DRIVER BOARD EBD5100

Product Specification Document

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CONTENTS

1 SCOPE

1.1 PURPOSE

The purpose of this document is to describe the set of functional features, the performance and the user interfaces of EXALOS' analog driver board EBD5100 for SLEDs (Super-Luminescent Emitting Diodes) and pin-compatible laser diodes.

1.2 BOARD REVISION

This product specification is based on the EBD5100 production series, revision V2.

1.3 RESPONSIBILITY

EXALOS is responsible for establishing, implementing and maintaining this specification. The quality representative shall ensure that a timely Engineering Change Notice (ECN) is issued in accordance with EXALOS' procedure for any changes.

2 PRODUCT DESCRIPTION

2.1 ARCHITECTURE

The EBD5100 is a high-performance analog driver board that consists of a multi-layer PCB board on which the 14-pin dual-in-line (DIL) module is soldered. The multi-layer PCB design with shielding ground layers allows for the co-existence of a highly efficient switched-mode temperature controller (TEC) with a low-noise linear SLED drive current controller in a compact form factor with the size of a credit card. Furthermore, the multi-layer PCB design features a sophisticated heat-spreading thermal design that reduces hot spots, which is the basis for stable operation at high ambient temperatures.

2.2 FEATURES

The main characteristics of the EBD5100 are:

- High-efficiency switched-mode TEC supporting high-power SLEDs at high ambient temperatures
- Generation of an ultra-stable, ultra-low noise SLED drive current
- Adjustment of the SLED drive current either through an external analog control voltage (0-2.5V) or through the on-board potentiometer
- SLED enable either through a mechanical code switch or through an electrical TTL signal
- Digital on-off modulation with TTL signals
- Noise and spike filter network and brown-out detector for input supply voltage

The EBD5100 features a stabilization feedback loop for the SLED drive current (automatic current control, ACC) but not for the SLED output power (automatic power control, APC). If required, APC would have to be realized through external control loops, for example using either the monitor photodiode (MPD) signal of the JP2 connector or using any external MPD in conjunction with control of the SLED drive current through an analog control signal at JP5.

2.3 OPERATING RANGE

The EBD5100 has been designed for operation over a wide temperature range. Only industrial-grade components have been selected that are qualified for operating temperatures from -40 °C to +85 °C. The standard temperature operating range of the EBD5100 is -20 °C to +65 °C.

The EBD5100 is designed to ensure proper operation in environments with electro-magnetic interference (EMI) by using a star-like ground concept and various levels of analog grounds throughout the design.

The EBD5100 requires a stable +5V power supply in the range of 4.90 V to 5.20 V. Supply voltages outside this range may result in improper operation or elevated power dissipation of the electronics. Spiky and unstable supply voltages may activate the on-board spike and brown-out detector, resulting in a controlled shut-off followed by a ramp-up of the SLED current. The required supply current is composed of the SLED drive current and the Peltier current. The maximum supply current is 3 A for a maximum SLED drive current of 1000 mA and a maximum Peltier current of 1800 mA. Typical supply current under operation might be significantly lower, depending on the SLED and ambient temperature.

2.4 ROHS COMPLIANCE

All components and fabrication or assembly processes used for the EBD5100 are compliant to the Restriction of Hazardous Substances (RoHS) directive 2002/95/EC.

3 EBD5100 DRIVER BOARD

3.1 PRINTED CIRCUIT BOARD (PCB)

The EBD5100 board has a size of 70 mm (L) x 55 mm (W). Fig. 1 shows pictures of the front side of the EBD5100 board. Fig. 2 shows a schematic top view of the board and the names of connectors, switches, potentiometers and LED indicators.

