

TZA3011A; TZA3011B

30 Mbit/s up to 3.2 Gbit/s A-rate™ laser drivers

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Product data sheet

1. General description

The TZA3011 is a fully integrated laser driver for optical transmission systems with data rates up to 3.2 Gbit/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 μ A to 1300 μ A 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 V and 5 V laser supply voltages.

2. Features

2.1 General

- A-rate™ from 30 Mbit/s to 3.2 Gbit/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), Low Voltage Positive Emitter Coupled Logic (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 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

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2.2 Control features

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

2.3 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

3. Applications

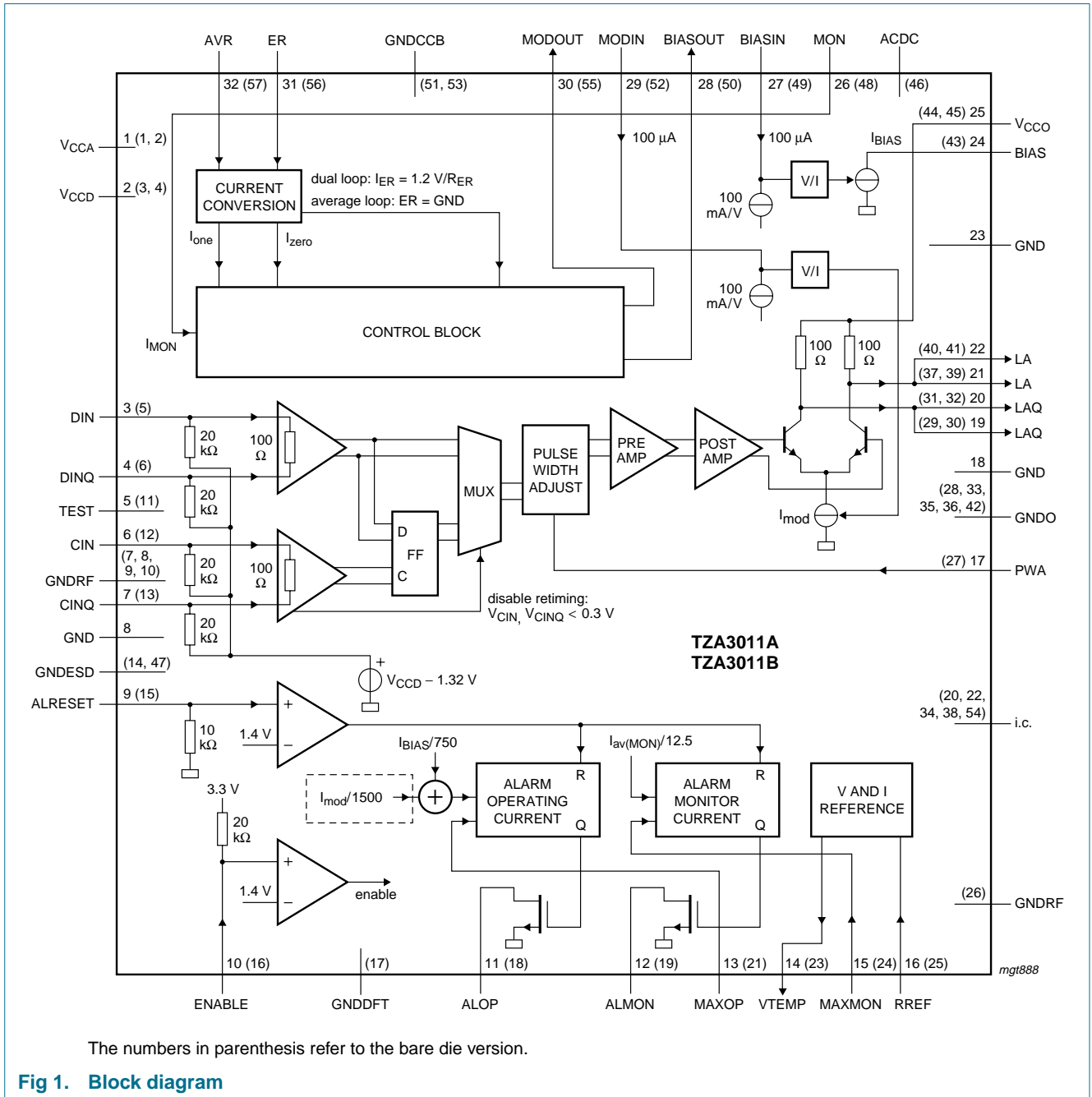
- SDH/SONET optical transmission systems
- High current drivers for converters
- High current drivers for high frequencies

4. Ordering information

Table 1: Ordering information

| Type number | Package | | |
|-------------|---------|---|----------|
| | Name | Description | Version |
| TZA3011AVH | HBCC32 | plastic thermal enhanced bottom chip carrier; | SOT560-1 |
| TZA3011BVH | | 32 terminals; body 5 × 5 × 0.65 mm | |
| TZA3011UH | - | bare die; 2 560 × 2 510 × 380 μm | - |

5. Block diagram



The numbers in parenthesis refer to the bare die version.

