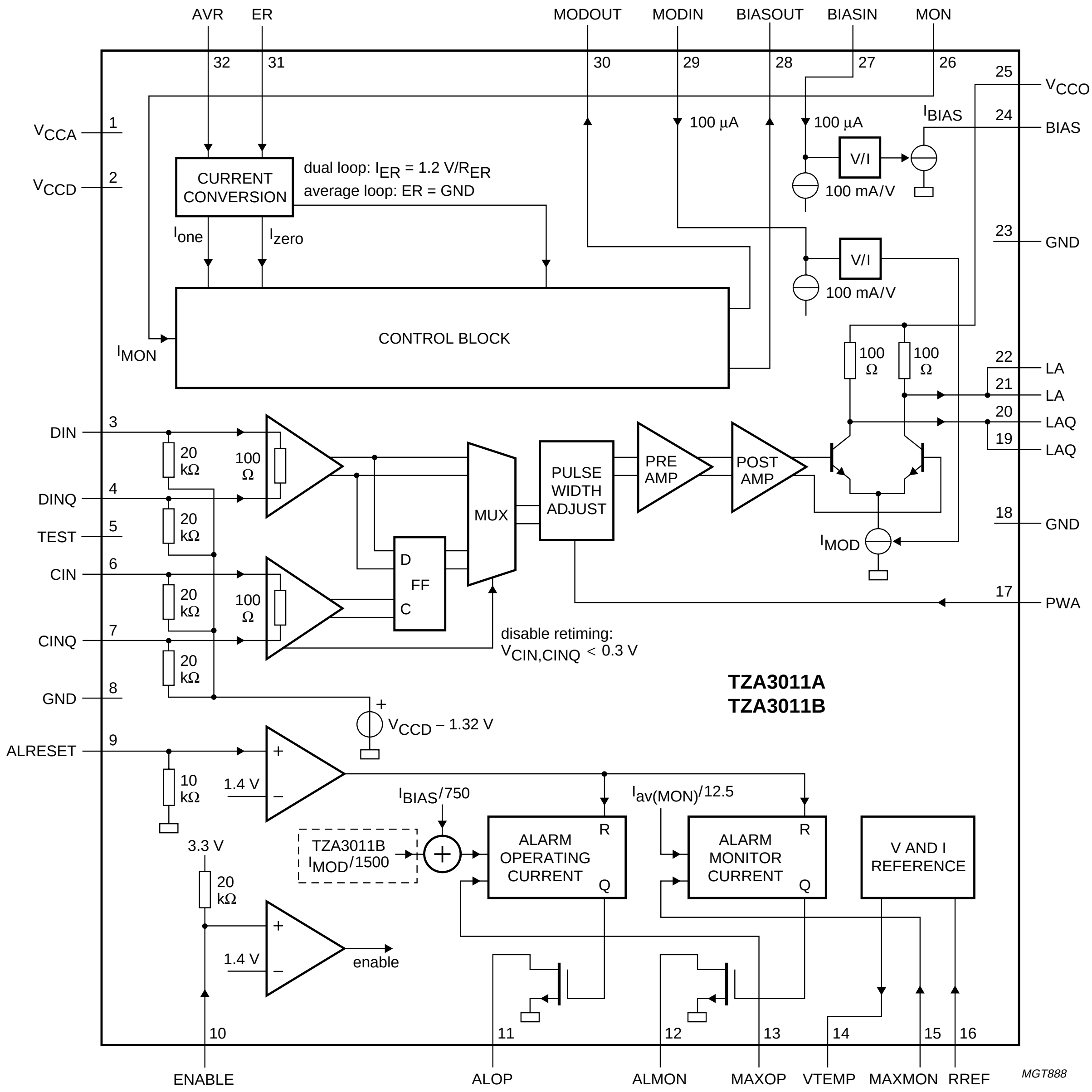


Fig.1 Block diagram.

8 PINNING

SYMBOL	PIN	DESCRIPTION
GND	die pad	common ground plane for V_{CCA}, V_{CCD}, V_{CCO}, RF and I/O; must be connected to GND
V_{CCA}	1	analog supply voltage
V_{CCD}	2	digital supply voltage
DIN	3	non-inverted data input (RF input)
DINQ	4	inverted data input (RF input)
TEST	5	test pin; must be connected to ground
CIN	6	non-inverted clock input (RF input)
CINQ	7	inverted clock input (RF input)
GND	8	ground
ALRESET	9	voltage input to reset the alarm outputs ALMON and ALOP
ENABLE	10	enable voltage input for modulation and bias current
ALOP	11	alarm output on operating current (open-drain)
ALMON	12	alarm output on monitor diode current (open-drain)
MAXOP	13	threshold level input for alarm on operating current
VTEMP	14	temperature dependent voltage output source
MAXMON	15	threshold level input for alarm on monitor diode current
RREF	16	reference current input; must be connected to ground with an accurate (1%) 10 kΩ resistor
PWA	17	pulse width adjustment input
GND	18	ground
LAQ	19	inverted laser modulation output (RF output); output for dummy load
LAQ	20	inverted laser modulation output (RF output); output for dummy load
LA	21	non-inverted laser modulation output (RF output); output for laser
LA	22	non-inverted laser modulation output (RF output); output for laser
GND	23	ground
BIAS	24	current source output for the laser bias current
V_{CCO}	25	supply voltage for the output stage and the laser diode
MON	26	current input for the monitor photodiode (RF input)
BIASIN	27	input voltage for the bias current setting
BIASOUT	28	output voltage of the control block for the bias current
MODIN	29	input voltage for the modulation current setting
MODOUT	30	output voltage of the control block for the modulation current
ER	31	input current for the optical extinction ratio setting
AVR	32	input current for the optical average power level setting

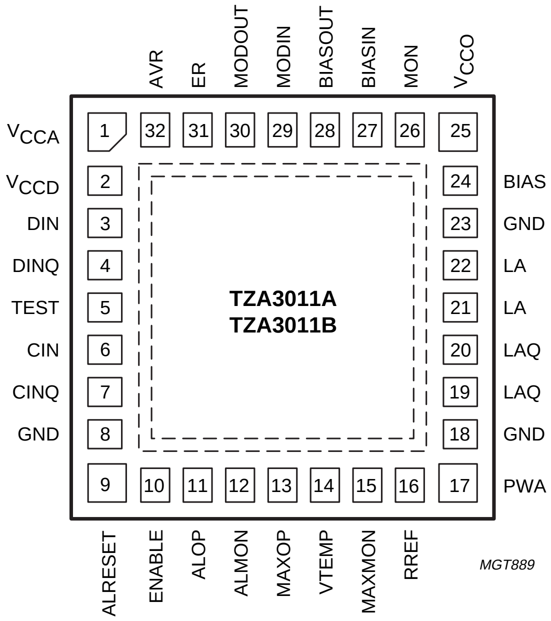


Fig.2 Pin configuration.

9 FUNCTIONAL DESCRIPTION

9.1 Data and clock input

The TZA3011 operates with differential Positive Emitter Coupled Logic (PECL) and Current Mode Logic (CML) data and clock inputs with a voltage swing from 100 mV to 1 V (p-p). It is assumed that both the data and clock inputs carry a complementary signal with the specified peak-to-peak value (true differential excitation).

The circuit generates an internal common mode voltage for AC-coupled data and clock inputs and for Single-Ended (SE) applications.

If $V_{DIN} > V_{DINQ}$, the modulation current is sunk by the LA pins and corresponds to an optical ‘one’ level of the laser.