Fig. 1 Top view of the EBD5100 board

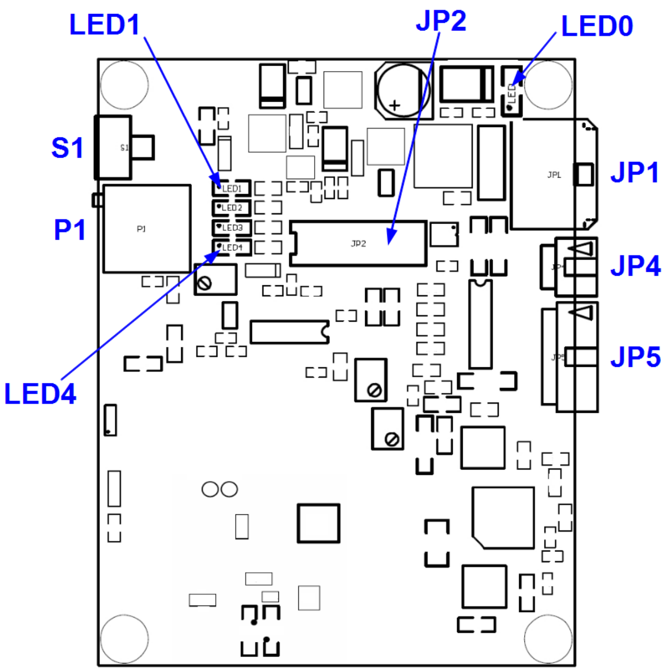

Fig. 2 Schematic top view of the EBD5100 indicating the user interfaces

3.2 ELECTRICAL USER INTERFACES

When the EBD5100 is, together with an SLED module, assembled into a metal case only connector JP1, JP4 and JP5 as well as potentiometer P1 are accessible from the outside. Hidden inside the metal case and hence not accessible from the outside are connector JP2, which features diagnostic signals to be used by EXALOS only, code switch S1, which allows for the selection of various operating modes, and five LED indicators. Table 1 provides a list of all electrical connectors that belong to the user interface.

Name	Connector on EBD5100 board	Function	Mating connector for cable assembly
JP1	MOLEX "Micro-Fit 3.0"; 43650-0300 Header (male)	+5V power supply, GND, PE	MOLEX "Micro-Fit 3.0"; 43645-0300 Receptacle (female)
JP2	Tyco "Micro-MaTch"; 1-215079-0 female-on-board	On-board diagnostics (for EXALOS use only)	Tyco "Micro-MaTch"; 8-215083-0 male-on-wire
JP4	MOLEX "Milli-Grid"; 87833-0420 Header (male)	SLED enable & on-off modulation	MOLEX "Milli-Grid"; 51110-0460 Crimp Housing
JP5	MOLEX "Milli-Grid"; 87833-1020 Header (male)	Analog and digital input & output signals	MOLEX "Milli-Grid"; 51110-1060 Crimp Housing

Table 1 List of electrical connectors (user interface)

Fig. 3 shows the front view of the connector JP1, JP4 and JP5. The corresponding pinout information is listed in Table 2, Table 3 and Table 4, respectively.

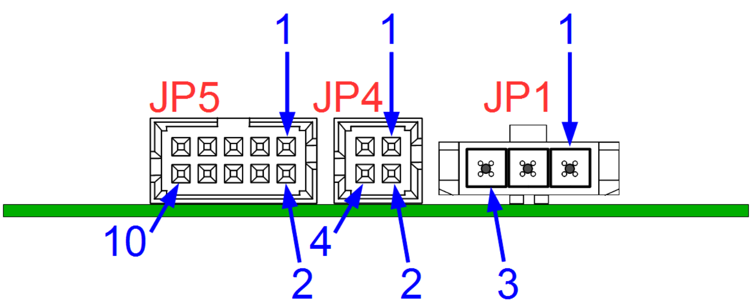

**Fig. 3 Front view of header JP5, JP4 and JP1 with pin indication.
The green bar indicates the PCB of the EBD5100.**

Pin	Name	Description /Comment
1	PE	Protective Earth, to ground the metal case
2	GND	External electrical Ground
3	+5Vext	External 5V power supply (4.90-5.20 V)

Table 2 Pinout of header JP1

Pin	Name	Description / Comment
1	Modulation	5V TTL digital modulation signal
2	+5Vin	5V supply voltage from JP1, for configuration purposes only, e.g., enable the SLED through short to pin3
3	SLEDenable	5V TTL digital signal to enable/disable the SLED
4	GNDext	GND reference for Modulation or SLEDenable when realized with open-collector outputs, preferably not be used otherwise to avoid GND loops (use instead pin2 of JP1 as GND reference for Modulation and SLEDenable if possible)