Fig 1. Block diagram

6. Pinning information

6.1 Pinning

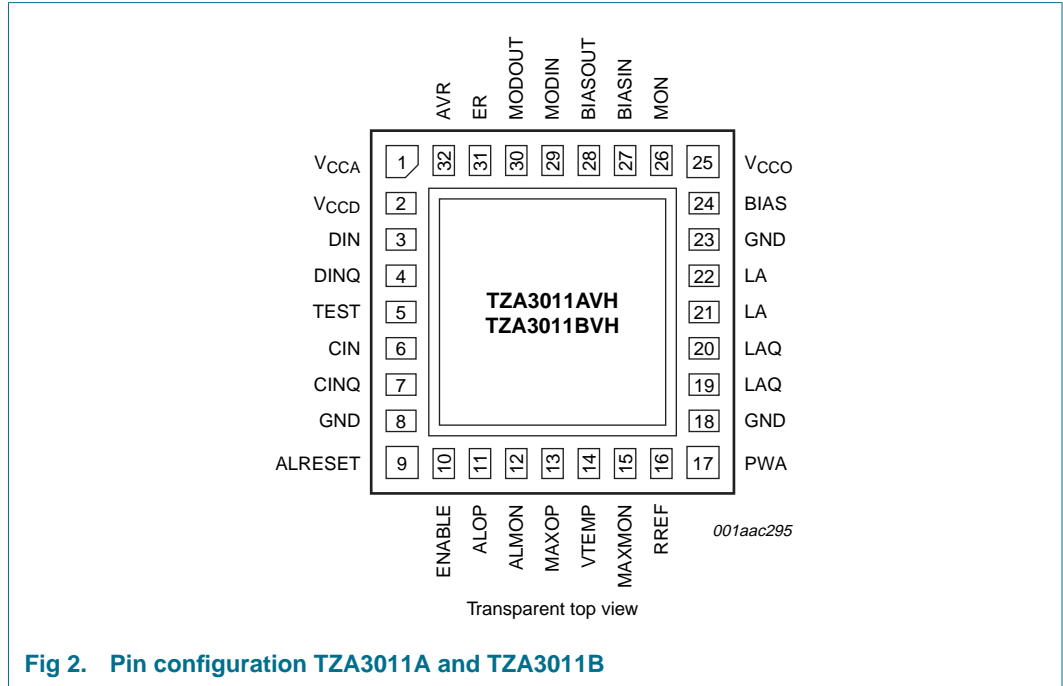
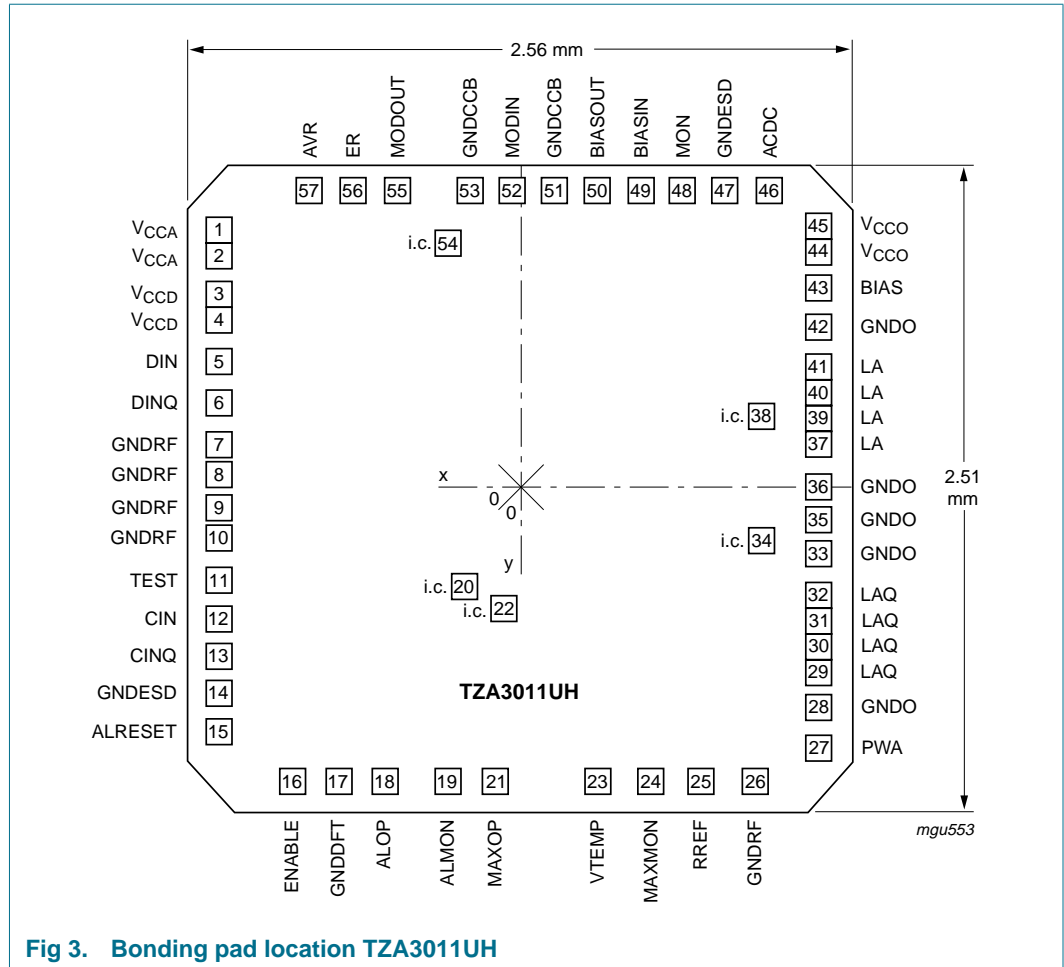


Fig 2. Pin configuration TZA3011A and TZA3011B



6.2 Pin description

Table 2: Pin description TZA3011A and TZA3011B

| Symbol | Pin | Description |
|------------------|---------|--|
| GND | die pad | common ground plane for V _{CCA} , V _{CCD} , V _{CCO} , RF and I/O; must be connected to ground |
| 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 or test pad; 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 | alarm reset input; resets ALMON and ALOP alarms |
| ENABLE | 10 | enable 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) |

Table 2: Pin description TZA3011A and TZA3011B ...continued

| Symbol | Pin | Description |
|------------------|-----|--|
| 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 | input for the monitor photodiode (RF input) |
| BIASIN | 27 | input for the bias current setting |
| BIASOUT | 28 | output of the control block for the bias current |
| MODIN | 29 | input for the modulation current setting |
| MODOUT | 30 | output of the control block for the modulation current |
| ER | 31 | input for the optical extinction ratio setting |
| AVR | 32 | input for the optical average power level setting |

Table 3: Bonding pad description TZA3011UH [1]

| Symbol | Pad | X | Y | Description |
|------------------|-----------|---------|---------|--|
| GND | substrate | - | - | common ground plane for V _{CCA} , V _{CCD} , V _{CCO} , RF and I/O; must be connected to ground |
| V _{CCA} | 1 | -1123.9 | +1029.3 | analog supply voltage |
| V _{CCA} | 2 | -1123.9 | +949.3 | analog supply voltage |
| V _{CCD} | 3 | -1123.9 | +844.3 | digital supply voltage |
| V _{CCD} | 4 | -1123.9 | +764.3 | digital supply voltage |
| DIN | 5 | -1124.0 | +604.3 | non-inverted data input (RF input) |
| DINQ | 6 | -1124.9 | +393.3 | inverted data input (RF input) |
| GNDRF | 7 | -1123.9 | +244.5 | ground |
| GNDRF | 8 | -1123.9 | +139.4 | ground |
| GNDRF | 9 | -1123.9 | +4.7 | ground |
| GNDRF | 10 | -1123.9 | -100.3 | ground |
| TEST | 11 | -1123.4 | -253.4 | test pin or test pad; must be connected to ground |
| CIN | 12 | -1123.9 | -441.2 | non-inverted clock input (RF input) |
| CINQ | 13 | -1123.9 | -697.1 | inverted clock input (RF input) |
| GNDESD | 14 | -1123.9 | -850.8 | ground |
| ALRESET | 15 | -1123.9 | -991.4 | alarm reset input; resets ALMON and ALOP alarms |

Table 3: Bonding pad description TZA3011UH [1] ...continued

| Symbol | Pad | X | Y | Description |
|------------------|--------|---------|---------|--|
| ENABLE | 16 | -829.8 | -1123.7 | enable input for modulation and bias current |
| GNDDFT | 17 | -665.6 | -1124.0 | ground |
| ALOP | 18 | -504.9 | -1124 | alarm output on operating current (open-drain) |
| ALMON | 19 | -267.6 | -1124.3 | alarm output on monitor diode current (open-drain) |
| i.c. | 20 [2] | -221.5 | -344.4 | internally connected |
| MAXOP | 21 | -98.5 | -1124.3 | threshold level input for alarm on operating current |
| i.c. | 22 [2] | -48.6 | -368.4 | internally connected |
| VTEMP | 23 | +294.0 | -1124.2 | temperature dependent voltage output source |
| MAXMON | 24 | +466.9 | -1124.2 | threshold level input for alarm on monitor diode current |
| RREF | 25 | +694.9 | -1124.0 | reference current input; must be connected to ground with an accurate (1 %) 10 kΩ resistor |
| GNDRF | 26 | +860.3 | -1124.0 | ground |
| PWA | 27 | +1098.9 | -979.4 | pulse width adjustment input |
| GNDO | 28 | +1099.0 | -829.7 | ground |
| LAQ | 29 | +1099.0 | -691.2 | inverted laser modulation output (RF output); output for dummy load |
| LAQ | 30 | +1099.0 | -611.2 | inverted laser modulation output (RF output); output for dummy load |
| LAQ | 31 | +1099.0 | -506.4 | inverted laser modulation output (RF output); output for dummy load |
| LAQ | 32 | +1099.0 | -426.4 | inverted laser modulation output (RF output); output for dummy load |
| GNDO | 33 | +1099.8 | -247.0 | ground |
| i.c. | 34 [2] | +839.0 | -194.4 | internally connected |
| GNDO | 35 | +1099.8 | -142.0 | ground |
| GNDO | 36 | +1099.8 | -36.8 | ground |
| LA | 37 | 1099.1 | 105.4 | non-inverted laser modulation output (RF output); output for laser |
| i.c. | 38 [2] | 839.0 | 179.6 | internally connected |
| LA | 39 | 1099.1 | 185.4 | non-inverted laser modulation output (RF output); output for laser |
| LA | 40 | 1099.1 | 290.5 | non-inverted laser modulation output (RF output); output for laser |
| LA | 41 | 1099.1 | 370.5 | non-inverted laser modulation output (RF output); output for laser |
| GNDO | 42 | 1099.1 | 670.8 | ground |
| BIAS | 43 | 1099.0 | 804.8 | current source output for the laser bias current |
| V _{CCO} | 44 | 1099.0 | 944.4 | supply voltage for the output stage and the laser diode |
| V _{CCO} | 45 | 1099.0 | 1024.4 | supply voltage for the output stage and the laser diode |
| ACDC | 46 [3] | 942.5 | 1124.3 | AC or DC coupled laser |