9.2 Retiming

The retiming function synchronizes the data with the clock to improve the jitter performance. The data latch switches on the rising edge of the clock input. The retiming function is disabled when both clock inputs are below 0.3 V.

At start-up the initial polarity of the laser is unknown before the first rising edge of the clock input.

9.3 Pulse width adjustment

The on-duration of the laser current can be adjusted from −100 to +100 ps. The adjustment time is set by resistor R_{PWA}. The maximum allowable capacitive load on pin PWA is 100 pF. Pulse width adjustment is disabled when pin PWA is short-circuited to ground.

9.4 Modulator output stage

The output stage is a high-speed bipolar differential pair with typical rise and fall times of 80 ps and with a modulation current source of up to 100 mA when the LA pins are connected to V_{CCO}.

The modulation current switches between the LA and the LAQ outputs. For a good RF performance the inactive branch carries a small amount of the modulation current.

The LA output is optimized for the laser allowing a 2 V dynamic range and a 1.2 V minimum voltage. The LAQ output is optimized for the dummy load.

The output stage of the TZA3011A is optimized for AC-coupled lasers and the output stage of the TZA3011B is optimized for DC-coupled lasers.

The BIAS output is optimized for low voltage requirements (0.4 V minimum for a 3.3 V laser supply; 0.8 V minimum for a 5 V laser supply).

9.5 Dual-loop control

The TZA3011 incorporates a dual-loop control for a constant, accurate and temperature-independent control of the optical average power level and the extinction ratio. The dual-loop guarantees constant optical ‘one’ and ‘zero’ levels which are independent of the laser temperature and the laser age.

The dual-loop operates by monitoring the current of the monitor photodiode which is directly proportional to the laser emission. The ‘one’ and ‘zero’ current levels of the monitor diode are captured by the detector of the dual-loop control. The pin MON for the monitor photodiode current is a RF input.

The average monitor current is programmable over a wide current range from 150 to 1300 µA for both the dual-loop control and the average loop control. The extinction ratio is programmable from 5 to 15.

The maximum allowable capacitive load on pins AVR, ER, BIASOUT and MODOUT is 100 pF.

9.6 Average loop control

The average power control loop maintains a constant average power level of the monitor current over temperature and lifetime of the laser. The average loop control is activated by short-circuiting pin ER to ground.

9.7 Direct current setting

The TZA3011 can also operate in open-loop mode with direct setting of the bias and modulation currents. The bias and modulation current sources are transconductance amplifiers and the output currents are determined by the BIASIN and MODIN voltages respectively. The bias current source has a bipolar output stage with minimum output capacitance for optimum RF performance.

9.8 Soft start

At power-up the bias and modulation current sources are released once the V_{CCA} voltage exceeds the 2.7 V level and the reference voltage has reached the correct value of 1.2 V.

The control loop starts with minimum bias and modulation current at power-up and when the device is enabled. The current levels increase until the MON input current matches the programmed average level and, in the case of dual-loop control, the extinction ratio.

9.9 Alarm functions

The TZA3011 features two alarm functions for the detection of excessive laser operating current and monitor diode current due to laser aging, laser malfunctioning or a too high laser temperature. The alarm threshold levels are programmed by a resistor or a current source. In the TZA3011A, for the AC-coupled application, the operating current is equal to the bias current. In the TZA3011B, for the DC-coupled application, the operating current equals the bias current plus half of the modulation current.

9.10 Enable

A low enable input disables the bias and modulation current sources and the laser is off. A high enable input or an open enable input switches on the bias and modulation current sources and the laser is operational.

9.11 Reference block

The reference voltage is derived from a band gap circuit and is available at pin RREF. An accurate (1%) 10 kΩ resistor has to be connected to pin RREF to provide the internal reference current. The maximum capacitive load on pin RREF is 100 pF.

The reference voltage on the setting pins (MAXOP, MAXMON, PWA, ER and AVR) is buffered and derived from the band gap voltage.

The output voltage on pin VTEMP reflects the junction temperature of the TZA3011, the temperature coefficient of VTEMP equals –2.2 mV/K.

10 LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134); all voltages are referenced to ground; positive currents flow into the IC.

SYMBOL	PARAMETER	CONDITION	MIN.	MAX.	UNIT
V_{CCD}	digital supply voltage		–0.5	+3.5	V
V_{CCA}	analog supply voltage		–0.5	+3.5	V
V_{CCO}	output stage supply voltage	3.3 V laser supply	–0.5	+3.5	V
		5 V laser supply (TZA3011B only)	–0.5	+5.3	V
V_n	voltage on all input and output pins		–0.5	$V_{CCA,CCD}$ + 0.5	V
I_n	input current on pins:				
	MAXOP, MAXMON, RREF, PWA, ER and AVR		–1.0	0	mA
	VTEMP, BIASOUT and MODOUT		–1.0	+1.0	mA
	ALOP, ALMON and MON		0	5.0	mA
$V_{o(LA)}$	output voltage at pin LA	TZA3011A; V_{CCO} = 3.3 V	1.2	4.5	V
		TZA3011B; V_{CCO} = 3.3 V	0.8	4.1	V
		TZA3011B; V_{CCO} = 5 V	1.2	4.5	V
$V_{o(LAQ)}$	output voltage at pin LAQ	TZA3011A; V_{CCO} = 3.3 V	1.8	4.5	V
		TZA3011B; V_{CCO} = 3.3 V	1.6	4.5	V
		TZA3011B; V_{CCO} = 5 V	2.0	5.2	V
V_{BIAS}	bias voltage	TZA3011A; V_{CCO} = 3.3 V	0.4	3.6	V
		TZA3011B; V_{CCO} = 3.3 V	0.4	3.6	V
		TZA3011B; V_{CCO} = 5 V	0.8	4.1	V
$R_{th(j-a)}$	thermal resistance	HBCC32 die pad soldered to PCB	–	60	K/W
T_{amb}	ambient temperature		–40	+85	°C
T_j	junction temperature		–40	+125	°C
T_{stg}	storage temperature		–65	+150	°C

11 THERMAL CHARACTERISTICS

In compliance with JEDEC standards JESD51-5 and JESD51-7.

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th(j-a)}$	Thermal resistance from junction to ambient; 4 layer Printed Circuit Board in still air with 9 plated vias connected with the heatsink and the first ground plane in the PCB.	35	K/W