Table 3 Pinout of header JP4

Pin	Name	Description / Comment
1	SLED_enabled	Open-collector output indicating SLED is on
2	AIN_enabled	Open-collector output indicating that SLED current is controlled through pin9/pin10
3	AIN_alarm	Open-collector output indicating excessive analog input voltage at pin9/pin10 is applied and limited to +2.5V
4	Temperature_alarm	Open-collector output indicating the read temperature of the SLED being either 1.5°C above or below the set temperature
5	GNDext	GND reference for pin1 to pin4
6	GNDext	GND reference for pin1 to pin4
7	AINenable	Enable SLED current control through pin9/pin10
8	+5Vin	5V supply voltage from JP1, for configuration purposes only, e.g., enable analog control through short to pin7
9	+AINextern	Analog input voltage (0-2.5V) to control SLED current
10	-AINextern	GND reference of analog input signal (pin 9)

Table 4 Pinout of header JP5

The right half of connector JP5 contains digital alarm or status signals that are decoupled from the rest of the electronics through opto-couplers. They are open-collector outputs with a common ground "GNDext" that is on pin5 and pin6 of JP5. These alarm signals are also logically connected to the four LEDs that are found on the board. As shown in Table 5, the pinout sequence of JP5 matches the configuration sequence of the LED indicators (except for power indicator LED0).

LED	Name	Description / Comment
LED0 (green)	Power	Indicating supply voltage with correct polarity after the fuse and brown-out and spike detector
LED1 (green)	SLED_enabled	Open-collector output indicating SLED is on
LED2 (orange)	AIN_enabled	Open-collector output indicating that SLED current is controlled through pin9/pin10
LED3 (orange)	AIN_alarm	Open-collector output indicating excessive analog input voltage at pin9/pin10 is applied and limited to +2.5V
LED4 (red)	Temperature_alarm	Open-collector output indicating the read temperature of the SLED being either 1.5°C above or below the set temperature

Table 5 Configuration of LED indicators

The left half of connector JP5 contains pins for analog control of the SLED drive current and hence of the optical output power. The analog input pins shall be handled with care as they are not decoupled through opto-couplers, which may, in cases of false connectivity, result in unwanted GND loops. Pin9 and pin10 allow for applying an analog control voltage (0 to +2.5V) in order to control the SLED current and to use the EBD5100 as part of an analog control loop. The analog control input voltage at +AINext and –AINext are fed into an instrumentation amplifier of high accuracy, low offset voltage and low drift.

Position	AINenable	SLEDenable	TECenable
0	Off	Off	On
1	Off	On	On
2	On	Off	On
3	On	On	On
4	Off	Off	Off
5	Off	On	Off
6	On	Off	Off
7	On	On	Off

Table 6 Configuration table for code switch S1

Table 6 shows possible configurations of the EBD5100 that can be selected through the code switch S1. The default configuration of S1 is '0', i.e. the temperature controller (TEC) is enabled but the SLED and the current control through an analog input signal is disabled. This means that the TEC is working as soon as a supply voltage is applied. The SLED is turned off and can be turned on through an active-HIGH (5V) signal on pin3 of JP4 or by switching the code switch S1 to '1'. The SLED current can be adjusted through the potentiometer P1.

Still, even in configuration '1' the SLED current can be adjusted electronically through pin9 and pin10 of JP5. In order to enable the control through an external analog signal an active-HIGH (5V) signal needs to be applied to pin7 of JP5, for example by shortening pin7 and pin8. In this case the setting of potentiometer P1 is ignored.

The TEC shall only be disabled for SLED modules not featuring a Peltier element. For standard DIL modules with an internal Peltier element the default configuration of S1 has the TEC enabled as it cannot be enabled electronically.

3.3 OPERATING CONDITIONS

Table 7 shows the typical, minimum and maximum operating conditions of the EBD5100 driver board.

Parameter	**Min.**	**Typ.**	**Max.**
Supply Voltage	4.9 V	5.0 V	5.2 V
Supply current, SLED disabled, TEC enabled (1)		0.3 A	2.0 A
Supple current, SLED enabled, TEC enabled (2)		0.8 A	3.0 A
Ambient operating temperature (3)	-20 °C		65 °C
Ambient storage temperature	-40 °C		85 °C

(1): Typical value at room temperature. Larger than typical supply currents can occur during power-up of the board or at extreme ambient temperatures.
(2): Typical value at room temperature and SLEDs up to 500 mA. Larger than typical supply currents can occur during power-up of the board or at extreme ambient temperatures.
(3): Extended temperature range from -40°C to +85°C available upon request.