Table 3: Bonding pad description TZA3011UH [1] ...continued

| Symbol | Pad | X | Y | Description |
|---------|--------|--------|---------|--|
| GNDSD | 47 | 765.0 | 1123.8 | ground |
| MON | 48 | 602.1 | 1123.7 | input for the monitor photodiode (RF input) |
| BIASIN | 49 | 431.7 | 1123.8 | input for the bias current setting |
| BIASOUT | 50 | 267.6 | 1123.8 | output of the control block for the bias current |
| GNDCCB | 51 | 100.8 | 1123.8 | ground |
| MODIN | 52 | -82.7 | +1123.8 | input for the modulation current setting |
| GNDCCB | 53 | -241.1 | +1123.8 | ground |
| i.c. | 54 [2] | -274.4 | +954.4 | internally connected |
| MODOUT | 55 | -487.2 | +1123.8 | output of the control block for the modulation current |
| ER | 56 | -645.6 | +1123.8 | input for the optical extinction ratio setting |
| AVR | 57 | -802.8 | +1123.8 | input for the optical average power level setting |

- [1] All GND connections should be used.
All ground pads must be connected to ground.
Recommended order of bonding: all GND first, then V_{CCA} , V_{CCD} and V_{CCO} supplies and finally the input and output pins.
All coordinates are referenced, in μm , to the center of the die.
- [2] Pad is internally connected, do not use.
- [3] ACDC pad must be left unconnected for AC-coupling applications. For DC-coupling applications, connect this pad to ground.

Table 4: Physical characteristics of TZA3011UH

| Parameter | Value |
|-----------------------|---|
| Glass passivation | 0.3 μm PSG (Phospho Silicate Glass) on top of 0.8 μm of silicon nitride |
| Bonding pad dimension | minimum dimension of exposed metallization is 80 μm \times 80 μm (pad size = 90 μm \times 90 μm) |
| Metallization | 2.8 μm AlCu |
| Thickness | 380 μm nominal |
| Size | 2.560 mm \times 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 |

7. Functional description

7.1 Data and clock input

The TZA3011 operates with differential Positive Emitter Coupled Logic (PECL), Low Voltage Positive Emitter Coupled Logic (LVPECL) 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 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.

7.2 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.

7.3 Pulse width adjustment

The on-duration of the laser current can be adjusted from -100 ps 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.

7.4 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 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).

7.5 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 an RF input.

The average monitor current is programmable over a wide current range from 150 μ A to 1300 μ A 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.

7.6 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.

7.7 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.

7.8 Soft start

At power-up the bias and modulation current sources are released when $V_{CCA} > 2.7$ V 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.

7.9 Alarm functions

The TZA3011 features two alarm functions for the detection of excessive laser operating current and monitor diode current due to laser ageing, 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.

7.10 Enable

A LOW-level on the enable input disables the bias and modulation current sources: the laser is off. A HIGH-level on the enable input or an open enable input switches both current sources on: the laser is operational.

7.11 Reference block

The reference voltage is derived from a band gap circuit and is available at pin RREF. An accurate (1 %) 10 k Ω 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 V_{VTEMP} equals -2.2 mV/K.

8. Limiting values

Table 5: 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 | Conditions | 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 |
| $V_{o(LA)}$ | 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 |
| V_n | voltage on other input and output pins | | | | |
| | | analog inputs and outputs | -0.5 | $V_{CCA} + 0.5$ | V |
| | | digital inputs and outputs | -0.5 | $V_{CCD} + 0.5$ | 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 |
| T_{amb} | ambient temperature | | -40 | +85 | °C |
| T_j | junction temperature | | -40 | +125 | °C |
| T_{stg} | storage temperature | | -65 | +150 | °C |

9. Thermal characteristics

Table 6: Thermal characteristics

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

| Symbol | Parameter | Conditions | Typ | 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 printed circuit board | 35 | K/W |
| | | HBCC32 die pad soldered to printed circuit board | 60 | K/W |

10. Static characteristics

Table 7: Characteristics

$T_{amb} = -40\text{ °C}$ to $+85\text{ °C}$; $R_{th(j-a)} = 35\text{ K/W}$; $P_{tot} = 400\text{ mW}$; $V_{CCA} = 3.14\text{ V}$ to 3.47 V ; $V_{CCD} = 3.14\text{ V}$ to 3.47 V ; $V_{CCO} = 3.14\text{ V}$ to 3.47 V ; $R_{AVR} = 7.5\text{ k}\Omega$; $R_{ER} = 62\text{ k}\Omega$; $R_{MODIN} = 6.2\text{ k}\Omega$; $R_{BIASIN} = 6.8\text{ k}\Omega$; $R_{PWA} = 10\text{ k}\Omega$; $R_{RREF} = 10\text{ k}\Omega$; $R_{MAXMON} = 13\text{ k}\Omega$; $R_{MAXOP} = 20\text{ k}\Omega$; 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_{CCA} | analog supply voltage | | 3.14 | 3.3 | 3.47 | V |
| V_{CCD} | digital supply voltage | | 3.14 | 3.3 | 3.47 | V |
| V_{CCO} | RF output supply voltage | 3.3 V laser supply | 3.14 | 3.3 | 3.47 | V |
| | | 5 V laser supply | 4.75 | 5.0 | 5.25 | V |
| I_{CCA} | analog supply current | | 30 | 40 | 50 | mA |
| I_{CCD} | digital supply current | | 35 | 45 | 55 | mA |
| I_{CCO} | RF output supply current | pins LA and LAQ open-circuit | | | | |
| | | 3.3 V laser supply | 8 | 15 | 25 | mA |
| | | 5 V laser supply | - | 20 | - | mA |
| P_{core} | core power dissipation | core excluding output currents $I_{o(LA)}$, $I_{o(LAQ)}$ and I_{BIAS} ; PWA and retiming off | - | 264 | - | mW |
| P_{tot} | total power dissipation | $V_{BIAS} = 3.3\text{ V}$; $I_{BIAS} = 20\text{ mA}$; $I_{mod} = 16\text{ mA}$ | [1] | 330 | 400 | 500 mW |
| Data and clock inputs: pins DIN and CIN | | | | | | |
| $V_{i(p-p)}$ | input voltage swing (peak-to-peak value) | $V_{i(DIN)} = (V_{CCD} - 2\text{ V})$ to V_{CCD} ; $V_{i(CIN)} = (V_{CCD} - 2\text{ V})$ 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 | | [2] | -10 | 0 | +10 mV |
| $Z_{i(dif)}$ | differential input impedance | | 80 | 100 | 125 | Ω |
| $Z_{i(cm)}$ | common mode input impedance | | 8 | 10 | 13 | k Ω |
| $V_{i(CIN)(dis)}$ | input voltage for disabled retiming | $V_{CIN} = V_{CINQ}$ | - | - | 0.3 | V |
| Monitor photodiode input: pin MON | | | | | | |
| $V_{i(MON)}$ | input voltage | $I_{MON} = 50\text{ }\mu\text{A}$ to $2500\text{ }\mu\text{A}$ | 0.9 | 1.1 | 1.3 | V |
| $Z_{i(MON)}$ | input impedance | $I_{MON} = 50\text{ }\mu\text{A}$ to $2500\text{ }\mu\text{A}$ | - | 27 | - | Ω |