12 DC CHARACTERISTICS

T_{amb} = –40 to +85 °C; $R_{th(j-a)}$ = 35 K/W; P_{tot} = 400 mW; V_{CCA} = 3.14 to 3.47 V; V_{CCD} = 3.14 to 3.47 V; V_{CCO} = 3.14 to 3.47 V; R_{AVR} = 7.5 kΩ; R_{ER} = 62 kΩ; R_{MODIN} = 6.2 kΩ; R_{BIASIN} = 6.8 kΩ; R_{PWA} = 10 kΩ; R_{RREF} = 10 kΩ; R_{MAXMON} = 13 kΩ; R_{MAXOP} = 20 kΩ; positive currents flow into the IC; all voltages are referenced to ground; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies: pins V_{CCA}, V_{CCD} and V_{CCO}						
V_{CC}	supply voltage	3.3 V supply (V_{CCA},V_{CCD},V_{CCO})	3.14	3.3	3.47	V
		5 V supply (V_{CCO} only)	4.75	5	5.25	V
I_{CCA}	analog supply current		30	40	50	mA
I_{CCD}	digital supply current		35	45	55	mA
I_{CCO}	output stage supply current	pins LA and LAQ open-circuit				
		3.3 V supply	8	15	25	mA
		5 V supply	–	20	–	mA
P_{core}	core power dissipation	core excluding output currents; $I_{o(LA)}$, $I_{o(LAQ)}$ and I_{BIAS}	–	297	–	mW
P_{tot}	total power dissipation	V_{BIAS} = 3.3 V; I_{BIAS} = 20 mA; I_{MOD} = 16 mA; note 1	330	400	500	mW
Data and clock inputs: pins DIN and CIN						
$V_{i(p-p)}$	input voltage swing (peak-to-peak value)	$V_{i(DIN)}$ = (V_{CCD} – 2 V) to V_{CCD}; $V_{i(CIN)}$ = (V_{CCD} – 2 V) to V_{CCD}	100	–	1000	mV
$V_{int(cm)}$	internal common mode voltage	AC-coupled inputs	–	V_{CCD} – 1.32	–	V
V_{IO}	input offset voltage	note 2	–10	0	+10	mV
$Z_{i(diff)}$	differential input impedance		80	100	125	Ω
$Z_{i(cm)}$	common mode input impedance		8	10	13	kΩ
$V_{i(CIN)(dis)}$	input voltage for disabled retiming	V_{CIN} = V_{CINQ}	–	–	0.3	V
Monitor photodiode input: pin MON						
$V_{i(MON)}$	input voltage	I_{MON} = 50 to 2500 µA	0.9	1.1	1.3	V
$Z_{i(MON)}$	input impedance	I_{MON} = 50 to 2500 µA	–	27	–	Ω
Extinction ratio setting for dual-loop control: pins MON and ER						
$ER_{(min)}$	low extinction ratio setting	dual-loop set-up; I_{ER} > –30 µA; note 3				
		linear scale	–	5	7	–
		dB scale	–	7	8.5	dB
$ER_{(max)}$	high extinction ratio setting	dual-loop set-up; I_{ER} < –10 µA; note 3				
		linear scale	13	15	–	–
		dB scale	11	11.8	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{ref(ER)}$	reference voltage on pin ER	I_{ER} = –35 to –5 μA; C_{ER} < 100 pF	1.15	1.20	1.25	V
I_{ER}	current sink on pin ER		–35	–	–5	μA
ER_{acc}	relative accuracy of ER	temperature and V_{CCA} variations; ER = 10; AVR = 550 μA	–10	–	+10	%
Average setting for dual-loop control and average loop control: pins MON and AVR						
$I_{av(MON)(low)}$	low average monitor current setting	I_{AVR} > –280 μA				
		dual-loop (ER = 5)	–	–	150	μA
		average loop (pin ER to GND)	–	–	150	μA
$I_{av(MON)(max)}$	high average monitor current setting	I_{AVR} = –15.0 μA				
		dual-loop (ER = 5)	1200	1300	–	μA
		average loop (pin ER to GND)	1200	1300	–	μA
$V_{ref(AVR)}$	reference voltage on pin AVR	I_{AVR} = –250 to –15 μA; C_{AVR} < 100 pF	1.15	1.20	1.25	V
I_{AVR}	current sink on pin AVR		–280	–	–15	μA
$I_{av(MON)}$	relative accuracy of AVR	temperature and V_{CCA} variations; ER = 10; AVR = 550 μA	–10	–	+10	%
Control loop modulation output: pin MODOUT						
$I_{source(MODOUT)}$	source current	V_{MODOUT} = 0.5 to 1.5 V; C_{MODOUT} < 100 pF	–	–	–200	μA
$I_{sink(MODOUT)}$	sink current	V_{MODOUT} = 0.5 to 1.5 V; C_{MODOUT} < 100 pF	200	–	–	μA
Control loop bias output: pin BIASOUT						
$I_{source(BIASOUT)}$	source current	$V_{BIASOUT}$ = 0.5 to 1.5 V; $C_{BIASOUT}$ < 100 pF	–	–	–200	μA
$I_{sink(BIASOUT)}$	sink current	$V_{BIASOUT}$ = 0.5 to 1.5 V; $C_{BIASOUT}$ < 100 pF	200	–	–	μA
Bias current source: pins BIASIN and BIAS						
$g_{m(BIAS)}$	transconductance	V_{BIASIN} = 0.5 to 1.5 V				
		V_{BIAS} = V_{CCO} = 3.3 V	90	110	125	mA/V
		V_{BIAS} = V_{CCO} = 5.0 V	95	110	130	mA/V
$I_{source(BIASIN)}$	source current at pin BIASIN	V_{BIASIN} = 0.5 to 1.5 V	–110	–100	–95	μA
$I_{bias(max)}$	maximum bias current	V_{BIASIN} = 1.8 V	100	–	–	mA
$I_{bias(min)}$	minimum bias current	V_{BIASIN} = 0 to 0.4 V	–	0.2	0.4	mA
$I_{bias(dis)}$	bias current at disable	V_{ENABLE} < 0.8 V	–	–	30	μA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{BIAS}	output voltage on pin BIAS	normal operation				
		V_{CCO} = 3.3 V	0.4	–	3.6	V
		V_{CCO} = 5 V	0.8	–	4.1	V
Modulation current source: pin MODIN						
$g_{m(MOD)}$	transconductance	V_{MODIN} = 0.5 to 1.5 V				
		$V_{LA} = V_{LAQ} = V_{CCO}$ = 3.3 V	78	90	105	mA/V
		$V_{LA} = V_{LAQ} = V_{CCO}$ = 5.0 V	80	95	110	mA/V
$I_{source(MODIN)}$	source current at pin MODIN	V_{MODIN} = 0.5 to 1.5 V	–110	–100	–95	μA
Modulation current outputs: pins LA						
$I_{o(LA)(max)(on)}$	maximum laser modulation output current at LA on	V_{MODIN} = 1.8 V; $V_{LA} = V_{CCO}$ = 3.3 V; note 4	100	–	–	mA
$I_{o(LA)(min)(on)}$	minimum laser modulation output current at LA on	V_{MODIN} = 0 to 0.4 V; $V_{LA} = V_{CCO}$ = 3.3 V; note 4	–	5	6	mA
$I_{o(LA)(min)(off)}$	minimum laser modulation output current at LA off	$V_{LA} = V_{CCO}$ = 3.3 V; note 4				
		V_{MODIN} = 0.5 V	–	–	0.8	mA
		V_{MODIN} = 1.5 V	–	–	2	mA
$Z_{o(LA,LAQ)}$	output impedance		80	100	125	Ω
$I_{o(dis)}$	non-inverted and inverted laser modulation output current at disable	V_{ENABLE} < 0.8 V	–	–	200	μA
$V_{o(LA)min}$	minimum output voltage at pin LA	TZA3011A; V_{CCO} = 3.3 V	1.6	–	–	V
		TZA3011B; V_{CCO} = 3.3 V	1.2	–	–	V
		TZA3011B; V_{CCO} = 5 V	1.6	–	–	V
Enable function: pin ENABLE						
V_{IL}	LOW-level input voltage	bias and modulation currents disabled	–	–	0.8	V
V_{IH}	HIGH-level input voltage	bias and modulation currents enabled	2.0	–	–	V
$R_{pu(int)}$	internal pull-up resistance		16	20	30	kΩ
Alarm reset: pin ALRESET						
V_{IL}	LOW-level input voltage	no reset	–	–	0.8	V
V_{IH}	HIGH-level input voltage	reset	2.0	–	–	V
$R_{pd(int)}$	internal pull-down resistance		7	10	15	kΩ

