DRIVER BOARD EBD5800

Product Specification Document

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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 EBD5800 for SLEDs (Super-Luminescent Emitting Diodes) in TOSA form factor.

1.2 BOARD REVISION

This product specification is based on the EBD5800 production series, revision V3.0.

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 LASER SAFETY

This driver board in combination with a SLED is an OEM, low-voltage, DC-powered laser component specifically designed for incorporation or integration into other equipment that is then sold as end product, i.e., as laser system that includes a power supply. As such, this component DOES NOT MEET the full requirements for a stand-alone laser system as defined by 21 CRF 1040.10 and IEC/EN 60825-1:2014.
During installation it is vital that the laser hazard is fully managed. In particular, the laser integrator (i.e., the manufacturer of the laser system as end product) is required to provision the engineering requirements detailed in Clause 4.0 of IEC/EN 60825-1, classify the end product (the laser system) and assure compliance with all clauses of IEC/EN 60825-1.

WARNING: If the OEM driver board is sold with an EXALOS SLED mounted, the laser class of the laser system as end product can be as high as Class 3B per IEC 60825-1:2014 depending on the SLED type. Refer to EXALOS' SLED specification documents for detailed information. For the safe use of the laser system, appropriate laser safety measures including protective equipment such as laser safety glasses may be required depending on SLED type mounted. Also follow the legal regulations on occupational safety in your country.

3 PRODUCT DESCRIPTION

3.1 ARCHITECTURE

The EBD5800 is a high-performance analog driver board that consists of a multi-layer PCB board on which the TOSA module is soldered. The multi-layer PCB design with shielding ground layers allows for 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.

3.2 FEATURES

The main characteristics of the EBD5800 are:

- 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 EBD5800 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 JP3.

3.3 OPERATING RANGE

The EBD5800 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 EBD5800 is -30 °C to +70 °C.

The EBD5800 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 EBD5800 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 an offset current. The maximum supply current is 1 A for a maximum SLED drive current of 600 mA. Typical supply current under operation might be significantly lower, depending on the SLED and ambient temperature.

3.4 ROHS COMPLIANCE

Based on the information obtained from our suppliers, the EBD5800 is compliant with the Restriction of Hazardous Substances (RoHS) directive 2011/65/EU and its subsequent amendments (including 2015/863/EU).

4 EBD5800 DRIVER BOARD

4.1 PRINTED CIRCUIT BOARD (PCB)

The EBD5800 board has a size of 55 mm (L) x 55 mm (W). Fig. 1 shows pictures of the front side of the EBD5800 board. Fig. 2 shows a schematic top view of the board and the names of connectors, switches, potentiometers and LED indicators.