Table 7: Characteristics ...continued

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

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|------|------|------|---------|
| Extinction ratio setting for dual-loop control: pins MON and ER | | | | | | |
| ER _{min} | low extinction ratio setting | dual-loop set-up; I _{ER} > -30 μ A | [3] | | | |
| | | linear scale | - | 5 | 7 | |
| | | dB scale | - | 7 | 8.5 | dB |
| ER _{max} | high extinction ratio setting | dual-loop set-up; I _{ER} < -10 μ A | [3] | | | |
| | | linear scale | 13 | 15 | - | |
| | | dB scale | 11 | 11.8 | - | dB |
| ER _{acc} | relative accuracy of ER | temperature and V _{CCA} variations; ER = 10; AVR = 550 μ A | -10 | - | +10 | % |
| V _{ref(ER)} | reference voltage on pin ER | I _{ER} = -35 μ A to -5 μ A; C _{ER} < 100 pF | 1.15 | 1.20 | 1.25 | V |
| I _{ER} | current sink on pin ER | | -35 | - | -5 | μ A |
| 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 μ A | | | | |
| | | dual-loop (ER = 5) | - | - | 150 | μ A |
| | | average loop (pin ER to GND) | - | - | 150 | μ A |
| I _{av(MON)(max)} | maximum average monitor current setting | I _{AVR} = -15.0 μ A | | | | |
| | | dual-loop (ER = 5) | 1200 | 1300 | - | μ A |
| | | average loop (pin ER to GND) | 1200 | 1300 | - | μ A |
| Δ I _{av(MON)} | relative accuracy of average current on pin MON | temperature and V _{CCA} variations; ER = 10; AVR = 550 μ A | -10 | - | +10 | % |
| V _{ref(AVR)} | reference voltage on pin AVR | I _{AVR} = -250 μ A to -15 μ A; C _{AVR} < 100 pF | 1.15 | 1.20 | 1.25 | V |
| I _{sink(AVR)} | current sink on pin AVR | | -280 | - | -15 | μ A |
| Control loop modulation output: pin MODOUT | | | | | | |
| I _{source(MODOUT)} | source current | V _{MODOUT} = 0.5 V to 1.5 V; C _{MODOUT} < 100 pF | - | - | -200 | μ A |
| I _{sink(MODOUT)} | sink current | V _{MODOUT} = 0.5 V to 1.5 V; C _{MODOUT} < 100 pF | 200 | - | - | μ A |
| Control loop bias output: pin BIASOUT | | | | | | |
| I _{source(BIASOUT)} | source current | V _{BIASOUT} = 0.5 V to 1.5 V; C _{BIASOUT} < 100 pF | - | - | -200 | μ A |
| I _{sink(BIASOUT)} | sink current | V _{BIASOUT} = 0.5 V to 1.5 V; C _{BIASOUT} < 100 pF | 200 | - | - | μ A |
| Bias current source: pins BIASIN and BIAS | | | | | | |
| g _{m(bias)} | bias transconductance | V _{BIASIN} = 0.5 V to 1.5 V | | | | |
| | | V _{BIAS} = V _{CCO} = 3.3 V | 90 | 110 | 125 | mA/V |
| | | V _{BIAS} = 4.1 V; V _{CCO} = 5.0 V | 95 | 110 | 130 | mA/V |
| I _{source(BIASIN)} | source current at pin BIASIN | V _{BIASIN} = 0.5 V to 1.5 V | -110 | -100 | -95 | μ A |

Table 7: Characteristics ...continued

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

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|--|---|---------|------|-----|---------------|
| $I_{BIAS(max)}$ | maximum bias current | $V_{BIASIN} = 1.8\text{ V}$ | 100 | - | - | mA |
| $I_{BIAS(min)}$ | minimum bias current | $V_{BIASIN} = 0\text{ V}$ to 0.4 V | - | 0.2 | 0.4 | mA |
| $I_{BIAS(dis)}$ | bias current at disable | $V_{ENABLE} < 0.8\text{ V}$ | - | - | 30 | μA |
| V_{BIAS} | output voltage on pin BIAS | normal operation | | | | |
| | | $V_{CCO} = 3.3\text{ V}$ | 0.4 | - | 3.6 | V |
| | | $V_{CCO} = 5\text{ V}$ | 0.8 | - | 4.1 | V |
| Modulation current source: pin MODIN | | | | | | |
| $g_{m(mod)}$ | modulation transconductance | $V_{MODIN} = 0.5\text{ V}$ to 1.5 V | | | | |
| | | $V_{LA} = V_{LAQ} = V_{CCO} = 3.3\text{ V}$ | 78 | 90 | 105 | mA/V |
| | | $V_{LA} = V_{LAQ} = V_{CCO} = 4.5\text{ V}$ | 80 | 95 | 110 | mA/V |
| $I_{source(MODIN)}$ | source current at pin MODIN | $V_{MODIN} = 0.5\text{ V}$ 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 | $V_{MODIN} = 1.8\text{ V}$; $V_{LA} = V_{CCO} = 3.3\text{ V}$ | [4] 100 | - | - | mA |
| $I_{o(LA)(min)(on)}$ | minimum laser modulation output current at LA on | $V_{MODIN} = 0\text{ V}$ to 0.4 V ; $V_{LA} = V_{CCO} = 3.3\text{ V}$ | [4] - | 5 | 6 | mA |
| $I_{o(LA)(min)(off)}$ | minimum laser modulation output current at LA off | $V_{LA} = V_{CCO} = 3.3\text{ V}$ | [4] | | | |
| | | $V_{MODIN} = 0.5\text{ V}$ | - | - | 0.8 | mA |
| | | $V_{MODIN} = 1.5\text{ V}$ | - | - | 2 | mA |
| $Z_{o(LA)}, Z_{o(LAQ)}$ | output impedance LA and LAQ pins | | 80 | 100 | 125 | Ω |
| $I_{o(LA)(dis)}, I_{o(LAQ)(dis)}$ | non-inverted and inverted laser modulation output current at disable | $V_{ENABLE} < 0.8\text{ V}$ | - | - | 200 | μA |
| $V_{o(LA)min}$ | minimum output voltage at pin LA | TZA3011A; $V_{CCO} = 3.3\text{ V}$ | 1.6 | - | - | V |
| | | TZA3011B; $V_{CCO} = 3.3\text{ V}$ | 1.2 | - | - | V |
| | | TZA3011B; $V_{CCO} = 5\text{ V}$ | 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 | k Ω |
| 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 | k Ω |

Table 7: Characteristics ...continued

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

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|--|--|------|------|------|--------|
| Alarm operating current: pins MAXOP and ALOP | | | | | | |
| $V_{ref(MAXOP)}$ | reference voltage on pin MAXOP | $I_{MAXOP} = 10\text{ }\mu\text{A}$ to $200\text{ }\mu\text{A}$ | 1.15 | 1.2 | 1.25 | V |
| N_{MAXOP} | ratio of $I_{oper(alarm)}$ and I_{MAXOP} | $I_{oper(alarm)} = 7.5\text{ mA}$ to 150 mA | | | | |
| | | $V_{CCO} = 3.3\text{ V}$ | 700 | 800 | 900 | |
| | | $V_{CCO} = 5.0\text{ V}$ | 750 | 850 | 950 | |
| $V_{D(ALOP)L}$ | drain voltage at active alarm | $I_{ALOP} = 500\text{ }\mu\text{A}$ | 0 | - | 0.4 | V |
| Alarm monitor current: pins MAXMON and ALMON | | | | | | |
| $V_{ref(MAXMON)}$ | reference voltage on pin MAXMON | $I_{MAXMON} = 10\text{ }\mu\text{A}$ to $200\text{ }\mu\text{A}$ | 1.15 | 1.2 | 1.25 | V |
| N_{MAXMON} | ratio of $I_{MON(alarm)}$ and I_{MAXMON} | $I_{MON(alarm)} = 150\text{ }\mu\text{A}$ to $3000\text{ }\mu\text{A}$ | 10 | 15 | 20 | |
| $V_{D(ALMON)L}$ | drain voltage at active alarm | $I_{ALMON} = 500\text{ }\mu\text{A}$ | 0 | - | 0.4 | V |
| Reference block: pins RREF and VTEMP | | | | | | |
| V_{RREF} | reference voltage | $R_{RREF} = 10\text{ k}\Omega$ (1 %); $C_{RREF} < 100\text{ pF}$ | 1.15 | 1.20 | 1.25 | V |
| V_{VTEMP} | temperature dependent voltage | $T_j = 25\text{ °C}$; $C_{VTEMP} < 2\text{ nF}$ | [5] | 1.15 | 1.20 | 1.25 V |
| TC_{VTEMP} | temperature coefficient of V_{VTEMP} | $T_j = -25\text{ °C}$ to $+125\text{ °C}$ | [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 |

[1] The total power dissipation P_{tot} is calculated with $V_{BIAS} = V_{CCO} = 3.3\text{ V}$ and $I_{BIAS} = 20\text{ mA}$. 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 $I_{MON} > 50\text{ }\mu\text{A}$ and $I_{MON} < 2500\text{ }\mu\text{A}$. Therefore, for large ER settings, minimum/maximum AVR cannot be reached.