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Alarm operating current: pins MAXOP and ALOP						
$V_{ref(MAXOP)}$	reference voltage on pin MAXOP	I_{MAXOP} = 10 to 200 μA	1.15	1.2	1.25	V
N_{MAXOP}	ratio of $I_{oper(alarm)}$ and I_{MAXOP}	$I_{oper(alarm)}$ = 7.5 to 150 mA				
		V_{CCO} = 3.3 V	700	800	900	
		V_{CCO} = 5.0 V	750	850	950	
$V_{ALOP(L)}$	drain voltage at active alarm	I_{ALOP} = 500 μA	0	–	0.4	V
Alarm monitor current: pins MAXMON and ALMON						
$V_{ref(MAXMON)}$	reference voltage on pin MAXMON	I_{MAXMON} = 10 to 200 μA	1.15	1.2	1.25	V
N_{MAXMON}	ratio of $I_{MON(alarm)}$ and I_{MAXMON}	$I_{MON(alarm)}$ = 150 to 3000 μA	10	15	20	
$V_{ALMON(L)}$	drain voltage at active alarm	I_{ALMON} = 500 μA	0	–	0.4	V
Reference block: pins RREF and VTEMP						
V_{RREF}	reference voltage	R_{RREF} = 10 kΩ (1%); C_{RREF} < 100 pF	1.15	1.20	1.25	V
V_{VTEMP}	temperature dependent voltage	T_j = 25 °C; C_{VTEMP} < 2 nF; note 5	1.15	1.20	1.25	V
TC_{VTEMP}	temperature coefficient of V_{VTEMP}	T_j = –25 to +125 °C; note 5	–	–2.2	–	mV/K
$I_{source(VTEMP)}$	source current of pin VTEMP		–	–	–1	mA
$I_{sink(VTEMP)}$	sink current of pin VTEMP		1	–	–	mA

Notes

1. The total power dissipation P_{tot} is calculated with $V_{BIAS} = V_{CCO}$ = 3.3 V and I_{BIAS} = 20 mA. In the application V_{BIAS} will be V_{CCO} minus the laser diode voltage which results in a lower total power dissipation.
2. The specification of the offset voltage is guaranteed by design.
3. Any (AVR, ER) settings need to respect I_{MON} > 50 μA and I_{MON} < 2500 μA. Therefore, for large ER settings, minimum/maximum AVR cannot be reached.
4. The voltage on pin MODIN controls I_{MOD}. $I_{o(LA)}$ is linked to I_{MOD} via the following formula: $I_{o(LA)} = \frac{I_{MOD} \times 100}{100 + Z_{L(LA)}}$
   a) $I_{o(LA)}$ is the current sunk on the LA pin. I_{MOD} is the current programmed via the MODIN voltage.
   b) $Z_{L(LA)}$ is the external load on LA: a 25 Ω external load will see a 80 mA current when 100 mA current is programmed (20 mA are flowing into the 100 Ω internal resistor connected to LA). This corresponds to a voltage swing of 2 V on the real application load.
5. The VTEMP voltage equals: V_{VTEMP} = 1.31 V + TC_{VTEMP}. The junction temperature $T_j = T_{amb} + P_{tot} \times R_{th(j-a)}$.

13 AC CHARACTERISTICS

T_{amb} = –40 to +85 °C; $R_{th(j-a)}$ = 35 K/W; P_{tot} = 400 mW; V_{CCA} = 3.14 to 3.47 V; V_{CCD} = 3.14 to 3.47 V; V_{CCO} = 3.14 to 3.47 V; R_{AVR} = 7.5 kΩ; R_{ER} = 62 kΩ; R_{MODIN} = 6.2 kΩ; R_{BIASIN} = 6.8 kΩ; R_{PWA} = 10 kΩ; R_{RREF} = 10 kΩ; R_{MAXMON} = 13 kΩ; R_{MAXOP} = 20 kΩ; positive currents flow into the IC; all voltages are referenced to ground; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
RF path						
BR	bit rate	dual-loop control	0.03	–	2.7	Gbits/s
		average loop control	0.03	–	3.2	Gbits/s
$t_{J(LA)(p-p)}$	output jitter of pin LA (peak-to-peak value)	R_L = 25 Ω; note 1	–	–	20	ps
t_r	rise time of voltage on pin LA	20% to 80%; R_L = 25 Ω; notes 2 and 3				
		I_{MOD} = 17 mA	70	85	100	ps
t_f	fall time of voltage on pin LA	80% to 20%; R_L = 25 Ω; notes 2 and 3				
		I_{MOD} = 17 mA	50	70	90	ps
$t_{su;DAT}$	data input set-up time		60	–	–	ps
$t_{h;DAT}$	data input hold time		60	–	–	ps
$t_{en(start)}$	start-up time at enable	direct current setting	–	–	1	µs
Current control						
TC_{int}	internal time constant	dual-loop control operating currents fully settled	30	–	–	ms
Pulse width adjustment						
$t_{PWA(min)}$	minimum pulse width adjustment on pins LA	R_{PWA} = 6.7 kΩ; C_{PWA} < 100 pF	–	–	–100	ps
t_{PWA}	pulse width adjustment on pins LA	R_{PWA} = 10 kΩ; C_{PWA} < 100 pF	–	0	–	ps
$t_{PWA(max)}$	maximum pulse width adjustment on pins LA	R_{PWA} = 20 kΩ; CPWA < 100 pF	80	100	–	ps

Notes

1. The output jitter specification is guaranteed by design.
2. With a 25 Ω load on the LA pins: I_{LA} = 14 mA when I_{MOD} = 17 mA.
3. For high modulation current, t_r and t_f are impacted by total inductance between the LA pads and the laser connection.

14 DESIGN EQUATIONS

14.1 Bias and modulation currents

The bias and modulation currents are determined by the voltages on pins BIASIN and MODIN. These voltages are applied by the BIASOUT and MODOUT pins for dual-loop control. For average loop control the BIASIN voltage is applied by the BIASOUT pin and the MODIN voltage is applied by an external voltage source or an external resistor R_{MODIN}.

For direct setting of bias and the modulation current, the BIASIN and MODIN voltages have to be applied by external voltage sources or by R_{BIASIN} and R_{MODIN} external resistors connected on BIASIN and MODIN pins:

$$I_{BIAS} = (R_{BIASIN} \times 100\ \mu A - 0.5\ V) \times g_{m(BIAS)}$$

$$I_{MOD} = (R_{MODIN} \times 100\ \mu A - 0.5\ V) \times g_{m(MOD)} + 5\ mA$$

The bias and modulation current sources operate with an input voltage range from 0.5 to 1.5 V. The output current is at its minimum level for an input voltage below 0.4 V; see Figs 3 and 4.

The bias and modulation current sources are temperature compensated and the adjusted current level remains stable over the temperature range.

The bias and modulation currents increase with increasing resistor values for R_{BIASIN} and R_{MODIN} respectively, this allows resistor tuning to start at a minimum current level.