Table 7 Operating conditions of the EBD5100

3.4 PERFORMANCE CHARACTERISTICS

Table 8 shows the typical performance of an EBD5100 driver board that was assessed with various short-wavelength and long-wavelength SLED modules from EXALOS. Furthermore, spectral noise measurements were performed with a high-precision electrical resistor and compared to optical relative intensity noise (RIN) measurements carried out with SLED modules.

During mid-term (up to 24 hours) experiments in an environmental chamber, measurements of the SLED current were performed every 6 seconds. The time-related drift was extracted through adjacent-averaging smoothing with a 1-hour window size (sliding-window averaging); the drift is not cumulative, i.e. drift over 24 hours can be zero. During mid-term and long-term (up to 1000 hours) experiments in a module test system, measurements of the SLED current and temperature were performed every 1 second and averaged over five minutes (300 samples) in order to record long-term trends.

Parameter (ptp=peak-to-peak, rms=root mean square)	**Typical**	**Maximum Rating**	**Conditions/Comments**
Drive current		600 mA	Extended current range up to 1000 mA upon request
Compliance voltage		3.0 V	
TEC current		1.8 A	Extended TEC currents up to 3.0 A upon request
TEC temperature stability ptp 24h	±0.002 °C	±0.01 °C	Equivalent to ±100 ppm @ 20 °C
TEC temperature drift 1000h	±0.07 ppm/h	±0.1 ppm/h	Linear interpolation over 1000 h
Current stability ptp 24h	±75 ppm	±100 ppm	Ambient temperature constant within ±0.5 °C
Current stability rms 24h	±20 ppm	±30 ppm	Ambient temperature constant within ±0.5 °C
Current stability ptp 1h	±75 ppm	±100 ppm	Ambient temperature constant within ±0.5 °C
Current stability rms 1h	±20 ppm	±30 ppm	Ambient temperature constant within ±0.5 °C
Mid-term current drift 24h	±9 ppm/h	±12 ppm/h	1h sliding window
Long-term current drift 1000h	±0.5 ppm/h	±0.8 ppm/h	Linear interpolation over 1000 h
Temperature-related current change (1)	±10 µA/°C	±15 µA/°C	Average value, not including warm-up
Current noise	1.3 μA_{rms}	1.5 μA_{rms}	Extracted from spectral noise measurements (1 kHz – 10 MHz)
Turn-on delay for SLED enable (2)	100 ms		
Turn-on delay on-off modulation (2)	10 ms		
10:90 rise time on-off modulation (2)	1 ms		
Max. on-off modulation frequency (3)	50 Hz		
Max. analog modulation frequency (3)	3 Hz		

(1): Typically a change of 1.0 mA or less in drive current is measured over temperature range from -40°C to +85°C.

(2): The EBD5100 features a built-in safety circuitry that powers down the electronic driver stage of the SLED whenever the SLED is disabled. This guarantees that under no circumstances the driver board can generate any light output from the SLED as long as the SLED is disabled. Furthermore, this turn-on delay also guarantees a controlled power-up behavior of the board in case the supply voltage is cycled while the SLED is enabled.

(3): The default configuration of the EBD5100 board is optimized for lowest possible noise performance with modulation rates of a few Hertz. The modulation switch on the board supports modulation rates up to 10 MHz and the default OpAmps support modulation rates up to 30 kHz. Upon request customized versions of the EBD5100 can be realized that support faster modulation rates, for example up to 10 kHz, at the expense of higher current noise.

Table 8 Typical performance characteristics of the EBD5100

4 PACKAGED SLED DRIVER MODULE

The EBD5100 was designed as an OEM board to be used in various system environments. The EBD5100 is only available as a packaged module with an aluminum metal case, in which the driver board and the SLED module are assembled. The bottom part of the aluminum case will act as a heat sink for the optical SLED module. The bottom part also features fins for improved heat dissipation. Furthermore, the metal case was designed to be mounted vertically on a base plate of the corresponding system. This serves two purposes:

1. Improved thermal dissipation through air convection flowing vertically through the fins
2. Reduced consumption of floor space inside the system

Fig. 4, Fig. 5 and Fig. 6 show the metal case for the EBD5100 driver board assembly. The outer dimensions of this packaged module without the metal stands are 76 mm (L) x 61 mm (H) x 32 mm (W). The metal stands overhang the module by 11 mm on each side. As shown on Fig. 6, the metal case features a hole at the bottom side through which a screw driver can be inserted to change the potentiometer P1 for adjusting the SLED drive current. The top side of the metal case provides access to the connectors JP1, JP4 and JP5.