[4] The relation between the sink current $I_{o(LA)}$ and the modulation current I_{mod} is: $I_{o(LA)} = I_{mod} \times \frac{100}{100 + Z_{L(LA)}}$ where $Z_{L(LA)}$ is the external load on pin LA. The voltage on pin MODIN programmes the modulation current I_{mod} . This current is divided between $Z_{L(LA)}$ and the $100\text{ }\Omega$ internal resistor connected to pins LA. When the modulation current is programmed to 100 mA , a typical $Z_{L(LA)}$ of $25\text{ }\Omega$ will result in an $I_{o(LA)}$ current of 80 mA , while 20 mA flows via the internal resistor. This corresponds to a voltage swing of 2 V on the real application load.

[5] $V_{VTEMP} = 1.31 + TC_{VTEMP} \times T_j$ and $T_j = T_{amb} + P_{tot} \times R_{th(j-a)}$.

11. Dynamic characteristics

Table 8: Characteristics

$T_{amb} = -40\text{ °C to }+85\text{ °C}$; $R_{th(j-a)} = 35\text{ K/W}$; $P_{tot} = 400\text{ mW}$; $V_{CCA} = 3.14\text{ V to }3.47\text{ V}$; $V_{CCD} = 3.14\text{ V to }3.47\text{ V}$; $V_{CCO} = 3.14\text{ V to }3.47\text{ V}$; $R_{AVR} = 7.5\text{ k}\Omega$; $R_{ER} = 62\text{ k}\Omega$; $R_{MODIN} = 6.2\text{ k}\Omega$; $R_{BIASIN} = 6.8\text{ k}\Omega$; $R_{PWA} = 10\text{ k}\Omega$; $R_{RREF} = 10\text{ k}\Omega$; $R_{MAXMON} = 13\text{ k}\Omega$; $R_{MAXOP} = 20\text{ k}\Omega$; 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 | Gbit/s | |
| | | average loop control | 0.03 | - | 3.2 | Gbit/s | |
| $J_{LA(p-p)}$ | jitter of pin LA output signal (peak-to-peak value) | $R_L = 25\ \Omega$ | [1] | - | 20 | ps | |
| t_r | rise time of voltage on pin LA | 20 % to 80 %; $R_L = 25\ \Omega$; $I_{mod} = 17\text{ mA}$ | [2][3] | 70 | 85 | 110 | ps |
| t_f | fall time of voltage on pin LA | 80 % to 20 %; $R_L = 25\ \Omega$; $I_{mod} = 17\text{ mA}$ | [2][3] | 50 | 70 | 100 | ps |
| $t_{su(D)}$ | data input set-up time | | 60 | - | - | ps | |
| $t_{h(D)}$ | data input hold time | | 60 | - | - | ps | |
| $t_{en(start)}$ | start-up time at enable | direct current setting | - | - | 1 | μs | |
| Current control | | | | | | | |
| $t_{c(int)}$ | 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 | $R_{PWA} = 6.7\text{ k}\Omega$; $C_{PWA} < 100\text{ pF}$ | - | - | -100 | ps | |
| t_{PWA} | pulse width adjustment on pins LA | $R_{PWA} = 10\text{ k}\Omega$; $C_{PWA} < 100\text{ pF}$ | - | 0 | - | ps | |
| $t_{PWA(max)}$ | maximum pulse width adjustment on pins LA | $R_{PWA} = 20\text{ k}\Omega$; $C_{PWA} < 100\text{ pF}$ | 80 | 100 | - | ps | |

[1] The output jitter specification is guaranteed by design.

[2] With a $25\ \Omega$ load on the LA pins: $I_{O(LA)} = 14\text{ mA}$ when $I_{mod} = 17\text{ mA}$.

[3] For high modulation current, t_r and t_f are impacted by total inductance between the LA pins and the laser connection.

12. Application information

12.1 Design equations

12.1.1 Bias and modulation currents

The bias and modulation currents are determined by the voltages on pins BIASIN and MODIN. These voltages are applied by pins BIASOUT and MODOUT for dual-loop control. For average loop control the BIASIN voltage is applied by pin BIASOUT 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 pins BIASIN and MODIN:

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

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

The bias and modulation current sources operate with an input voltage range from 0.5 V to 1.5 V. The output current is at its minimum level for an input voltage below 0.4 V; see [Figure 4](#) and [Figure 5](#).

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.

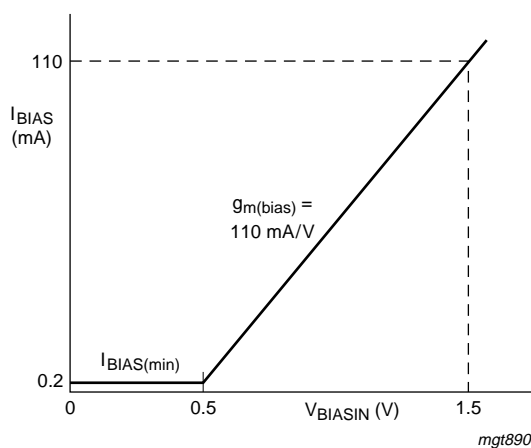
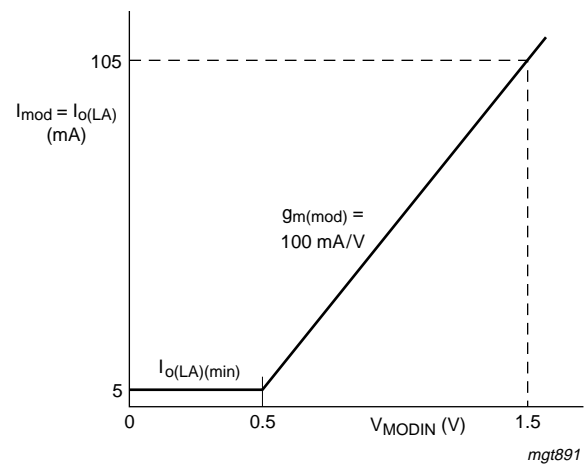


Fig 4. Bias current as a function of BIASIN voltage



LA current when LA output is on.

$V_{o(LA)} = V_{CCO}$.