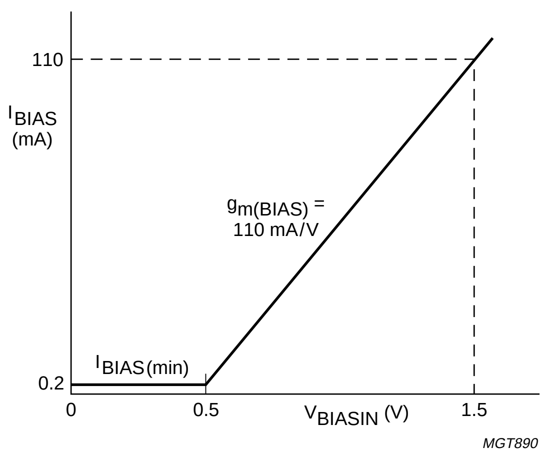


Fig.3 Bias current as a function of BIASIN voltage.

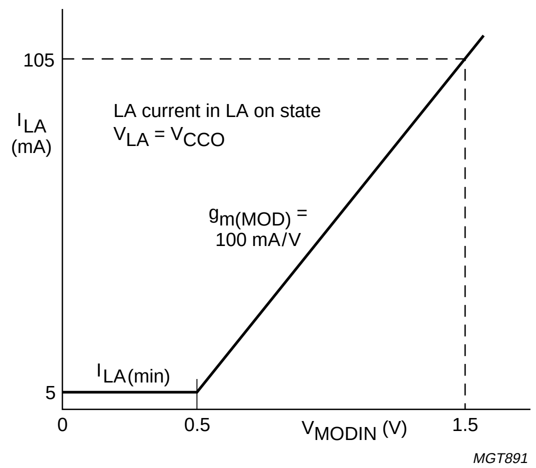


Fig.4 Modulation current as a function of MODIN voltage.

14.2 Average monitor current and extinction ratio

The average monitor current $I_{av(MON)}$ in dual-loop or average loop operation is determined by the source current (I_{AVR}) of the AVR pin. The current can be sunk by an external current source or by an external resistor (R_{AVR}) connected to ground:

$$I_{av(MON)} = 1580\ \mu A - 5.26 \times I_{AVR} =$$

$$1580\ \mu A - 5.26 \times \frac{V_{AVR}}{R_{AVR}}$$

The extinction ratio in dual-loop operation is determined by the source current (I_{ER}) of the ER pin. The current can be sunk by an external current source or by an external resistor (R_{ER}) connected to ground:

$$ER = 20 - \frac{I_{ER}}{2\ \mu A} = 20 - \frac{1}{2\ \mu A} \times \frac{V_{ER}}{R_{ER}}$$

The average monitor current and the extinction ratio as a function of the I_{AVR} and I_{ER} current are illustrated in Fig.5.

The average monitor current increases with a decreasing I_{AVR} or increasing R_{AVR}, this allows resistor tuning of R_{AVR} to start at minimum I_{AVR} current level.

The formulas used to program AVR and ER are valid for typical conditions; tuning is necessary to achieve good absolute accuracy of AVR and ER values.

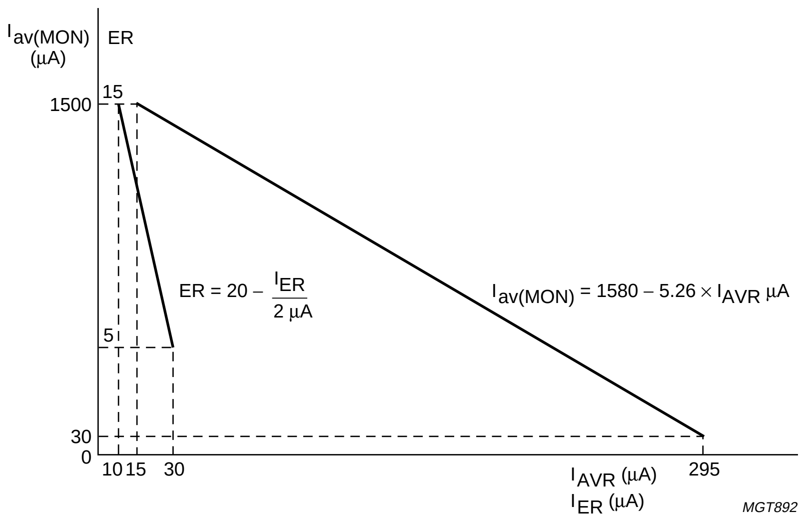


Fig.5 Average monitor current and extinction ratio as a function of I_{AVR} and I_{ER}.

14.3 Dual-loop control

The dual-loop control measures the monitor current (I_{MON}) corresponding with an optical 'one' level and the I_{MON} corresponding with the optical 'zero' level. The measured $I_{MON(one)}$ and $I_{MON(zero)}$ are compared with the average monitor current setting and the extinction ratio setting according to:

$$I_{av(MON)} = \frac{I_{MON(one)} + I_{MON(zero)}}{2}$$

$$ER = \frac{I_{MON(one)}}{I_{MON(zero)}}$$

The dual-loop controls the bias and the modulation current for obtaining the $I_{MON(one)}$ and $I_{MON(zero)}$ current levels which correspond with the programmed AVR and ER settings.

Performance of the dual-loop for high data-rate is linked to the quality of the incoming IMON signal: a high performance interconnection between monitor photodiode and MON input is requested for maximum data rate applications (2.7 Gbits/s).

The operational area of the dual-loop and the control area of the monitor input current must respect the following equations:

$$50\ \mu A < I_{MON(zero)} < 500\ \mu A$$

$$250\ \mu A < I_{MON(one)} < 2500\ \mu A$$

Stability of ER and AVR settings are guaranteed over a range of temperature and supply voltage variations.

14.4 Alarm operating current

The alarm threshold $I_{oper(alarm)}$ on the operating current is determined by the source current I_{MAXOP} of the MAXOP pin. The current range for I_{MAXOP} is from 10 to 200 μA which corresponds with an $I_{oper(alarm)}$ from 7.5 to 150 mA. The I_{MAXOP} current can be sunk by an external current source or by connecting R_{MAXOP} to ground:

$$I_{oper(alarm)} = N_{MAXOP} \times \frac{V_{MAXOP}}{R_{MAXOP}}$$

The operating current equals the bias current for an AC-coupled laser application and equals the bias current plus half of the modulation current for the DC-coupled laser application:

$$I_{oper(TZA3011A)} = I_{BIAS}$$

$$I_{oper(TZA3011B)} = I_{BIAS} + \frac{I_{MOD}}{2}$$

14.5 Alarm monitor current

The alarm threshold $I_{MON(alarm)}$ on the monitor current is determined by the source current I_{MAXMON} of the MAXMON pin. The current range for I_{MAXMON} is from 10 to 200 μA which corresponds with an $I_{MON(alarm)}$ from 150 to 3000 μA. The I_{MAXMON} current can be sunk by an external current source or by connecting R_{MAXMON} to ground:

$$I_{MON(alarm)} = N_{MAXMON} \times \frac{V_{MAXMON}}{R_{MAXMON}}$$

14.6 Pulse width adjustment

The pulse width adjustment time is determined by the value of resistor R_{PWA}, as shown below.

$$t_{PWA} = 200\ \text{ps} \times \frac{R_{PWA} - 10\ \text{k}\Omega}{R_{PWA}}$$

The t_{PWA} range is from –100 to +100 ps which corresponds with a R_{PWA} range between a minimum resistance of 6.7 kΩ and a maximum resistance of 20 kΩ. The PWA function is disabled when the PWA input is short-circuited to ground; t_{PWA} equals 0 ps for a disabled PWA function.