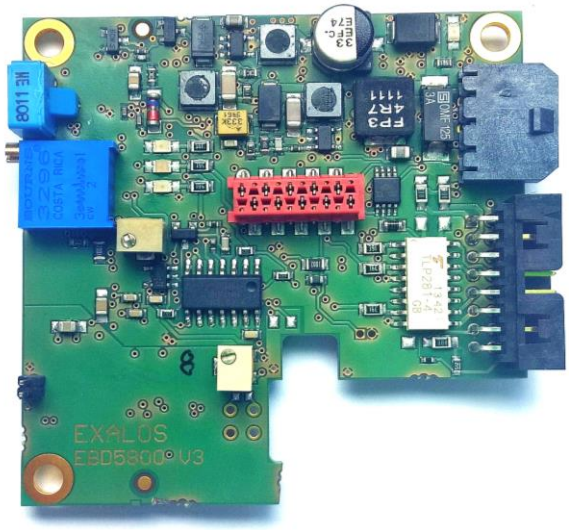

Fig. 1 Top view of the EBD5800 board

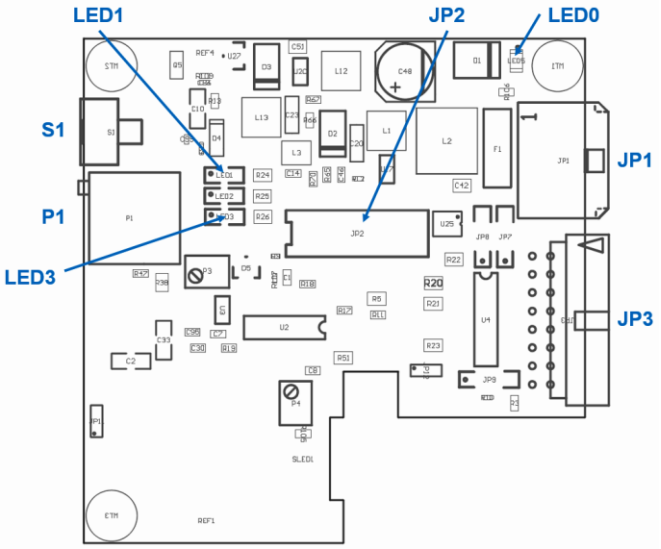

Fig. 2 Schematic top view of the EBD5800 indicating the user interfaces

4.2 ELECTRICAL USER INTERFACES

When the EBD5800 is, together with an SLED module, assembled into a metal case only connector JP1 and JP3 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 four LED indicators. Table 1 provides a list of all electrical connectors that belong to the user interface.

Name	Connector on EBD5800 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
JP3	MOLEX "Milli-Grid"; 87833-1620 Header (male)	SLED enable & on-off modulation, analog and digital input & output signals	MOLEX "Milli-Grid"; 51110-1651 Crimp Housing

Table 1 List of electrical connectors (user interface)

Fig. 3 shows the front view of the connector JP1 and JP3. The corresponding pinout information is listed in Table 2 and **Error! Reference source not found.**, respectively.

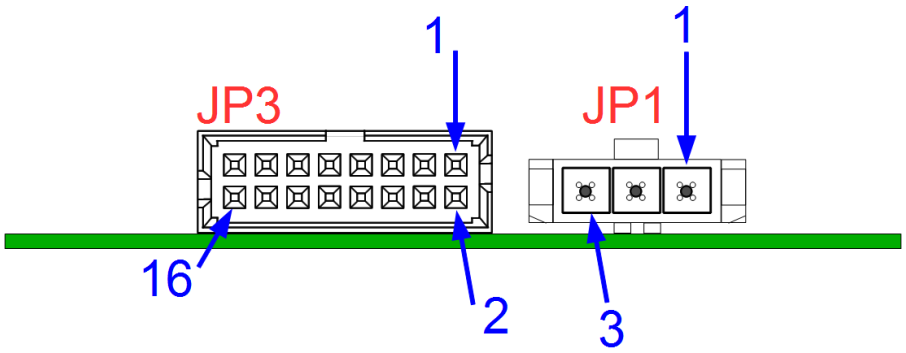

Fig. 3 Front view of header JP3 and JP1 with pin indication. The green bar indicates the PCB of the EBD5800.

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

Table 2 Pinout of header JP1

Pin	Name	Function	Description / Comment
1	Modulation	Input	5V TTL digital modulation signal
2	+5Vin	Output	5V supply voltage from JP1, for configuration purposes only, e.g., enable the SLED through short to pin3
3	SLEDenable	Input	5V TTL digital signal to enable/disable the SLED
4	GNDext	Output	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)
5	n/c	None	Not connected
6	n/c	None	Not connected
7	SLED_enabled	Output	Open-collector output indicating SLED is on
8	AIN_enabled	Output	Open-collector output indicating that SLED current is controlled through pin 15/pin 16
9	AIN_alarm	Output	Open-collector output indicating excessive analog input voltage at pin 15/pin 16 is applied and limited to +2.5V
10	Temperature	Output	Analog output signal indicating the temperature of the TOSA through an on-board NTC sensor
11	GNDext	Output	GND reference for pin 7, pin 8, pin 9, pin 10
12	GNDext	Output	GND reference for pin 7, pin 8, pin 9, pin10
13	AINenable	Input	Enable SLED current control through pin 15/pin 16
14	+5Vin	Output	5V supply voltage from JP1, for configuration purposes only, e.g., enable analog control through short to pin 13
15	+AINextern	Input	Analog input voltage (0-2.5V) to control SLED current
16	-AINextern	Input	GND reference of analog input signal (pin 15)

Table 3 Pinout of header JP3

Pin 7 to pin 9 contain 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 pin 11 and pin 12 of JP3. These alarm signals are also logically connected to the three LEDs that are found on the board. As shown in Table 4, the pinout sequence of JP3 matches the configuration sequence of the LED indicators.