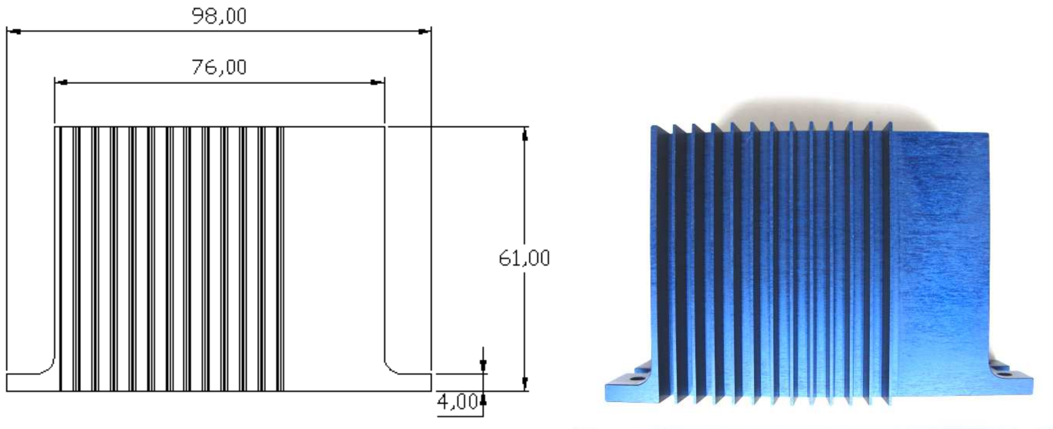

Fig. 4 Side view of the EBD5100 metal case: Mechanical drawing on left and photograph on right (fiber output is on right side).

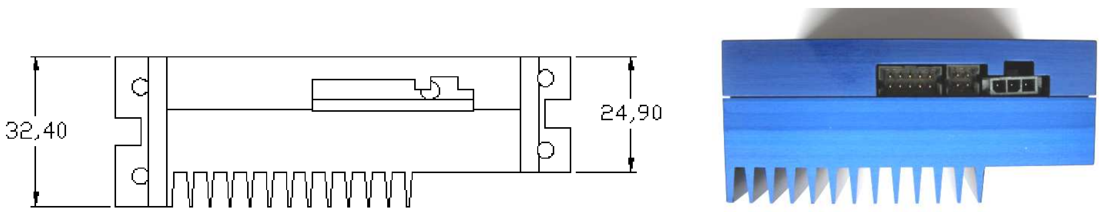

Fig. 5 Top view of the EBD5100 metal case: Mechanical drawing on left and photograph on right (fiber output is on right side).

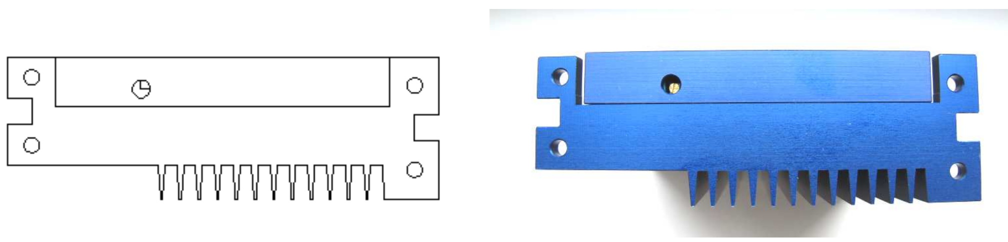

Fig. 6 Bottom view of the EBD5100 metal case: Mechanical drawing on left and photograph on right (fiber output is on left side).

In order to provide a shield against electro-magnetic interference (EMI), pin1 of JP1 shall be connected to PE through a short cable. Having a short contact to PE is essential to provide high-frequency shielding of the driver board and the mounted SLED. Internally, pin2 (GND of the supply voltage) and pin1 (PE contact) are shorted. Alternatively to a PE cable on pin1, the metal case can be mounted on a base plate that is on PE. It needs to be ensured that during the assembly of the case onto the base plate the non-conductive electroplated surface finish is scratched by the mounting screw, for example by using a jawed washer in between the screw and the metal case.

5 OPERATING INSTRUCTIONS

5.1 AMBIENT TEMPERATURE

Make sure the ambient operating temperature is within -20 °C to +65 °C, unless specified differently by EXALOS.