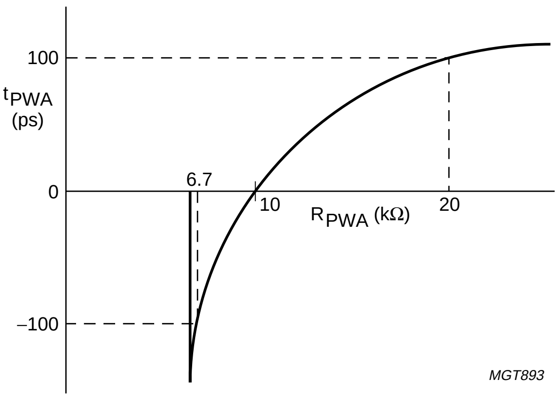


Fig.6 Pulse width adjustment.

15 APPLICATION INFORMATION

15.1 TZA3011A with dual-loop control

A simplified application using the TZA3011A with dual-loop control and with an AC-coupled laser at 3.3 V laser voltage is illustrated in Fig.7. The average power level and the extinction ratio are determined by the resistors R_{AVR} and R_{ER}. The MODOUT and BIASOUT outputs are connected to the MODIN and the BIASIN inputs respectively. The alarm threshold on the operating current is made temperature dependant with resistor R_{VTEMP} connected between VTEMP and MAXOP. This alarm detects the end of life of the laser.

$$I_{oper(alarm)} = N_{MAXOP} \times \left(\frac{V_{MAXOP}}{R_{MAXOP}} - \frac{tc_{VTEMP} \times (T_j - 25\ °C)}{R_{VTEMP}}\right)$$

The resistor R_{PWA} enables pulse width adjustment for optimizing the eye diagram.

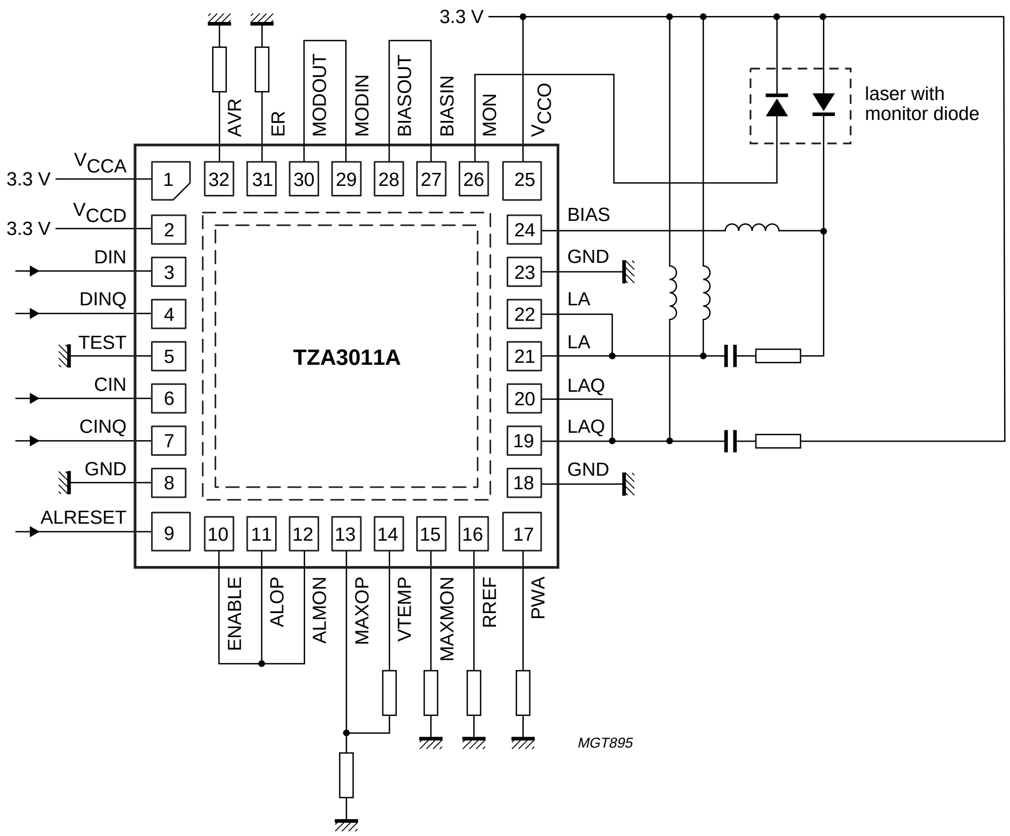


Fig.7 TZA3011A with AC-coupled laser and dual-loop control.

15.2 TZA3011B with dual-loop control

A simplified application using the TZA3011B with dual-loop control and with a DC-coupled laser at 3.3 V or 5 V laser voltage is illustrated in Fig.8. The average power level and the extinction ratio are determined by the resistors R_{AVR} and R_{ER}. The MODOUT and BIASOUT outputs are connected to the MODIN and the BIASIN inputs respectively.

The open-drain outputs ALOP and ALMON are short-circuited with the ENABLE and an active alarm disables the bias and modulation current sources. The ALRESET input will reset the alarm latches and enable normal operation.

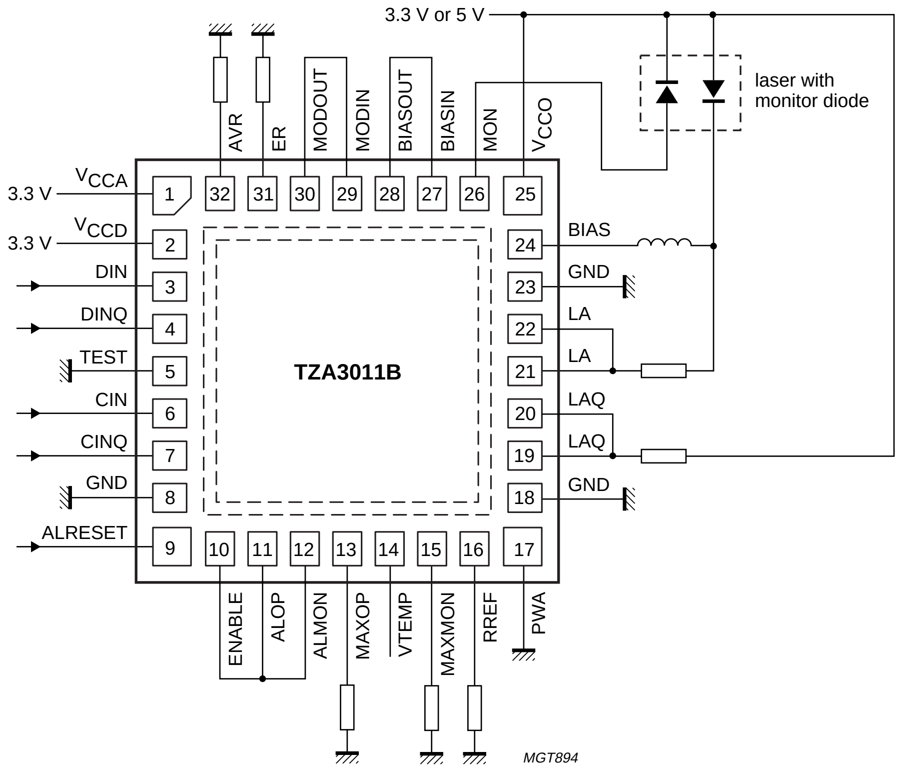


Fig.8 TZA3011B with DC-coupled laser and dual-loop control.