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

Table 4 Configuration of LED indicators

Pin 13 to pin 16 of connector JP3 contain 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. Pin 159 and pin 1610 allow for applying an analog control voltage (0 to +2.5V) in order to control the SLED current and to use the EBD5800 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 5 Configuration table for code switch S1

Table 5 shows possible configurations of the EBD5800 that can be selected through the code switch S1. The last column can be ignored as it represents the different mode settings for boards having an on-board temperature controller (TEC), which is not the case for the EBD5800. The default configuration of S1 is '4', i.e. the SLED and the current control through an analog input signal is disabled. The SLED is turned off and can be turned on through an active-HIGH (5V) signal on pin 3 of JP3 or by switching the code switch S1 to '5'. The SLED current can be adjusted through the potentiometer P1.

Still, even in configuration '5' the SLED current can be adjusted electronically through pin 159 and pin 16 of JP3. In order to enable the control through an external analog signal an active-HIGH (5V) signal needs to be applied to pin 13 of JP3, for example by shortening pin 13 and pin 14. In this case the setting of potentiometer P1 is ignored.

4.3 OPERATING CONDITIONS

Table 6 shows the typical, minimum and maximum operating conditions of the EBD5800 driver board.

Parameter	Min.	Typ.	Max.
Supply Voltage	4.9 V	5.0 V	5.2 V
Supply current, SLED disabled		0.1 A	0.4 A
Supple current, SLED enabled (1)		0.4 A	1.0 A
Ambient operating temperature (2)	-30 °C		70 °C
Ambient storage temperature	-40 °C		85 °C

(1): Typical value at room temperature and SLEDs up to 250 mA. Larger than typical supply currents can occur for extreme ambient temperatures.
(2): Extended temperature range from -40°C to +85°C available upon request.

Table 6 Operating conditions of the EBD5800

4.4 PERFORMANCE CHARACTERISTICS

Table 7 shows the typical performance of an EBD5x00 driver board series 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	
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 EBD5800 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 EBD5800 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 EBD5800 can be realized that support faster modulation rates, for example up to 10 kHz, at the expense of higher current noise.

Table 7 Typical performance characteristics of the EBD5800

5 PACKAGED SLED DRIVER MODULE

The EBD5800 was designed as an OEM board to be used in various system environments. The EBD5800 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 EBD5800 driver board assembly. The outer dimensions of this packaged module without the metal stands are 61 mm (L) x 61 mm (H) x 29 mm (W). The metal stands overhang the module by 11 mm on each side, as shown in Fig. 4. At the bottom of the assembly, 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 side of the metal case provides access to the connectors JP1 and JP3 and to the optical fiber, as shown in Fig. 5.