Fig 5. Modulation current as a function of MODIN voltage

12.1.2 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:

$$I_{av(MON)} = 1580 - 5.26 \times I_{AVR} = 1580 - 5.26 \times \frac{V_{AVR}}{R_{AVR}} \text{ } [\mu\text{A}]$$

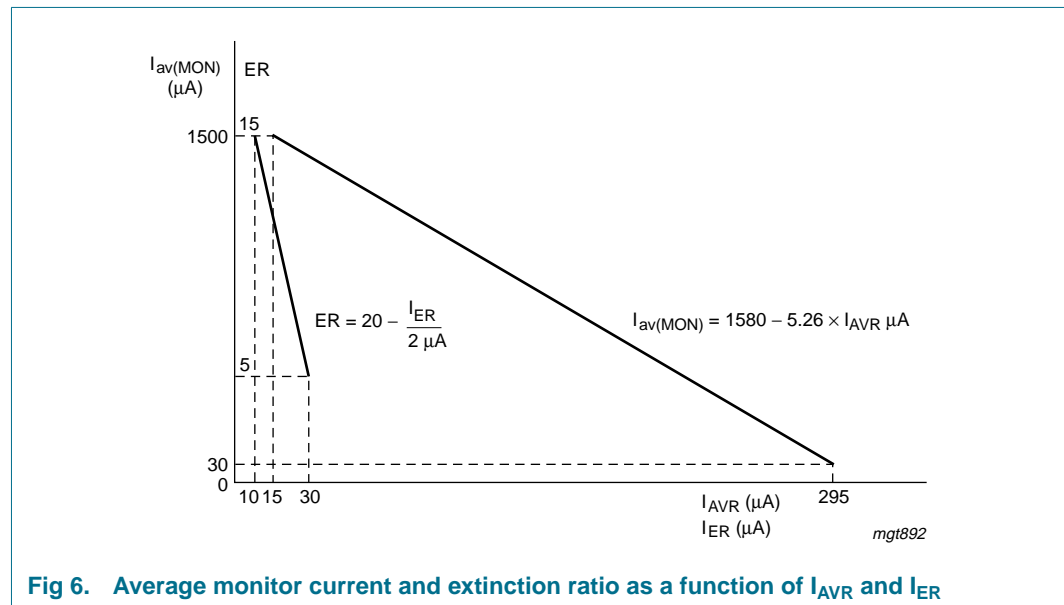
The extinction ratio in dual-loop operation is determined by the source current (I_{ER}) of the ER pin. The current can be sunk by an external current source or by an external resistor

$$(R_{ER}) \text{ connected to ground: } ER = 20 - \frac{I_{ER}}{2 \mu\text{A}} = 20 - \frac{I}{2 \mu\text{A}} \times \frac{V_{ER}}{R_{ER}}$$

The average monitor current and the extinction ratio as a function of the I_{AVR} and I_{ER} current are illustrated in [Figure 6](#).

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.



12.1.3 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 Gbit/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.

12.1.4 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 μA to 200 μA which corresponds with an $I_{oper(alarm)}$ from 7.5 mA 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:

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

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

12.1.5 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 μ A to 200 μ A which corresponds with an $I_{MON(alarm)}$ from 150 μ A to 3000 μ A. The I_{MAXMON} current can be sunk by an external current source or by connecting R_{MAXMON} to ground:

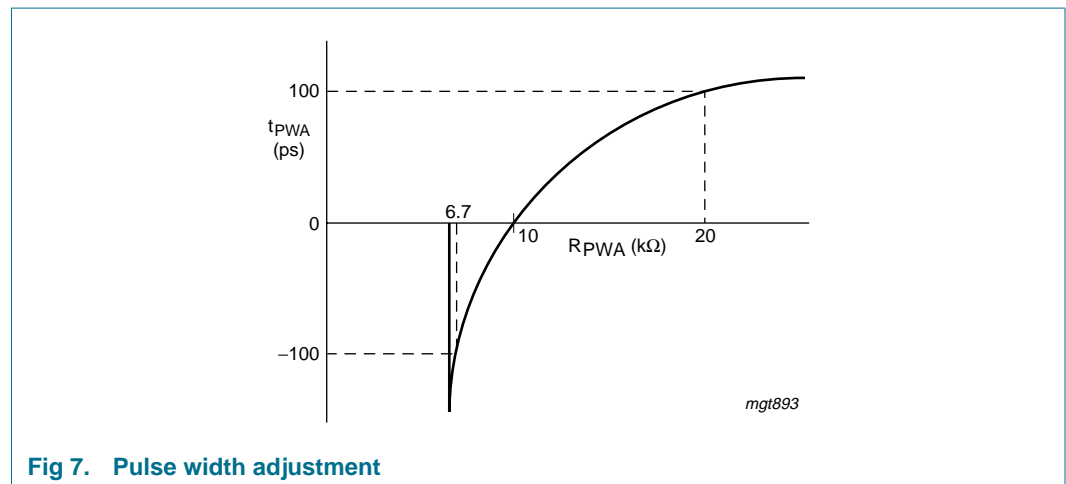
$$I_{MON(alarm)} = N_{MAXMON} \times \frac{V_{MAXMON}}{R_{MAXMON}}$$

12.1.6 Pulse width adjustment

The pulse width adjustment time is determined by the value of resistor R_{PWA} ; see [Figure 7](#).

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

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



12.2 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 Figure 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 alarm threshold on the operating current is made temperature dependent with resistor R_{VTEMP} connected between VTEMP and MAXOP. This alarm detects the end of life of the laser.

$$I_{oper(alarm)} = N_{MAXOP} \times \left(\frac{V_{MAXOP}}{R_{MAXOP}} - \frac{TC_{VTEMP} \times (T_j - 25\text{ }^\circ\text{C})}{R_{VTEMP}} \right)$$

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

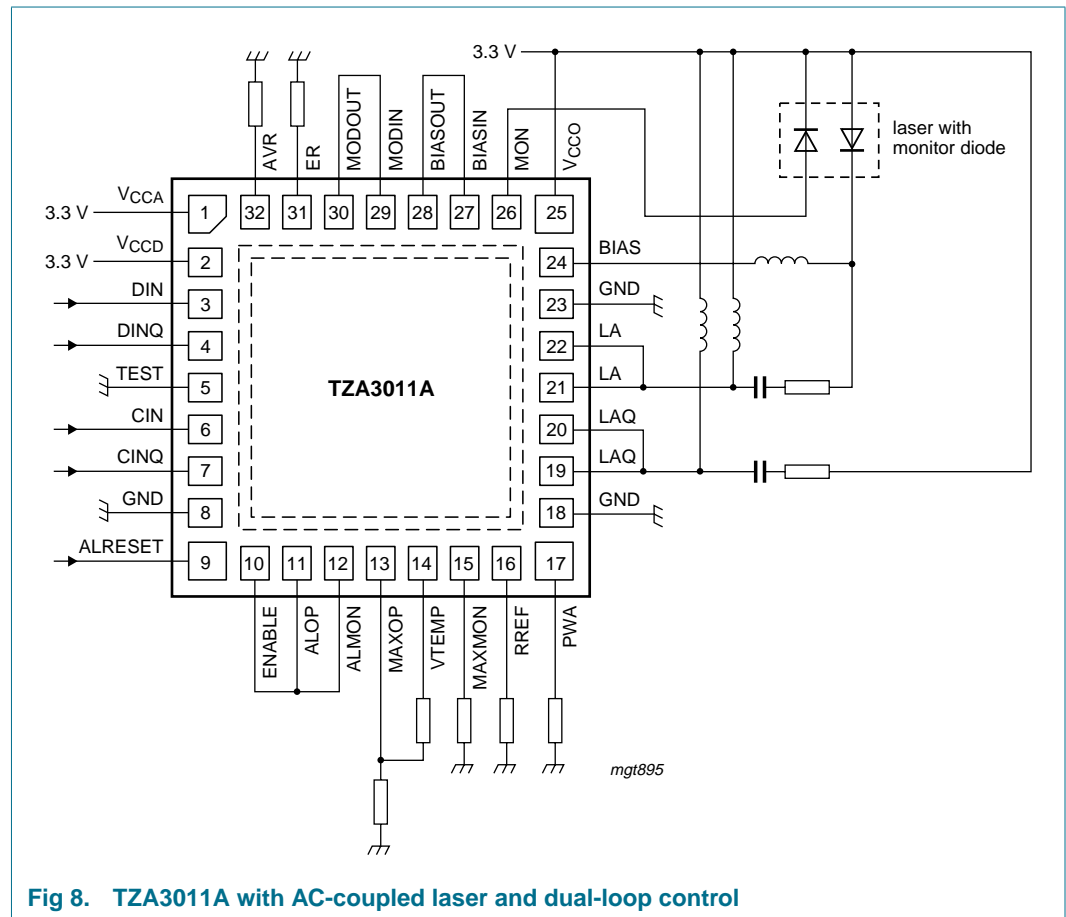


Fig 8. TZA3011A with AC-coupled laser and dual-loop control

12.3 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 [Figure 9](#). 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 pin ENABLE causing an active alarm to disable the bias and modulation current sources. The ALRESET input will reset the alarm latches and enable normal operation.