15.3 TZA3011B with average loop control

A simplified application using the TZA3011B with average loop control and a DC-coupled laser at 3.3 or 5 V laser voltage is illustrated in Fig.9. The ER pin is short-circuited to ground for the average loop control. The average power level is determined by the resistor R_{AVR}. The average loop controls the bias current and the BIASOUT output is connected to the BIASIN input. The modulation current is determined by the MODIN input voltage which is generated by the resistor R_{MODIN} and the 100 µA source current of the MODIN pin.

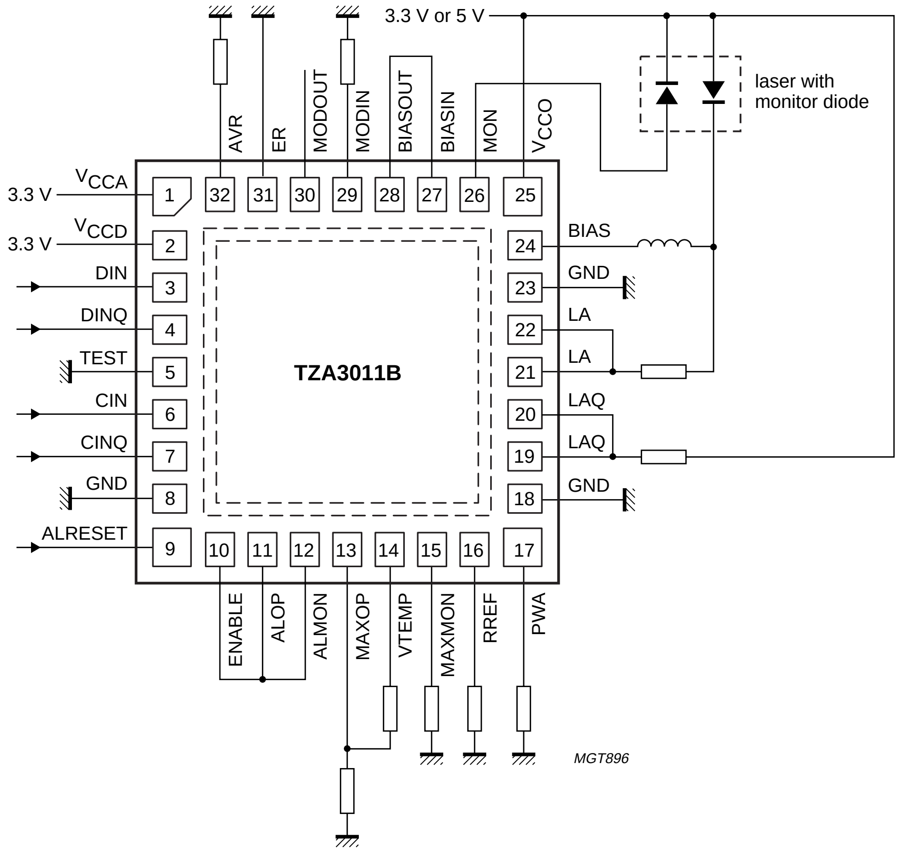


Fig.9 TZA3011B with DC-coupled laser and average loop control.

16 BONDING PAD LOCATIONS

SYMBOL	PAD (TZA3011U)	COORDINATES(1)		COMMENT(2)(3)
		x	y	
V_{CCA}	1	–1123.9	1029.3	
V_{CCA}	2	–1123.9	949.3	
V_{CCD}	3	–1123.9	844.3	
V_{CCD}	4	–1123.9	764.3	
DIN	5	–1124	604.3	
DINQ	6	–1124.9	393.3	
GND	7	–1123.9	244.5	
GND	8	–1123.9	139.4	
GND	9	–1123.9	4.7	
GND	10	–1123.9	–100.3	
GND	11	–1123.4	–253.4	
CIN	12	–1123.9	–441.2	
CINQ	13	–1123.9	–697.1	
GND	14	–1123.9	–850.8	
ALRESET	15	–1123.9	–991.4	
ENABLE	16	–829.8	–1123.7	
GND	17	–665.6	–1124.0	
ALOP	18	–504.9	–1124	
ALMON	19	–267.6	–1124.3	
TP_RF1	20	–221.5	–344.4	not connected
MAXOP	21	–98.5	–1124.3	
TP_RF2	22	–48.6	–368.4	not connected
VTEMP	23	294.0	–1124.2	
MAXMON	24	466.9	–1124.2	
RREF	25	694.9	–1124.0	
GND	26	860.3	–1124.0	
PWADJ	27	1098.9	–979.4	
GND	28	1099.0	–829.7	
LAQ	29	1099.0	–691.2	
LAQ	30	1099.0	–611.2	
LAQ	31	1099.0	–506.4	
LAQ	32	1099.0	–426.4	
GND	33	1099.8	–247.0	
TP_DFTLAQ	34	839.0	–194.4	not connected
GND	35	1099.8	–142.0	
GND	36	1099.8	–36.8	
LA	37	1099.1	105.4	
TP_DFTLA	38	839.0	179.6	not connected

SYMBOL	PAD (TZA3011U)	COORDINATES(1)		COMMENT(2)(3)
		x	y	
LA	39	1099.1	185.4	
LA	40	1099.1	290.5	
LA	41	1099.1	370.5	
GND	42	1099.1	670.8	
BIAS	43	1099.0	804.8	
V_{CCO}	44	1099.0	944.4	
V_{CCO}	45	1099.0	1024.4	
ACDC	46	942.5	1124.3	note 4
GND	47	765.0	1123.8	
MON	48	602.1	1123.7	
BIASIN	49	431.7	1123.8	
BIASOUT	50	267.6	1123.8	
GND	51	100.8	1123.8	
MODIN	52	–82.7	1123.8	
GND	53	–241.1	1123.8	
TP_VALLEY	54	–274.4	954.4	not connected
MODOUT	55	–487.2	1123.8	
ER	56	–645.6	1123.8	
AVR	57	–802.8	1123.8	

Notes

1. All coordinates are referenced, in µm, to the centre of the die.
2. All GND connections should be used.
3. Recommended order of bonding: all GND first, then V_{CCA},V_{CCD} and V_{CCO} supplies and finally the input and output pins.
4. For the AC-coupling application, the ACDC pin should be left unconnected. For the DC-coupling applications, the ACDC pin should be connected to GND.