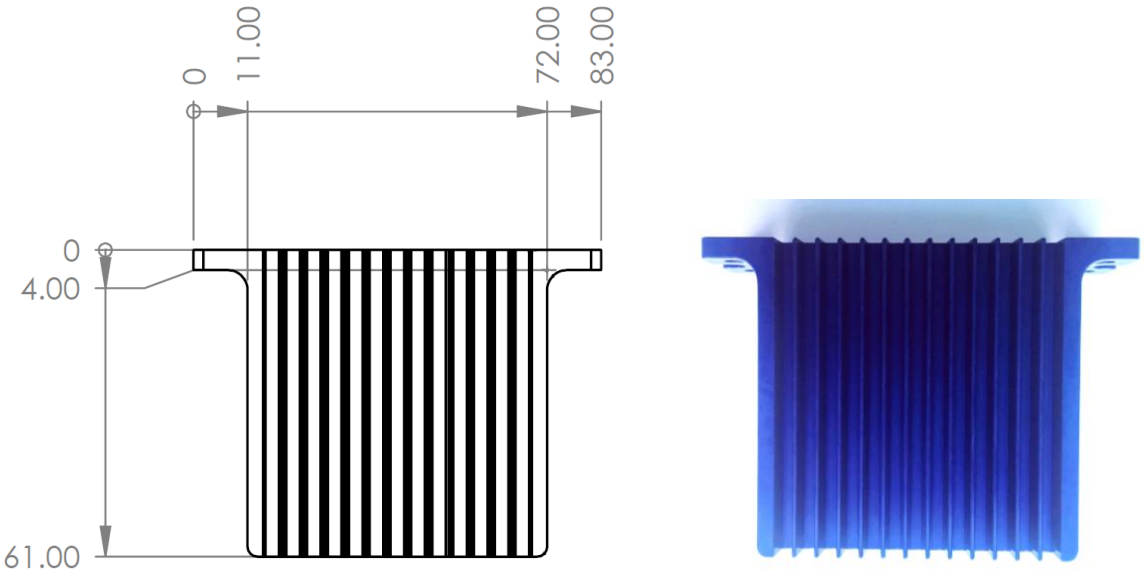

Fig. 4 Side view of the EBD5800 metal case: Mechanical drawing on left and photograph on right (fiber output is on right side).

Fig. 5 Another side view of the EBD5800 metal case showing fiber output and electrical connectors.

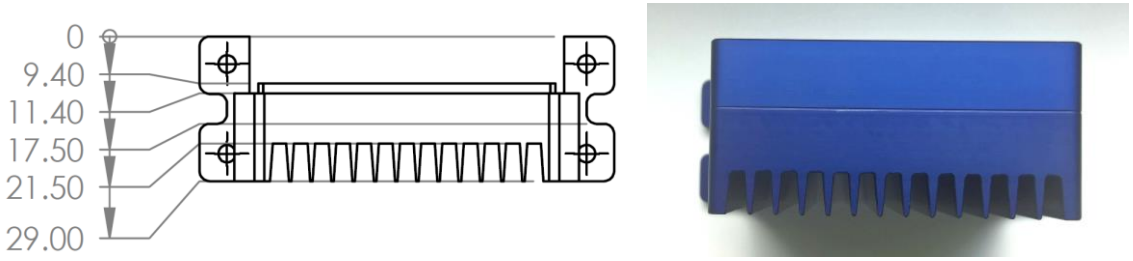

Fig. 6 Top view of metal case: Mechanical drawing on left and photograph on right.

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 toothed washer in between the screw and the metal case.

6 OPERATING INSTRUCTIONS

6.1 AMBIENT TEMPERATURE

Make sure the ambient operating temperature is within -30 °C to +70 °C, unless specified differently by EXALOS.

6.2 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 1.0 A. 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 EBD5800 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.

6.3 PROTECTIVE EARTH (PE)

Make sure to provide a low-impedance connection to protective earth in order to avoid unwanted and uncontrolled electro-static discharges (ESD). A PE connection can either be realized through a short cable connection at the power supply connector JP1 (pin 1) or through direct connection to the metal case. For the latter, a toothed washer could be used to remove locally the anodization and to realize a conductive connection to the PE of the surrounding system.

6.4 ENABLING THE SLED

The SLED is enabled and the optical power is turned on either by applying a 5V signal to pin 3 of JP3 (active-HIGH) or by turning the code switch S1, for example to '5'. When using an electronic enable signal, e.g., 5V TTL, make sure that the voltage is relative to the GNDext on pin 4 of JP3. 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.

6.5 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 pin 159 and pin 16 of JP3. When adjusting the current level electronically, make sure that the analog control is enabled (AINenable, pin 13 of JP3) or that the code switch S1 is in a position that enables the analog control, for example position '6'. When using a signal for AINenable, e.g., 5V TTL, make sure that the voltage is relative to the GNDext on pin 11 or pin 12 of JP3.

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 pin 9 of JP3).

6.6 ON-OFF MODULATION

The SLED current can be turned on and off with a TTL modulation signal through pin 1 of JP3. 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 pin 4 of JP3. Fig. 7 shows the modulation behavior and modulation bandwidth of the EBD5800 driver board in its standard configuration. The maximum modulation frequency is specified in Table 7.