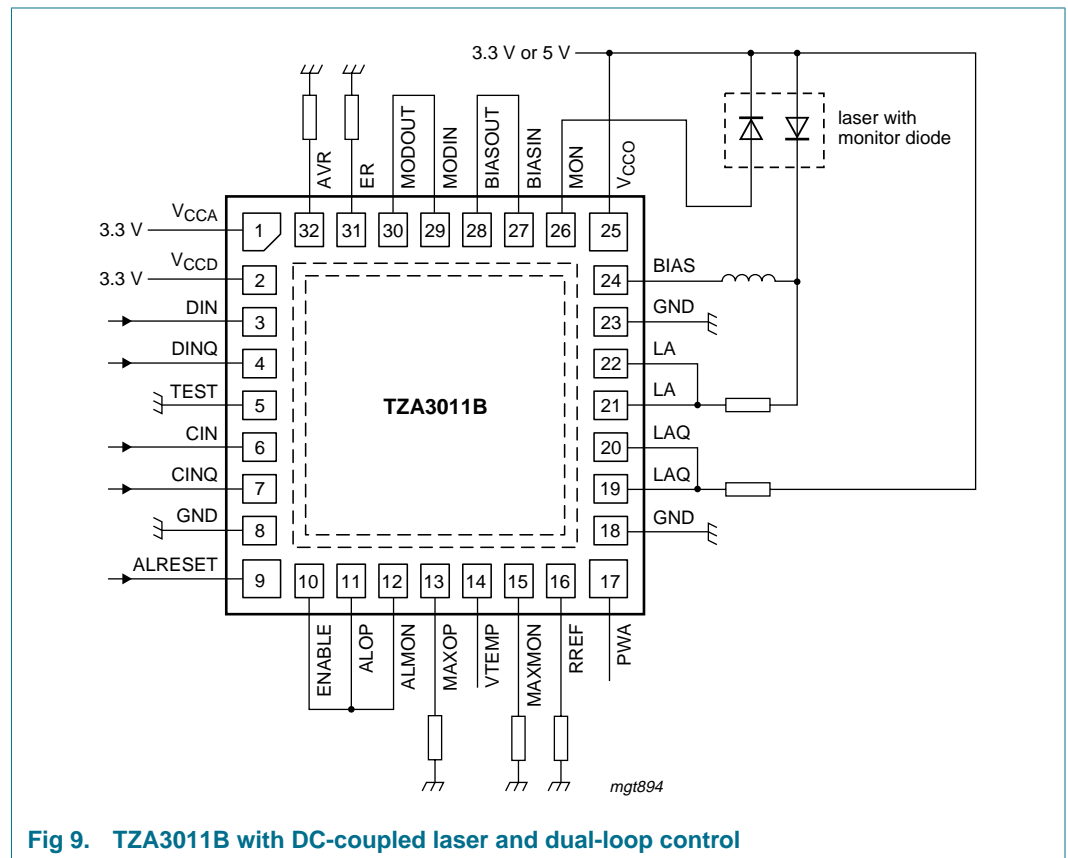


Fig 9. TZA3011B with DC-coupled laser and dual-loop control

12.4 TZA3011B with average loop control

A simplified application using the TZA3011B with average loop control and a DC-coupled laser at 3.3 V or 5 V laser voltage is illustrated in [Figure 10](#). 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 μ A source current of the MODIN pin.

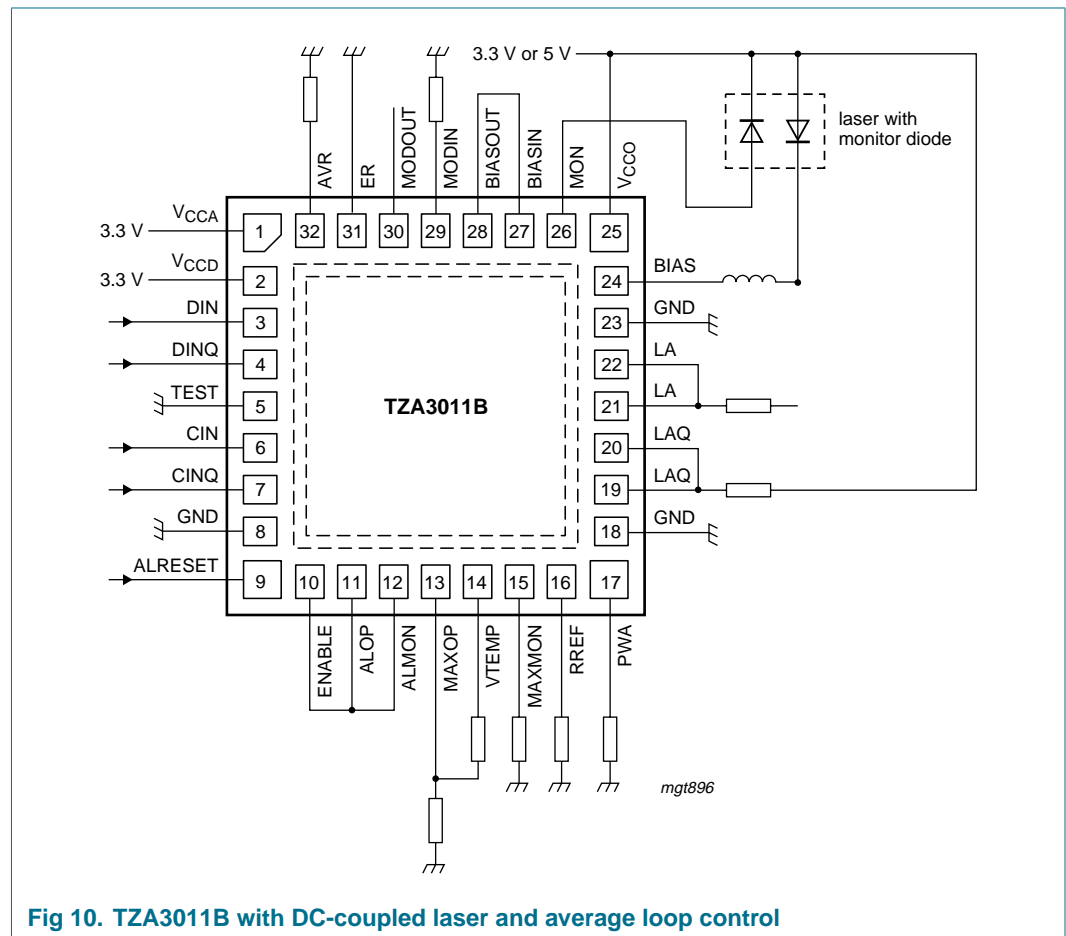


Fig 10. TZA3011B with DC-coupled laser and average loop control

13. Package outline

HBCC32: plastic thermal enhanced bottom chip carrier; 32 terminals; body 5 x 5 x 0.65 mm