5.2 SUPPLY VOLTAGE

Make sure a stable supply voltage within 4.90 V to 5.20 V is applied with the correct polarity. Polarity inversion will not harm the SLED but might eventually result in damage of the on-board supply voltage filter network. For first testing it might be therefore useful to set the current limit to 1.5-2.0 A and monitor the LED0 indicator. The on-board 3A fuse has a current- and temperature-dependent pre-arcing time, i.e. lower current limits will result in longer pre-arcing times and hence more time for the user to react to accidental polarity inversion. The EBD5100 is not sensitive to noise of the supply voltage as it features various filter networks and ground decoupling stages as well as a spike and brown-out detector.

5.3 TEMPERATURE CONTROLLER (TEC)

For the default configuration of code switch S1 and for SLED modules featuring a Peltier element, the TEC is working as soon as a supply voltage is applied to the board. The TEC is a high-performance switched-mode controller that is working at an internal frequency of 1 MHz. Depending on the ambient temperature it may take a few seconds after turn-on of the board for the TEC to stabilize the SLED temperature. During this stabilization period the TEC may operate the Peltier element at a maximum current of 1.8 A, resulting in a high supply current. It is recommended to enable the SLED only when the TEC is in a stable condition, indicated through the temperature alarm (LED4 and pin4 of JP5) being off.

5.4 ENABLING THE SLED

The SLED is enabled and the optical power is turned on either by applying a 5V signal to pin3 of JP4 (active-HIGH) or by turning the code switch S1, for example to '1'. When using an electronic enable signal, e.g., 5V TTL, make sure that the voltage is relative to the GNDext on pin4 of JP4. Enabling the SLED will first power up all OpAmps of the driver stage before the optical power is turned on after a built-in time delay. The turn-on sequence guarantees proper operation of the driver board even when the power supply is hot-plugged though the SLED was enabled. This means that the SLED can be enabled with the drive current being set to the maximum level, i.e. it is not necessary to ramp up the drive current manually. Furthermore, the driver board generates a current ramp of several milliseconds at turn-on to avoid optical power overshoots. The time delay for the turn-on depends on the SLED drive current. For zero drive current the SLED will not be enabled (infinite time delay) while for maximum drive current the SLED will be enabled fastest.

5.5 ADJUSTING THE DRIVE CURRENT

The SLED current level can be either manually adjusted through the potentiometer P1 using a screwdriver (turning the screw counterclockwise increases the drive current) or through an analog control signal (AIN, 0 to +2.5V) applied to pin9 and pin10 of JP5. When adjusting the current level electronically, make sure that the analog control is enabled (AINenable, pin7 of JP5) or that the code switch S1 is in a position that enables the analog control, for example position '2'. When using an signal for AINenable, e.g., 5V TTL, make sure that the voltage is relative to the GNDext on pin6 of JP5.

The analog input voltage is limited to 2.5V on the board to ensure safe operation. AIN voltages larger than 2.5V are clipped and an alarm signal is enabled (LED3 and pin3 of JP5).

5.6 ON-OFF MODULATION

The SLED current can be turned on and off with a TTL modulation signal through pin1 of JP4. The logic is inverted, i.e. an open connection at pin1 or 0V (LOW) leaves the SLED on (optical power is HIGH) while 5V at pin1 (HIGH) turns the SLED off (optical power is LOW). When using an active modulation signal, e.g., 5V TTL, make sure that the voltage is relative to the GNDext on pin4 of JP4. Fig. 7 shows the modulation behavior and modulation bandwidth of the EBD5100 driver board in its standard configuration. The maximum modulation frequency is specified in Table 8.