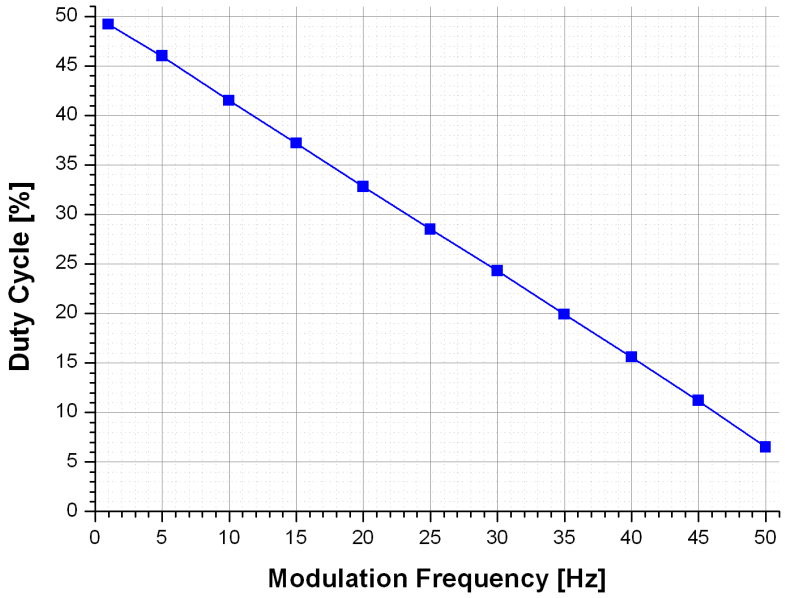

Fig. 7 Duty cycle of SLED current or optical output power for a TTL modulation input signal with 50% duty cycle as a function of modulation frequency for the standard configuration of the EBD5800. Because of the inverted logic of the modulation input this graphs also shows the required duty cycle of 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 pin 1 of JP3 will also not power down the OpAmps of the driver stage.

6.7 ANALOG CURRENT MODULATION

The SLED current level and hence the optical power can be varied or modulated through pin 159 and pin 16 of JP3. The maximum modulation frequency is specified in Table 7. Faster modulation frequencies may be realized upon request.

6.8 OPEN-COLLECTOR OUTPUTS

Status and alarm indicators at JP3 are realized as open-collector outputs that are decoupled from the GND potentials of the EBD5800 driver board. According to Table 3, these digital outputs are "SLED_enabled" (pin 7), "AIN_enabled" (pin 8) and "AIN_alarm" (pin 9). 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 EBD5800 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 pin 11 or pin 12 of JP3.

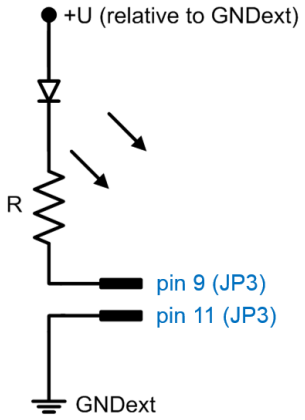

Fig. 8 Example of using an open-collector alarm output of JP3 to illuminate an external LED. The load R limits the current to max. 20 mA.

6.9 ANALOG TEMPERATURE OUTPUT

The EBD5800 also provides an analog output signal for the on-board temperature at pin 10 of JP3 through an on-board NTC sensor. At 25 °C the analog output voltage is 0.75V. It increases roughly linearly with higher temperatures and decreases with lower temperatures.

6.10 DISABLING THE SLED

In order to disable the SLED and hence the optical output apply 0V to pin3 of JP3 (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.

6.11 HOT-PLUGGING THE SUPPLY VOLTAGE

As mentioned earlier the supply voltage of the EBD5800 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.

6.12 WARM-UP TIME

As any other electronics the EBD5800 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.

7 REVISION HISTORY

Revision History				
Rev.	**Description**	**ECN Number**	**Date (ECN)**	**Released**
0.1	Initial document for EBD5800	-	-	05.11.2009
1.0	First full specification release	-	-	29.02.2012
1.1	Updated information on user interface connector due to new driver board version 3.0 of EBD5200 with 16-pin connector JP3 instead of JP4 and JP5; added information on power LED	EXS-EC-00868	25.06.2015	25.06.2015
1.2	Added section 2 about laser safety	1310	18.02.2021	P. Vorreau
1.3	Updated RoHS reference in section 3.4	1372	02.12.2021	P. Vorreau