SOT560-1

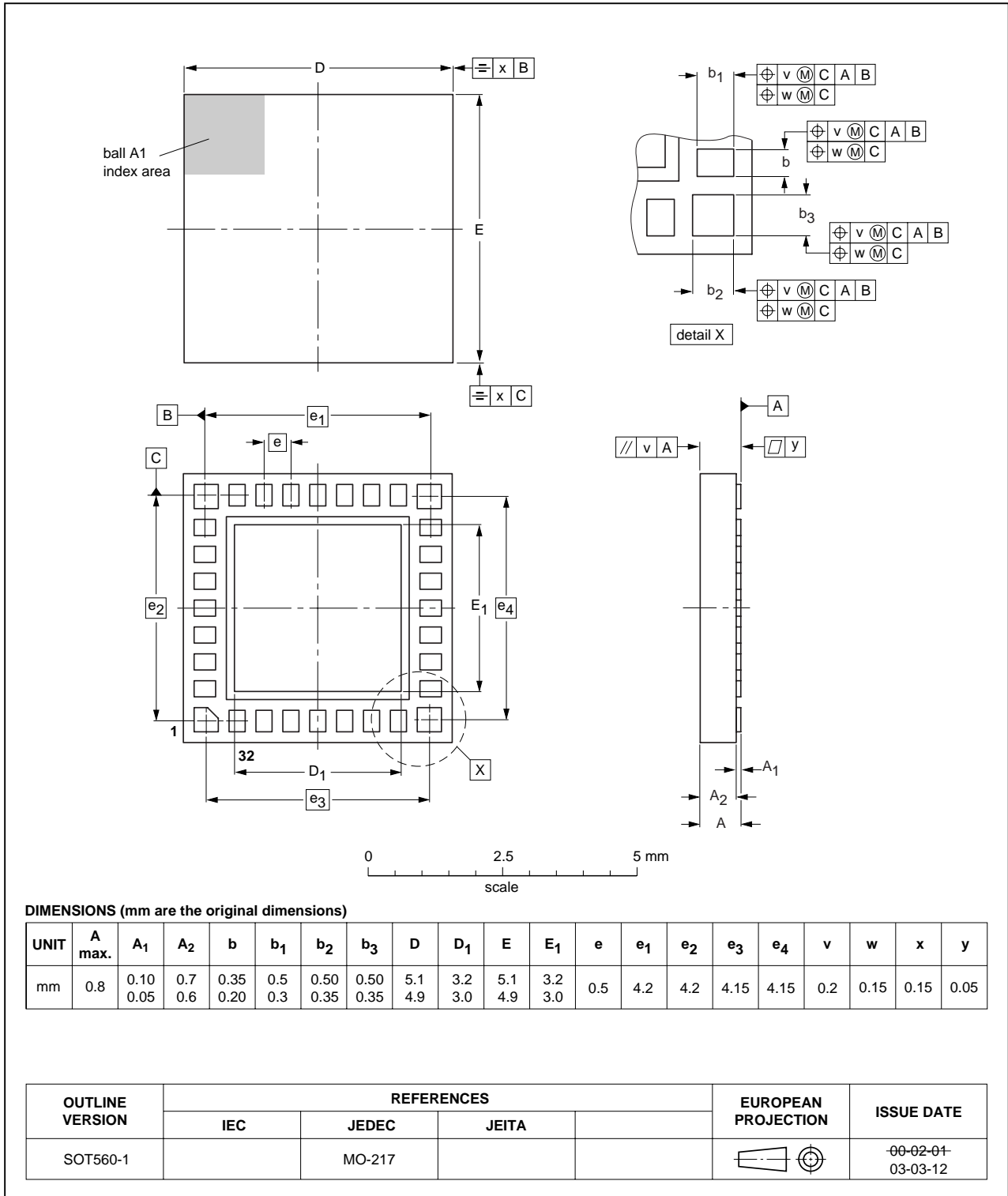


Fig 11. Package outline SOT560-1 (HBCC32)

14. Soldering

14.1 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.

14.2 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. Driven by legislation and environmental forces the worldwide use of lead-free solder pastes is increasing.

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 seconds and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 °C to 270 °C depending on solder paste material. The top-surface temperature of the packages should preferably be kept:

- below 225 °C (SnPb process) or below 245 °C (Pb-free process)
 - for all BGA, HTSSON..T and SSOP..T packages
 - for packages with a thickness ≥ 2.5 mm
 - for packages with a thickness < 2.5 mm and a volume ≥ 350 mm³ so called thick/large packages.
- below 240 °C (SnPb process) or below 260 °C (Pb-free process) for packages with a thickness < 2.5 mm and a volume < 350 mm³ so called small/thin packages.

Moisture sensitivity precautions, as indicated on packing, must be respected at all times.

14.3 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 of the leads in the wave ranges from 3 seconds to 4 seconds at 250 °C or 265 °C, depending on solder material applied, SnPb or Pb-free respectively.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

14.4 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 seconds to 5 seconds between 270 °C and 320 °C.

14.5 Package related soldering information

Table 9: Suitability of surface mount IC packages for wave and reflow soldering methods

| Package [1] | Soldering method | |
|--|-------------------------|--------------|
| | Wave | Reflow [2] |
| BGA, HTSSON..T [3], LBGA, LFBGA, SQFP, SSOP..T [3], TFBGA, VFBGA, XSON | not suitable | suitable |
| DHVQFN, HBCC, HBGA, HLQFP, HSO, HSOP, HSQFP, HSSON, HTQFP, HTSSOP, HVQFN, HVSON, SMS | not suitable [4] | suitable |
| PLCC [5], SO, SOJ | suitable | suitable |
| LQFP, QFP, TQFP | not recommended [5] [6] | suitable |
| SSOP, TSSOP, VSO, VSSOP | not recommended [7] | suitable |
| CWQCCN..L [8], PMFP [9], WQCCN..L [8] | not suitable | not suitable |

[1] For more detailed information on the BGA packages refer to the *(LF)BGA Application Note (AN01026)*; order a copy from your Philips Semiconductors sales office.

[2] 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*.

[3] These transparent plastic packages are extremely sensitive to reflow soldering conditions and must on no account be processed through more than one soldering cycle or subjected to infrared reflow soldering with peak temperature exceeding 217 °C ± 10 °C measured in the atmosphere of the reflow oven. The package body peak temperature must be kept as low as possible.

- [4] These packages are not suitable for wave soldering. On versions with the heatsink on the bottom side, the solder cannot penetrate between the printed-circuit board and the heatsink. On versions with the heatsink on the top side, the solder might be deposited on the heatsink surface.
- [5] 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.
- [6] Wave soldering is suitable for LQFP, QFP and TQFP packages with a pitch (e) larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
- [7] Wave soldering is suitable for SSOP, TSSOP, VSO and VSSOP 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.
- [8] Image sensor packages in principle should not be soldered. They are mounted in sockets or delivered pre-mounted on flex foil. However, the image sensor package can be mounted by the client on a flex foil by using a hot bar soldering process. The appropriate soldering profile can be provided on request.
- [9] Hot bar soldering or manual soldering is suitable for PMFP packages.

15. Revision history

Table 10: Revision history

| Document ID | Release date | Data sheet status | Change notice | Doc. number | Supersedes |
|---|--------------|---------------------------|---------------|----------------|---------------------|
| TZA3011A_TZA3011B_6 | 20050120 | Product data sheet | - | 9397 750 14437 | TZA3011A_TZA3011B_5 |
| Modifications: | | | | | |
| <ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors. change unit bits/s to bit/s. | | | | | |
| TZA3011A_TZA3011B_5 | 20030402 | Product specification | | 9397 750 11282 | TZA3011A_TZA3011B_4 |
| TZA3011A_TZA3011B_4 | 20021106 | Product specification | | 9397 750 10185 | TZA3011A_TZA3011B_3 |
| TZA3011A_TZA3011B_3 | 20020523 | Preliminary specification | | 9397 750 09671 | TZA3011A_TZA3011B_2 |
| TZA3011A_TZA3011B_2 | 20020312 | Preliminary specification | | 9397 750 09231 | TZA3011A_B_1 |
| TZA3011A_B_1 | 20010129 | Objective specification | | 9397 750 07764 | - |

16. Data sheet status

| Level | Data sheet status [1] | Product status [2] [3] | Definition |
|-------|-----------------------|------------------------|--|
| I | 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. |
| II | Preliminary data | Qualification | This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product. |
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[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

17. Definitions

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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