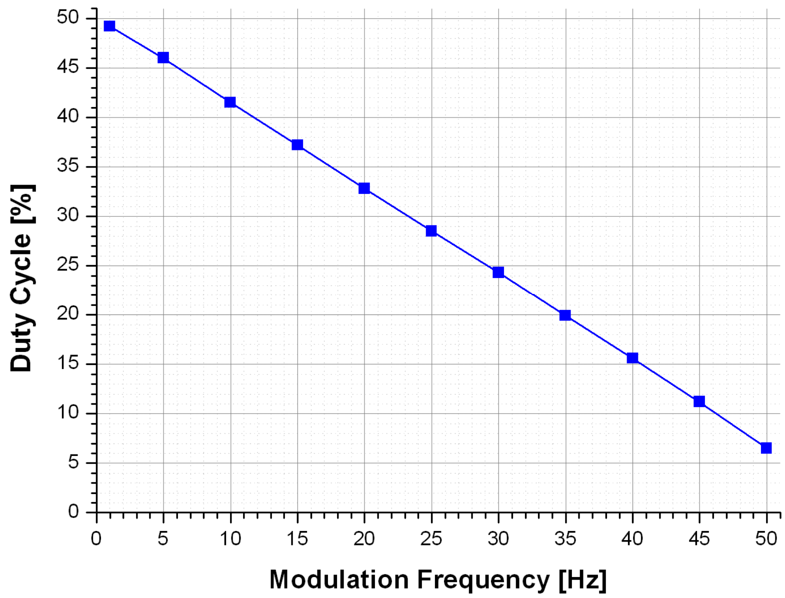

Fig. 7 Duty cycle of SLED current or optical output power for a TTL modulation input signal with 50% duty cycle as a function of modulation frequency for the standard configuration of the EBD5100. Because of the inverted logic of the modulation input this graphs also shows the required duty cycle of the electrical modulation input signal in order to achieve a 50% duty cycle for the optical output or SLED current.

Faster modulation frequencies may be realized upon request. However, faster current rise times can, in principle, lead to unwanted optical power transients if the rise time of the drive current is below ten microseconds. Therefore, EXALOS offers faster modulation rates only based on customer requests.

There is no intentional time delay or current ramp for the turn-on of the SLED under on-off modulation, different to the procedure of enabling the SLED. Turning off the SLED through pin1 of JP4 will also not power down the OpAmps of the driver stage.

5.7 ANALOG CURRENT MODULATION

The SLED current level and hence the optical power can be varied or modulated through pin9 and pin10 of JP5. The maximum modulation frequency is specified in Table 8. Faster modulation frequencies may be realized upon request.

5.8 OPEN-COLLECTOR OUTPUTS

Status and alarm indicators at JP5 are realized as open-collector outputs that are decoupled from the GND potentials of the EBD5100 driver board. According to Table 4, these digital outputs are "SLED_enabled" (pin1), "AIN_enabled" (pin2), "AIN_alarm" (pin3) and "Temperature_alarm" (pin4). In order, for example, to illuminate an external LED in the presence of an alarm, a minimum load has to be considered to limit the current through the open-collector opto-couplers on the EBD5100 board, as shown in Fig. 8. Positive external voltages (+U) in the range of 3V to 28V are acceptable as long as the current does not exceed 20 mA. For example, for a voltage +U=5V a minimum load R of 250 Ohms would be required. The external voltage +U shall be relative to GNDext at pin5 or pin6 of JP5.

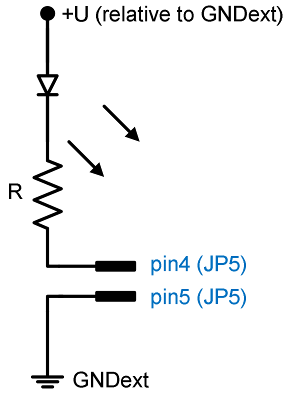

Fig. 8 Example of using an open-collector alarm output of JP5 to illuminate an external LED. The load R limits the current to max. 20 mA.

5.9 DISABLING THE SLED

In order to disable the SLED and hence the optical output apply 0V to pin3 of JP4 (active-HIGH). If the code switch S1 was previously used to enable the SLED then S1 may be switched back to the original position to disable the SLED while it is running, i.e. it is not required to turn down the drive current of the SLED before disabling it. When the SLED is disabled all OpAmps of the SLED driver stage are powered down as an additional safety feature. In case of loss of supply voltage before disabling it, the SLED is automatically and safely powered down.

5.10 HOT-PLUGGING THE SUPPLY VOLTAGE

As mentioned earlier the supply voltage of the EBD5100 can be hot-plugged while the SLED is enabled without harming the SLED. The SLED is safely powered up or powered down when the supply voltage is hot-plugged.

5.11 WARM-UP TIME

As any other electronics the EBD5100 has a warm-up time until, for example, the current drift during the turn-on phase is minimized. Typical warm-up time at 20 °C ambient temperature is 20 minutes.

6 REVISION HISTORY

Revision History				
Rev.	**Description**	**ECN Number**	**Date (ECN)**	**Released**
1.0	First full specification release	-	-	13.12.2010