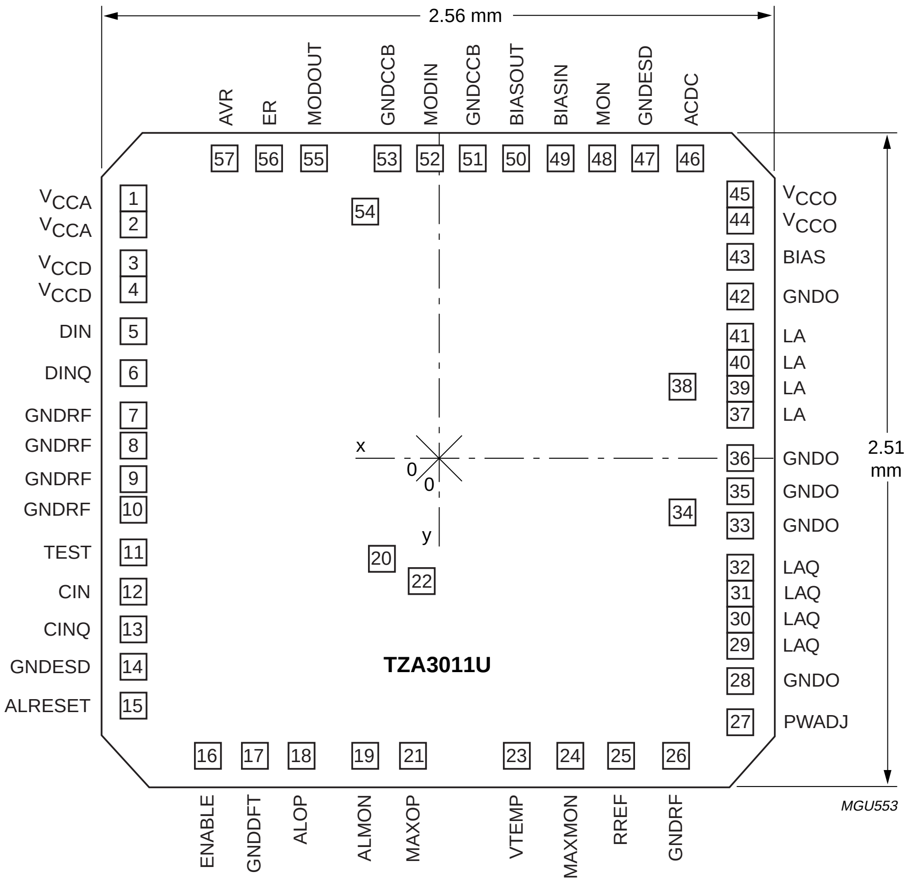


Fig.10 TZA3011U die.

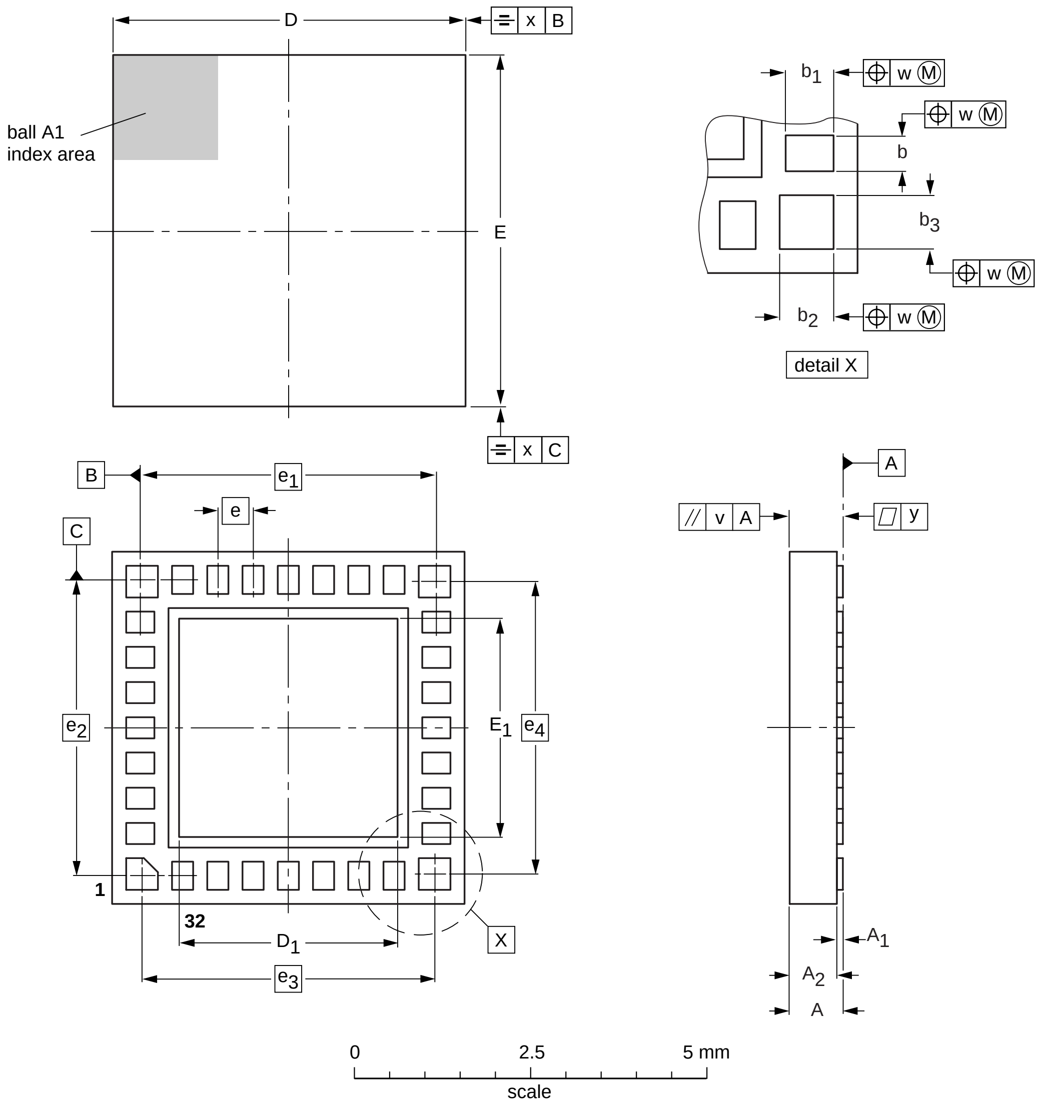
17 PHYSICAL CHARACTERISTICS OF THE BARE DIE

Table 1 Physical characteristics of the bare die

PARAMETER	VALUE
Glass passivation	0.3 µm PSG (PhosphoSilicate Glass) on top of 0.8 µm of silicon nitride
Bonding pad dimension	minimum dimension of exposed metallization is 80 × 80 µm (pad size = 90 × 90 µm)
Metallization	2.8 µm AlCu
Thickness	380 µm nominal
Size	2.560 × 2.510 mm (6.43 mm^2)
Backing	silicon; electrically connected to GND potential through substrate contacts
Attach temperature	<440 °C; recommended die attachment is by gluing
Attach time	<15 s

18 PACKAGE OUTLINE

HBCC32: plastic, heatsink bottom chip carrier; 32 terminals; body 5 x 5 x 0.65 mm **SOT560-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	b	b_1	b_2	b_3	D	D_1	E	E_1	e	e_1	e_2	e_3	e_4	v	w	x	y
mm	0.80	0.10 0.05	0.70 0.60	0.35 0.20	0.50 0.30	0.50 0.35	0.50 0.35	5.1 4.9	3.2 3.0	5.1 4.9	3.2 3.0	0.5	4.2	4.2	4.15	4.15	0.2	0.15	0.15	0.05

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT560-1		MO-217				~~99-09-10~~ 00-02-01

19 SOLDERING

19.1 Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *“Data Handbook IC26; Integrated Circuit Packages”* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering can still be used for certain surface mount ICs, but it is not suitable for fine pitch SMDs. In these situations reflow soldering is recommended.

19.2 Reflow soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, convection or convection/infrared heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferable be kept below 220 °C for thick/large packages, and below 235 °C for small/thin packages.

19.3 Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

  The footprint must incorporate solder thieves at the downstream end.
- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250 °C.
A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

19.4 Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

19.5 Suitability of surface mount IC packages for wave and reflow soldering methods

PACKAGE	SOLDERING METHOD	
	WAVE	REFLOW(1)
BGA, HBGA, LFBGA, SQFP, TFBGA	not suitable	suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, SMS	not suitable(2)	suitable
PLCC(3), SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended(3)(4)	suitable
SSOP, TSSOP, VSO	not recommended(5)	suitable

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *“Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods”*.
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

20 DATA SHEET STATUS

DATA SHEET STATUS(1)	PRODUCT STATUS(2)	DEFINITIONS
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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